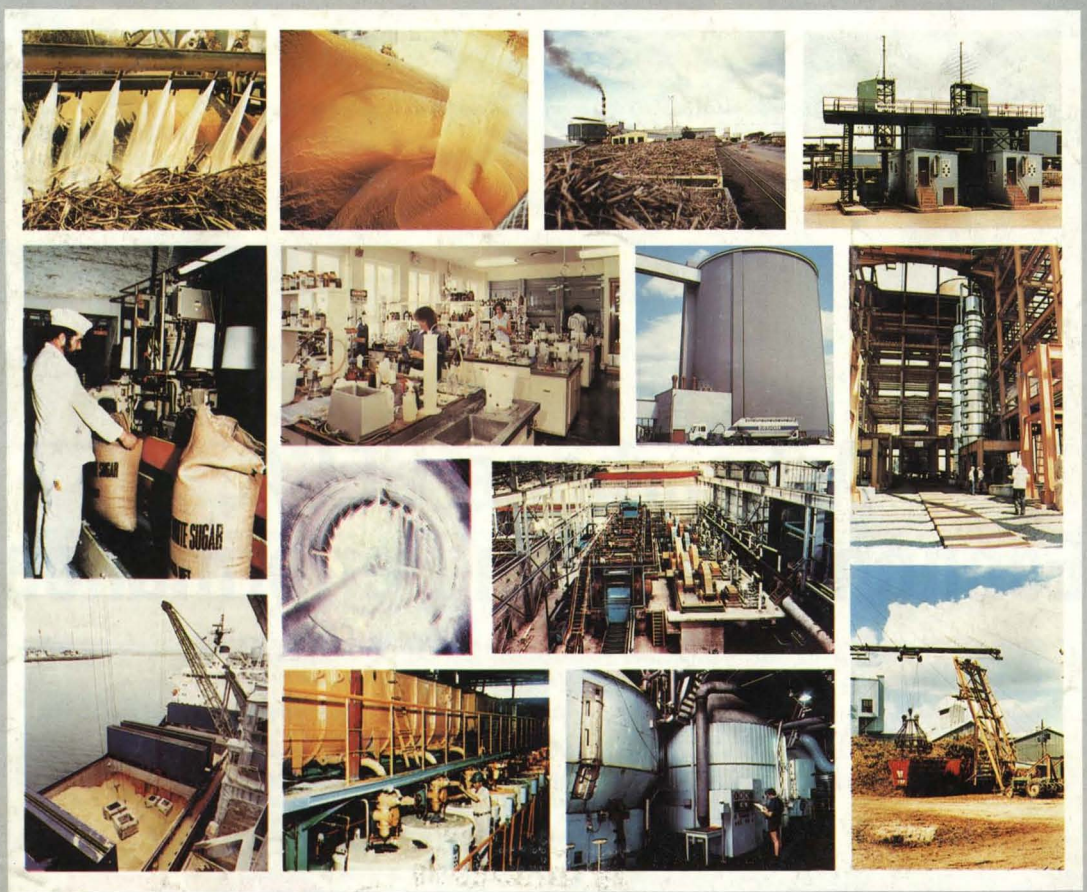
INTERNATIONAL SUGAR JOURNAL



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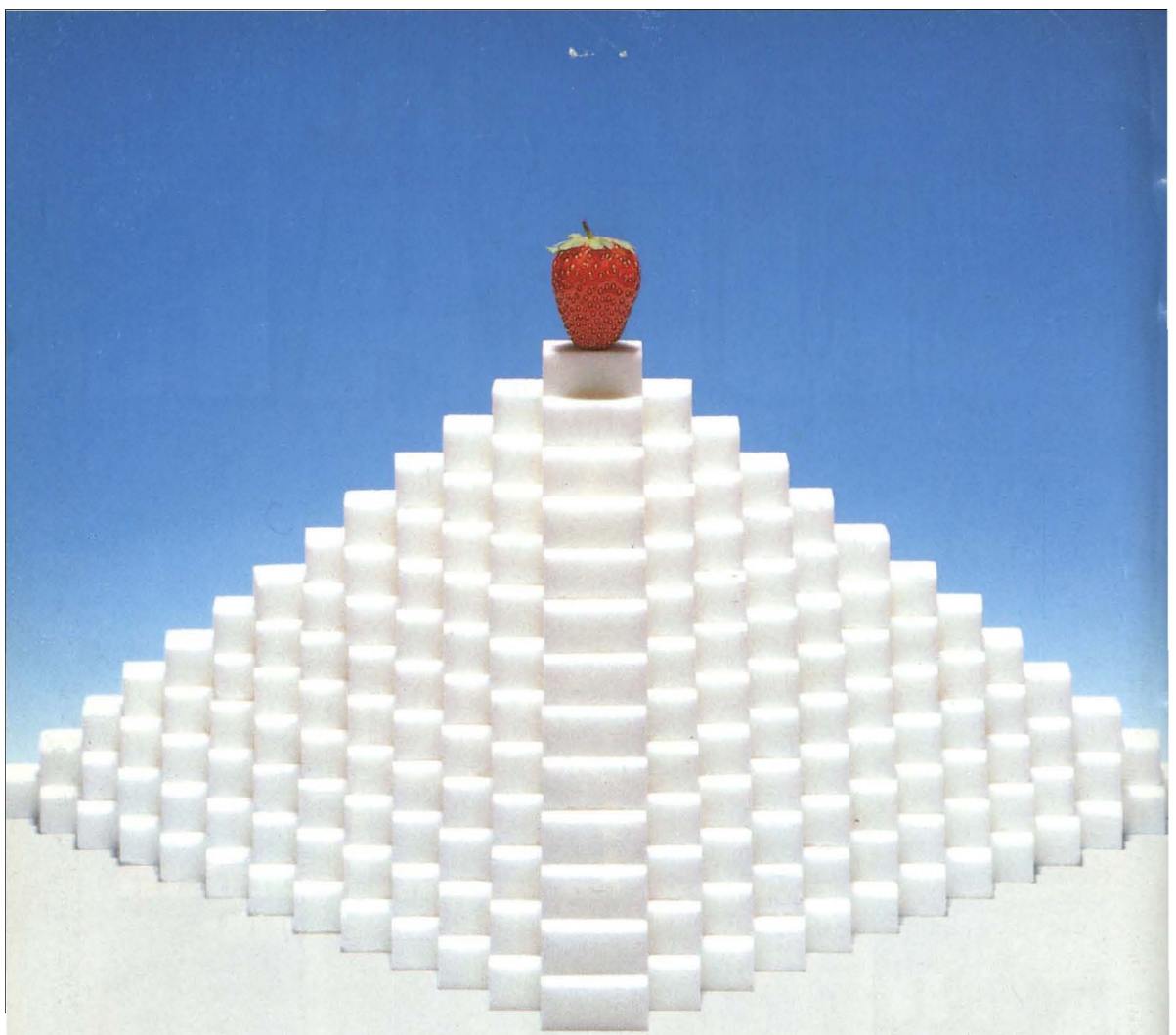

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CONTENTS

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News and views

World sugar prices

During much of August, the lack of news of purchases, especially those expected by India, caused a gradual downward trend in sugar prices, with occasional fluctuations. This trend was also the result of a realization from beet tests that the European beet crop was not going to be as badly affected by dry weather and aphids as had been expected. As a consequence, the London Daily Price for raw sugar, which started the month at $359.50 had fallen to $336 by August 21. At the same time the white sugar price fell from $505 to $487. An Indian tender for 200,000 tonnes lifted the LDP to $352.20 and the LDP(W) to $501, but the slide resumed and the LDP fell to $328 on September 6, thereafter fluctuating between $330 and $340 for a further week while the LDP(W) continued to weaken, reaching $421 on September 15.

A considerable number of news items then caused improvement in raw sugar prices; the US increased its sugar import quota, hurricane Hugo threatened crops in the Caribbean, and India finally bought some significant quantities of sugar with the likelihood of more purchases to follow, while the Brazil export quota was set at a much lower level than originally and Algeria bought sugar in volume. The LDP rose to $358 by September 28 but, in the absence of further end-user purchases, it then declined to end the month at $353, while the LDP(W) was carried to $433 on September 25 before declining to $412.

Europe 1989 beet area estimates

A further reduction has been made in F. O. Licht's estimates[1] of the area sown to beet for the 1989/90 crop, now put at a total of 7,063,000 hectares against the initial estimate of 7,203,000 ha and the 1988/89 figure of 6,963,000 ha. The estimates for Western Europe are unchanged but that for Eastern Europe has been reduced by 2.5%, with 90,000 ha less in the USSR.

Based on average yields, the area should produce an overall outturn of 31.1 million tonnes of white sugar but the EEC figure could be a million tonnes lower than in 1988/89, which could be critical for the white sugar market. To increase above last campaign would require good weather and no pests or diseases; while the weather has not been bad there has been a build-up of aphids and the threat of virus yellows is one which could affect sugar content.

HFS in Japan[2]

Japan is second only to the US in the production and use of high fructose syrup. Production grew from 84,000 tonnes, dry basis, in 1977/78 to an estimated 650,000 tonnes in 1987/88, according to Japan's Ministry of Agriculture, Forestry & Fisheries (MAFF). Growth was rapid in the late 1970's and early 1980's but in recent years has stabilized. Currently, about two-thirds of Japan's HFS goes into soft drinks and total HFS use represents about 20% of all caloric sweeteners consumed.

The price of HFS-55 during 1987/88 averaged 81.50 yen/kg (28 cents/lb) compared with 185.33 yen/kg (64 cents/lb) for refined sugar. HFS manufacturers change their prices mainly in relation to the delivered cost of corn, the imported raw material. HFS is considered competitive with sugar in Japan when its price is below one-half that of sugar.

Unlike the European Community, which strictly limits the growth of HFS through annual production quotas, Japan's policy allows HFS to expand. Expansion is constrained, however, by taxing HFS to support domestically grown sweeteners. Starting in 1982, for example, a surcharge was placed on HFS with the proceeds used to help finance the domestic sugar support program. The surcharge also makes sugar more price competitive with HFS. Since the surcharge was imposed there has been a recovery in sugar consumption and an end to the rapid growth of HFS use. This in part reflects the rapid market maturity achieved by HFS in the beverage industry.

Corn wet millers in Japan are also required by the MAFF to produce 1 tonne of starch from domestic potatoes for every 7.6 tonnes of starch produced from imported corn. Imports of corn for wet milling use above the blending ratio are subject to a prohibitive duty. By 1992 the ratio will be raised to 9:1 and the tariff reduced from 15,000 to 12,000 yen per tonne.

With growth of HFS production and use and doubling of domestic beet and cane sugar output to 950,000 tonnes as a result of high support prices, Japan has been able, over the past decade, to reduce sugar imports by nearly a third, from 2.6 million tonnes in 1979/80 to an estimated 1.8 million tonnes in 1988/89. Still, Japan in the late 1980's ranks as the world's third largest sugar import market, behind the USSR and China.

Europe beet sugar production, 1989/90

The first estimate by F. O. Licht GmbH of beet sugar production in the next campaign was published[3] at the end of August. It foresees a rise in output to 32,307,000 tonnes, raw value, from the 30,960,000 tonnes of 1988/89 which was itself reduced from the 31,700,000 tonnes of the previous two campaigns. Production in the EEC is expected to fall slightly, from 14,804,000 tonnes in 1988/89 to 14,657,000 tonnes in 1989/90; increases in Greece and recoveries in Holland, Italy, West Germany are more than offset by reductions in Belgium, Denmark, Spain and especially France. Austrian, Turkish and Yugoslavian production are expected to recover to more usual levels and consequently the figure for West Europe as a whole is set 337,000 tonnes higher, not a significant proportion.

East Europe estimates are, however, set higher in many cases than for 1988/89; rises are forecast for Bulgaria, Czechoslovakia, East Germany, Rumania and especially the USSR, so that

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 325 - 328.
2 *U.S.D.A. Sugar & Sweetener Situation & Outlook Rpt.*, June 1989, 14.
3 *Int. Sugar Rpt.*, 1989, **121**, 387 - 391.

around 1 million tonnes extra is expected from this group of countries. Licht remarks that the forecast increase should bring relief to the world market which is going through a phase of tight supplies. However, weather during harvesting always plays an important role in East Europe and, although the outlook is currently for a good crop, the weather factor remains a major uncertainty.

New tariff levels for Australian sugar imports[4]

After more than 12 months of continuous pressure from Australian cane sugar producers, the Australian Federal Minister for Primary Industries, John Kerin, has accepted grower demands for stiffer import tariffs. Originally, as reported earlier[5], it was proposed that the former sugar import embargo would be replaced on July 1, 1989, by a 35% *ad valorem* tariff which would be reduced to 15% over three years. The Australian industry argued that during times of low world prices this protection would not be adequate and in the end Kerin conceded higher specific duty rates which, after the three-year period, would translate into a 45% tariff if prices were low and the equivalent of a 20% tariff at current high prices. At both ends of the scale the specific tariff will provide a higher level of protection than originally proposed. A tariff of $Aus 115 per tonne came into force on July 1, and will be phased down to $Aus 70 per tonne by July 1, 1992. An inquiry will be conducted into long-term arrangements to apply thereafter.

World sugar balance, 1988/89[6]

The fourth estimate of the world sugar balance in 1988/89 by F. O. Licht GmbH shows a production of 104,925,000 tonnes, raw value and a consumption of 107,893,000 tonnes. With a difference of only 4000 tonnes between imports and exports, the consequence is a reduction from an initial stock of 33,321,000 tonnes to a final figure of 30,557,000 tonnes or only 28.37% of consumption, against 31.09 for the final stocks in August 1988.

Since the previous balance estimate, it has become clear that relatively high prices have taken their toll of consumption and this has been set at a lower figure, so that decreased production in Brazil, India and the USSR have not resulted in a smaller stock/consumption ratio. Even though stocks as a percentage of consumption have fallen below what was witnessed in 1980/81, when the average ISO daily price peaked at 41.09 cents/lb in October 1980, prices find it hard to break the 15 cents/lb barrier. As soon as prices approach this level potential buyers back off, which in turn causes prices to fall again.

Stocks have reached a perilously low level and initial projections for 1989/90 show a production of some 109 million tonnes against a potential demand of 110 million. Coupled with the usual gap between imports and exports of about 0.7 million tonnes, this could mean a further shortfall of 1.7 million tonnes. There are practically no surplus stocks left and it is uncertain how far countries are willing to cut into pipeline stocks.

Drawdown of stocks may be lower if governments in the developing world curtail domestic consumption in the face of high prices. Although prices will continue to fluctuate and the peak of the current upward trend may not have been reached, it is not likely that they will reach the levels seen in 1980, owing to the profound structural changes than have taken place in the past ten years.

US sugar crop forecasts

In August, the US Department of Agriculture estimated[7] that the area of sugar beet for the 1989/90 campaign will rise by 1.7% from 1,300,700 acres in 1988 to 1,322,100 acres. The crop estimate for 1989 was 26,615,000 short tons, against 24,810,000 tons in 1988. The 1989 crop forecast was reduced in September[8], however, to 26,495,000 tonnes. Applying the average recovery rate for the past two years (14.2%) would result in a beet sugar output of 3,762,000 tons while applying the 5-year average of 13.68% would give 3,624,500 tons. Both are considerably lower than the 3.9 million short tons projected earlier by the Department; however, the latter is likely to have to be amended owing to drought affecting part of the Red River Valley.

The sugar cane area in Florida continues its steady increase and is set at 423,000 acres against 421,000 in 1988; the cane crop is expected to rise from 13,304,000 tons to 13,959,000 tons. Good weather in Louisiana, coupled with an increase from 305,000 to 320,000 acres, is set to give a record crop of 8,640,000 tonnes of cane against 7,708,000 tons in 1988.

Dry weather in Texas is expected to reduce yields so that cane output is expected to fall to 1,035,000 tons (from 35,700 acres) against 1,088,000 tons from 33,200 acres. Weather related problems are also likely to reduce yields in Hawaii so that, coupled with a fall in area from 86,100 to 84,000 acres, the crop is forecast to fall from 7,804,000 to 7,182,000 tons. The estimate of cane sugar production remains unchanged from the earlier one of 3.4 million tons.

US sugar quota increase

On September 12 the US Secretary of Agriculture announced that the import quota for sugar had been increased by just over 860,000 tonnes, raw value, from 1,125,255 tonnes to 1,986,950 tonnes. He also announced that the 1989 quota period was extended by nine months from calendar 1989 to a period from January 1, 1989 to September 30, 1990. The change put quota shipments for the 21-months period at a somewhat higher level on a 12-months equivalent basis than the previous quota. Total authorized quota shipments are equal to the sum of the specialty sugar quota (1815 tonnes), the minimum quota allocations, the quota adjustment amount (94,117 tonnes) and the base quota amount (1,860,000 tonnes) minus certain adjustments in the last.

4 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 372.
5 *I.S.J.*, 1988, **90**, 171.
6 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 405 - 413.
7 *Czarnikow Sugar Review*, 1989, (1788), 124.
8 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 446.

The change in the quota was an action independent of the recent panel finding that found import quotas to be inconsistent with the GATT. The Secretary said: "We are continuing to look at the options for bringing these quotas into conformity with the GATT, but a decision on how to do that has not been made. In the interim, this modification of the import quota and the quota period is necessary to correct for a tightness in (the US) sugar market, particularly during the last quarter of this calendar year".

The new country-by-country allocations, in tonnes, raw value, for January 1, 1989 to September 30, 1990 are listed below; they include a reallocation of Panama's initial quota of 30,537 tonnes and leave 23,403 tonnes unallocated and not yet authorized for shipment to the US. The latter amount may be allocated to other countries in due course.

Argentina	81,366
Australia	157,056
Barbados	13,246
Belize	20,815
Bolivia	15,138
Brazil	274,375
Canada	20,815
Colombia	45,414
Congo	12,500
Costa Rica	38,468.5
Dominican Republic	333,035
Ecuador	20,815
Fiji	16,966
Gabon	12,500
Guatemala	90,828
Guyana	22,707
Haiti	12,500
Honduras	36,401.8
India	15,138
Ivory Coast	12,500
Jamaica	20,815
Madagascar	12,500
Malawi	18,826
Mauritius	22,675
Mexico	12,500
Mozambique	244,599
Papua New Guinea	12,500
Paraguay	12,500
Peru	77,582
Philippines	298,975
St. Kitts	12,500
El Salvador	55,248.7
Taiwan	22,707
Thailand	26,491
Trinidad	13,246
Uruguay	12,500
Zimbabwe	22,707

Fuel alcohol project approved in South Africa

After a decade of research and development and negotiation, the South African Government has given the green light to a fuel alcohol project of the South African sugar industry. It is part of a substantial expansion and deregulation package announced earlier[9], which will allow small (mainly black) growers to increase production and new small growers to enter the industry, mainly in KwaZulu and KaNgwane and will create 20,000 new jobs supporting 100,000 people directly in these areas. As part of the package, small growers will receive preferential A-pool price for their cane deliveries and within 30 km of their mill will have no restriction on their production.

The 120 million Rand distillery will provide 150 million litres a year of alcohol, sufficient to create a blend similar to gasohol in the province of Natal. When the project is on stream in 1992 the whole of the Transvaal Sasol supply area, Natal and the Eastern Cape will have gasohol. Corrosion and octane enhancement tests have been conducted with the help of the Energy Research Institute at the University of Cape Town with satisfactory results. Alcohol will assist in the program to reduce lead and an environmental impact study by the Environmental Evaluation Unit at the University has been commissioned.

It is not intended to follow Brazil into the running of cars on pure alcohol; at the moment it is intended to limit alcohol to 10% of the fuel blend. The project is a fully private enterprise, with the South African Sugar Association constructing the plant at Richards Bay. The only delay now is establishing the financing arrangements between the sugar industry and the government to bring the cost of alcohol into line with other fuels.

Announcing the government's decision, Mr. George Bartlett, Deputy Minister of Economic Affairs and Technology (and formerly of Illovo Sugar Company) said that expansion of new cane areas in the Onderburg and KaNgwane and at Pongola, subject to the availability of irrigation water, could enable the erection of a new sugar factory. The expansion of cane growing, especially by small farmers would encourage development of other crops, help substitute a cash-based economy for subsistence farming, improve the infrastructure of the region and help reduce the urban drift of the population.

International Sugar Organization

While member countries make no progress towards establishing an Agreement with economic clauses, the function of the International Sugar Organization as a forum and a source of information increases in importance. A meeting of the Market Evaluation, Consumption and Statistics Committee of the ISO was held in September to review the world sugar economy in 1988 and to examine the situation in 1989. The market for white sugar on a country-by-country basis was examined as was the importance of sugar earnings. Details of its sugar policy and arrangements were submitted in a paper by the US and this will be discussed at the meeting of the Committee in November in the presence of an official from Washington; a similar paper will be submitted by the EEC in November for discussion at the February 1990 meeting.

Australian raw sugar sales arrangements[10]

The Sugar Board and CSR Limited agreed on new arrangements for marketing raw sugar following deregulation at the beginning of July; these are that the Queensland government will still acquire all raw sugar produced in Queensland but the Sugar Board will sell it to buyers on the domestic market in Australia and New Zealand (including CSR and Millaquin refineries.) However, CSR will retain its position as the Board's sole agent for raw sugar export marketing.

9 *I.S.J.*, 1989, **91**, 122.
10 *Australian Canegrower*, 1989, **11**, (13), 2.

Product news

Enzyme suppliers merger

A merger of Novo Industri A/S and Nordisk Gentofte A/S has taken place, and the name of the new company is Novo-Nordisk A/S. Its address will be the same as for Novo Industri, viz. Novo Allé, DK-2880 Bagsvaerd, Denmark, while the new telephone number for Novo-Nordisk A/S is +45-4449-0033.

Non-asbestos braided packings guide

The Merkel range of non-asbestos braided packings is detailed in a new 32-page product guide which lists the products available, and their respective operating conditions with regard to pressure, speed, temperature and pH value. It illustrates how they should be installed, with diagrams showing typical applications, lists the packings to be used in relation to the media, and their use in pumps, agitators, etc. and valves. The guide will be particularly useful to engineers in the sugar industry, where the main Merkel non-asbestos packings used are Ramilon 4586 and Univerdit 7000 for pumps and agitators, and Arostat 6204 for valves. The guide is available free on request from F.T.L Fluid Seals Ltd., Howley Park Road, Morley, Leeds LS27 0BN, England.

New mould resistant coatings

The need to maintain constantly high standards of hygiene often pose considerable problems. High relative humidity together with the presence of organic substances provide an ideal environment for the development of mould and organic growth. As an extension to its range of Labour Saver coatings Rust-Oleum have introduced a fast-drying, mould-resistant coating system which helps to solve these problems. Particularly in plants with continuous processing this new system can simplify maintenance and improve standards of hygiene. The new, mould-resistant coatings have been formulated with a plasticized vinyl acrylic binder, low-odour aliphatic hydrocarbons as solvents, and special fungicides. The binder ensures excellent colour retention; painted white, a wall will not yellow under the influence of light or frequent cleaning. The new coating is resistant to alkali; even frequent chemical cleaning does not affect the coatings and the special fungicides are not washed out. Thus, long-lasting mould resistance and an extended service life can be expected. As there are no aromatic solvents the coating produces minimum odour during application. Ease of application is another time and money saving aspect. The coatings can be applied by brush, roller or spray.

Further details:

Rust-Oleum Corporation,
P.O. Box 138,
4700 AC Roosendaal,
Holland.

New TKL pump buyer's guide

Australia's major pump maker, Thompsons, Kelly & Lewis Ltd., has released its latest catalogue, a 22-page product directory to enable potential buyers to identify the right pump for their needs. The guide covers the full TKL range of more than 50 basic pump types, in categories which range from radially split centrifugal pumps, axially split and multistage versions, to vertical sump and multistage pumps, self-priming pumps, sewage, slurry and positive displacement pumps. Each pump is illustrated and accompanied by a brief specification, as well as a summary of its features, benefits and applications. Copies are available from TKL's Marketing Services Dept., P.O. Box 160, Springvale, Vic., Australia 3171.

New heavy duty sack closing machines

The essential feature of the Doboy model D 97 HD is that the sewing head operates in the same manner as the slower model D 95 stitcher using the well-proven and trouble-free swing-needle principle. The D 97 HD heavy machine is equipped with roller bearings and is oil lubricated, resulting in very smooth operation and a much longer machine life. Of equal importance, the unique sack transportation system does not place any grip marks on the outer edges of the sacks, thus ensuring that they remain clean and in good condition.

Further details:

Doboy Ltd.,
Middlefield Industrial Estate,
Sunderland Road,
Sandy, Beds. SG19 1RB,
England.

New temperature transmitter

Moore Industries have announced a new high-performance 2-wire, isolated, characterized thermocouple transmitter. The Model TIX is intended for accurate temperature measurement in the food and other industries. It accepts thermocouple inputs direct, and provides a linear, isolated, loop powered 4-20 mA output for use with indicators, recorders, controllers, PLC's and control computers. Models are available to work with most thermocouples including K and T types. The type T versions cover the ranges –100°C to +100°C and 0 - 200°C. Accuracy of the model TIX is exceptionally high at 0.05% of span, making it suitable for even the most critical applications. Two alternative housings are offered, DIN rail and sensor head mounting, the latter offered both separately and as part of a complete range of temperature sensor assemblies which include stainless steel pockets and a wide range of fittings. The DIN rail mounting version is intended for high density control room applications and occupies only 36 mm of rail width. Other products from Moore Industries include a complementary resistance thermometer transmitter, transmitters for flow, power and most process parameters, plus P/I and I/P converters for interfacing control systems to pneumatic valves.

Further details:

Moore Industries,
18 Royce Road,
Crawley, W. Sussex RH10 2NX,
England.

Sugar grain size calculation methods
Part II. Comparison of results with raw sugar

By José A. Urrutia and Julián Rodríguez
(Cuban Sugar Research Institute ICINAZ, Havana, Cuba)

Introduction

On a worldwide scale, over the past two decades, two calculation methods and one graphical method for grain size determination have come forth to compete with the more widespread method of Powers[1]; they are discussed in the first part of this paper[2]. For raw sugars, however, only a comparison in Mauritius of the above-mentioned method with that of Butler[3] has been reported[4].

The limited publications of methods for this product, in contrast to those for white sugars[5,6], lies in the lack of agreement at ICUMSA on the procedure for separating syrup from crystals. In 1970 the Referee for Subject 27 recommended the Hawaiian procedure[7], based on methanol/iso-propanol washing followed by drying for 3 hours. At a meeting of the international committee for ICUMSA Subject 19 in 1974 the Cuban Referee called attention to the formation of conglomerates and proposed the variant of 50°C temperature and 15 minutes drying, respectively[8]. Fifteen years later, the issue still remains outstanding[9,10].

In the present work a crystal cleaning method is used based on three contacts with sucrose-saturated ethanol and drying at ambient temperature on filter paper, which minimizes the possibility of conglomerate formation with slow solvent evaporation. Once this problem was solved, a comparison was made of the results obtained with the four methods and with some variants thereof.

Experimental

Sample preparation

120 g of raw sugar is placed in a 500 cm^3 Erlenmeyer flask, 150 cm^3 of sucrose-saturated ethanol is added and the flask covered. After agitating with an arm stirrer for 5 minutes, the solvent is allowed to settle. The operation is repeated twice more, draining as much solvent as possible the last time. The sugar is spread on a 50-cm dia. filter paper for 1 hour, stirring with stirrer or

J. A. Urrutia J. Rodríguez

spatula, especially when wet, to prevent conglomerate formation.

Sieving

100 g of the dried, syrup-free sugar is weighed onto the largest size (1.6 mm) sieve below which are, in descending order, 1.2, 1.0, 0.8, 0.63 mm DIN Series (or equivalent) sieves. After fitting the top cover and bottom tray, the sample is sieved in a Ro-Tap machine during 10 minutes. The sieves, previously tared, are separated and weighed one by one to within 0.1 g accuracy.

MA and dispersion values

From the distributions by weight of sugar on the various screens, calculations for each method were made as follows:

MA/CV of Powers[3]: The mean aperture (MA) and coefficient of variation (CV) were determined according to the ICUMSA-recommended method, i.e., by plotting the cumulative percentage of sugar held on the nest of sieves against the aperture of each of them on an arithmetical probability graph. Values above 90 and below 10 were discarded.

Numerical Powers: Such was the name assigned to a variant, to be discussed in detail in the third part of this series[11] and based on the cumulative percentage values held on one given sieve in variable Z, deviation (given in fractions of the standard deviation) of the cumulative percentage from the mean. This variable is taken as the dependent variable *versus* the sieve aperture size in mm and an equation of the type Z = mx + b is obtained. From it, the mean aperture (Z = 0) is calculated; the coefficient of variation is found, in turn, by the formula:

$$CV = (X_{z=-1} - X_{z=+1})/2X_{z=0}$$

Butler: The mean aperture (MA) and coefficient of variation (CV) were obtained by the method described in the *Proceedings* of the 16th ICUMSA Session, in 1974[3].

Corrected Butler: The proposed modification uses directly for calculation the aperture of the sieve retaining the sugar fraction, in contrast to the classical Butler procedure which employs for calculation the mean value between the next to the largest sieve aperture and the aperture of the sieve retaining the sugar fraction.

Rens: This author's instructions[12] were followed in this work; furthermore, the correlation coefficient for each analysed sample was obtained.

Numerical Rosin-Rammler-Bennet: Taking as a basis the principle used by these authors[13], the values of d′ and n were calculated numerically using the equation:

$$100/R = e^{(d/d')n} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where R = residual percentage held on a given sieve for a particle size >d; d = sieve aperture (mm) holding residue R; and d′ and n are parameters characterizing the screened particle distribution.

By applying logarithms the following equation is obtained:

$$\log \log 100/R = n \log d + b \quad \ldots \quad (2)$$

where b is log log e – n log d′.
If a graph is drawn of log log (100/R) *versus* log d, a straight line results the slope of which is n while the value of d′ can be obtained by means of the independent term.

1 *I.S.J.*, 1948, **50**, 149 - 150.
2 Rodríguez & Urrutia: *Centro Azúcar*, in press.
3 *Proc. 16th Session ICUMSA*, 1974, 262 - 263.
4 Vignes: *Proc. 16th Congr. ISSCT*, 1977, 2563 - 2568.
5 *Proc. 18th Session ICUMSA*, 1982, 330 - 351.
6 *Proc. 19th Session ICUMSA*, 1986, 353 - 349.
7 Payne: "Sugar cane factory control" (Elsevier, Amsterdam) 1968.
8 Ortega: *Proc. 16th Session ICUMSA*, 1974, 362.
9 *Proc. 18th Session ICUMSA*, 1982, Subject 27.
10 *Proc. 19th Session ICUMSA*, 1986, Subject 27.
11 Rodríguez & Urrutia: In press.
12 *Sucr. Belge*, 1978, **97**, 169 - 174.
13 Schiweck: *Zucker*, 1967, **20**, 33 - 34.

Unlike the original method, the values of sieve aperture corresponding to 50% retention of the original weight of screened sugar were calculated. Calculations of this index and of n were made from an adjustment by least squares of equation 2. Additionally, the correlation coefficient was determined.

Study of the dispersion of the values obtained by the various methods

The mean aperture and coefficient of variation (or n) for each of the 5 samples were determined fivefold, as described above under Powers, Butler, Rens and Numerical RRB. The mean and standard deviation were calculated, with the values of mean aperture (MA) and coefficient of variation (CV) for each sample.

The mean standard deviation for each method for the indices mentioned above were obtained from the square root of the sum of the variances of each sample divided by the number of samples.

Discussion

The first aspect considered within the comparison of methods was the kind of influence that the method of calculation could have on the dispersion of the values obtained and determination of the number of significant digits by which results should be expressed.

The mean aperture values obtained show very similar dispersion, as may be seen in Table I, through the mean standard deviation $\overline{S}$ of each method. While of the same order, dispersion of the Rens method is slightly higher. In all cases, results may be expressed with three significant digits.

From the results of Table II it may be inferred that, although the Butler and Rens methods are more precise, according to their lower mean coefficient of variation, differences however are very small. Generally, both CV and n values can be expressed with two significant figures.

Comparison of results obtained by various methods: Mean Aperture (MA)

Table I. Variability of the mean aperture determination data obtained by various methods (Standard deviation values appear in parentheses)

Sample	Butler	Rens	Numerical RRB	Powers
1	1.04 (0.03)	1.02 (0.02)	1.02 (0.02)	1.01 (0.02)
2	1.14 (0.02)	1.07 (0.02)	1.07 (0.02)	1.07 (0.02)
3	0.94 (0.03)	0.89 (0.04)	0.89 (0.03)	0.89 (0.02)
4	1.00 (0.01)	0.96 (0.03)	0.96 (0.03)	0.96 (0.03)
5	1.07 (0.01)	1.04 (0.01)	1.04 (0.01)	1.02 (0.01)
$\overline{S}$	(0.020)	(0.024)	(0.022)	(0.021)

Table II. Dispersion of the coefficient of variation (CV) values obtained by various methods (Standard deviation values shown in parentheses)

Sample	Butler	Rens	Numerical RRB	Powers
1	23.0 (1.8)	33.0 (2.4)	3.4 (0.41)	33.0 (2.4)
2	22.6 (0.7)	31.0 (1.9)	3.7 (0.2)	32.0 (2.6)
3	24.3 (0.6)	31.0 (1.4)	3.7 (0.2)	30.0 (2.2)
4	24.9 (0.6)	32.0 (1.1)	3.4 (0.1)	32.0 (1.9)
5	19.3 (0.3)	21.6 (0.2)	5.7 (0.15)	21.0 (0.76)
$\overline{S}$	(1.2)	(1.6)	(0.26)	(2.1)
$\overline{CV}$	(5.3)	(5.3)	(6.5)	(7.1)

Table III shows average results, and their dispersion, obtained by calculation of this index for samples from different sources by the corrected Butler and numerical Powers methods besides the four used in determining variability.

The values obtained by the various methods are of the same order, which is corroborated by the finding of no significant difference in an analysis of variance that was carried out. If subjected, however, to a more rigorous examination as, for example, the Student test for paired samples (see Table IV), it is found that the Butler results are equal only to those obtained by its numerical homologue.

Table III. Mean values of 33 mean aperture determinations by various methods

Index	Mean of mean aperture	Standard deviation
Corrected Butler	1.05	0.11
Butler	1.07	0.07
Rens	1.02	0.12
Numerical RRB	1.03	0.13
Powers	1.02	0.13
Numerical Powers	1.02	0.12

This result does not agree with those of Vignes on Mauritius raws[4]. It does agree, however, with the highest Butler values in comparison with those of Rens and Powers as reported by Hibbert for white sugars in his paper to the 18th Session[5]. The explanation is found in the principle of the method which takes as sieve size the mean between that retaining the sugar and the top one. The *corrected* Butler method was aimed precisely at correcting this situation but the values obtained are reduced only by 20 microns. This fact makes them different from the other four methods, as may be seen in Table IV, by comparing the results obtained with its

Table IV. Result of the 't' test for paired samples on the mean aperture values obtained by various methods

Compared methods	Mean difference	Difference standard deviation	Calculated 't'	't' 95%/30	't' 99%/30
Butler-Powers	0.051	0.065	4.48	2.04	2.75
Butler-numerical RRB	0.045	0.069	3.75		
Butler-Corrected Butler	0.0045	0.047	0.55		
Corrected Butler-Numerical RRB	0.028	0.043	3.86		
Numerical RRB-Powers	0.006	0.016	2.15		

next finer method (numerical RRB), ruling out its use also with raws.

It may also been seen that the mean aperture values obtained by the numerical RRB method show significant differences with respect to Powers, to within 95% reliability. The two methods are not significantly different, however, with 99% confidence limits and their mean difference is under the average level of the dispersion brought about by repetition of the methods (0.02 mm) shown in Table I. From this, one can regard the difference as not significant and the results of the numerical RRB method to be equivalent to those given by Rens and the two Powers variants as regards mean aperture.

The above analysis confirms the equivalence between the MA results obtained from the procedures of Powers and Rens for white sugar[6]. Included in the list are the numerical variants of Powers and RRB, the latter in changing the approach of reporting the d' (50%) as the others do instead of the d' (36.5%).

Coefficient of Variation

The average CV results of the six methods show differences between one another according to the variance analysis carried out (Table V). The complementary Scheefe Test[14] yields significant differences between CV's of the Butler method and the results of the Rens method which are the nearest to it, unlike the comparison between the two ends of the other five (corrected Butler and Rens), as evidenced in Table VI, which indicates equivalence between its results.

Additionally, the values of n were related, through linear equations, to the CV results of the remaining five. According to the data of Table VII, they possess a significant reverse relation with all except the two Butler variants.

In brief, it can be affirmed that, as in the papers submitted on white sugars[6], the CV's obtained by Rens and Powers are equivalent to one another and, in turn, agree with those yielded by the numerical variant of Powers and corrected Butler. Additionally, the values of n can be converted to CV's, calculated by the two variants of the Rens and Powers methods.

Table V. Mean values of 33 CV (or n) determinations by various procedures

Index	Mean	Standard deviation
Corrected Butler	34.0	2.4
Butler	24.0	2.0
Rens	32.0	6.7
Numerical RRB (n)	3.7	0.68
Powers	33.0	7.8
Numerical Powers	33.0	4.2

Table VI. Comparison of means to determine the sources of significance of a variance analysis[14]

Compared methods	Butler-Rens	Corrected Butler-Rens
Difference between their values	8.0	2.0
Experimental F value	42.8	1.9
F 95%	2.27	
F 99%	3.14	

Table VII. Correlation coefficients (r); slopes (m) and intercepts (b) obtained by adjusting to a straight line by the least squares method, the results of n (Numerical RRB) as the dependent variable *vs.* the coefficients of variation (CV) yielded by the other five

Method	r	m	b	r 95/30	r 99.9/30
Powers	–0.709	–8.1210	63.26	0.349	0.554
Rens	–0.634	–6.2865	56.02		
Numerical Powers	–0.849	–5.8348	59.93		
Butler	–0.011				
Corrected Butler	–0.059				

Table VIII. Average correlation coefficient ($\bar{r}$) of 33 grain size determinations using three numerical methods

Method	$\bar{r}$	$\bar{r}$ 95/30	$\bar{r}$ 99/30
Powers	0.9798	0.349	0.554
Rens	0.9797		
RRB	0.9825		

Validity of the principles on which the methods for Cuban raw sugar samples are based

Lastly, an analysis was made of the adjustment of crystal size distribution of our raws to the principles on which the Powers, Rens and RRB methods are based, since the three methods possess numerical variants which allow calculation of the correlation coefficient of the equations used for the calculation of the mean aperture and dispersion of the same CV or n.

This analysis of the suitability of the adjustment confirms that the distribution of the RRB method is the one that fits best to the data of Cuban raws; the other two, however, come very close and, therefore, can be regarded as equally valid for this purpose.

Final analysis

To date the Powers method has retained tentative status for both Subjects 19 and 27, on white and raw sugars, respectively, with only the known remark that determination has a certain degree of subjectivity when drawing graphs[9].

In addition to easiness and readiness to use and the degree of difusion it enjoys from the 40 years since it was proposed[1] there are still other factors favouring its adoption as an official method.

(a) its distribution, based on arithmetical probability, adjusts to the same degree as the Rens and RRB, with which its theoretical base is reinforced.

(b) The MA and CV results obtained agree with those of Rens, Powers and numerical RRB in the case of mean aperture (MA) and with the first two for the CV, and these do not have any subjective element within their methodology.

(c) There is also the possibility of using the numerical variant if computerware is available and in case of extreme

continued on page 221

14 Klugh: "Statistics: The essentials for research", 2nd Edn. (Wiley, New York), 1974.

The fluid film surrounding a sucrose crystal immersed in its mother liquor

By Andrew VanHook
(Chemistry Department, Holy Cross College, Worcester, Massachusetts 01610, USA)

The fluid film concept has had a stormy history[1,2] but there can be no denying its reality in view of spectacular interferograms[3] and pronounced Schlieren patterns[4] about a moving, growing or dissolving crystal. Much of the discussion, including the writer's previous communications[5,6], have been concerned with the dimensions and profile of the solid immersed in a liquid. The present note is essentially an extension of the previous ones.

The identification of the growth of sucrose crystals with transport at higher temperatures[7-9] (above 50°C) suggests an estimate of the thickness of the fluid film by virtues of the ratio of D/δ which was pointed out by Nernst many years ago. Even at lower temperatures[10] where both diffusion and surface integration contribute, each factor can be assessed from the overall rate constant $1/k = 1/k_T + 1/k_s$ and the ratio of k_s/k_T estimated from the curves of $E_{Act.}$ *vs.* T. This estimate can then be substantiated from the rate of dissolution which is totally transport controlled[11]. To apply

A. VanHook

the basic Nernst ratio the rate constant, k, must be expressed as $R/(c - c_s)$ where R is the usual growth rate in g/cm²/sec and the supersaturation as g/cm³. Then $\delta = D/k = D(c - c_s)/R$.

(A) *Higher temperatures*

D remains small but real as saturation is approached and remains so out to 81 - 84°Brix[12] which, at 70°C, is more than 30% supersaturated in usual weight dimensions. Both R and $c - c_s$ tend to zero at saturation but the ratio remains constant at 70°C and 80°C, deteriorating, however, at lower temperatures owing to the influence of surface integration.

If, for instance, we take the most constant value for R/σ of Golovin & Gerasimenko[13], viz. 140×10^{-6} at 70°C, which is for static conditions, and $D = 1.5 \times 10^{-6}$, calculated from the empirical equations of Schliephake[12], we can work out that ∂ is about 100μm or 10^4 molecular diameters. δ fades away from this value on either side of saturation, probably faster on the undersaturated side than the oversaturated because $R_{Diss} >> R_G$, at least at ordinary temperatures[11]. The film profile will accordingly look something like that sketched in Figure 1. There is insufficient information on D and R at these higher temp-

1 Levich: "Physicochemical hydrodynamics" (Prentice Hall, Englewood Cliffs, N.J.) 1962.
2 Mullin: "Crystallization" (Butterworth, London) 1972.
3 Bunn: *Disc. Faraday Soc.*, 1949, **5**, 132.
4 Mantovani *et al.*: *Paper presented to the Amer. Soc. Sugar Beet Tech.*, 1987.
5 VanHook: *I.S.J.*, 1980, **82**, 331.
6 Idem: *Proc. 16th Congr. C.I.T.S.*, 1977, 2627.
7 Kaganov & Tushilkin: *Sakhar. Prom.*, 1986, **42**, (10), 11 - 12.
8 Schliephake: *Zucker*, 1965, **18**, 514.
9 Dedek: *Proc. 7th Congr. C.I.T.S.*, 1953, 81 - 106.
10 VanHook: *Zuckerind.*, 1988, **113**, 591.
11 Idem: *I.S.J.*, 1988, **90**, 65.
12 Schliephake: *Zucker*, 1965, **18**, 138.
13 *Proc. 10th Congr. ISSCT.*, 1959, 248 - 262

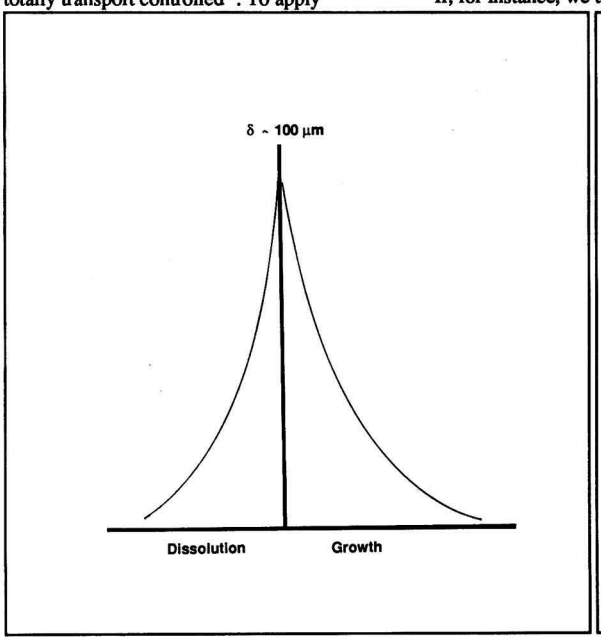

Fig. 1. Schematic film profile

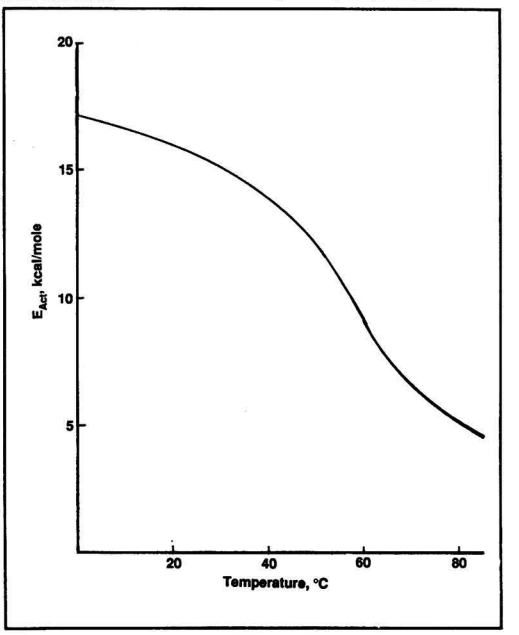

Fig. 2. E_{Act} *vs.* Temperature, after Schliephake[8] and VanHook[10]

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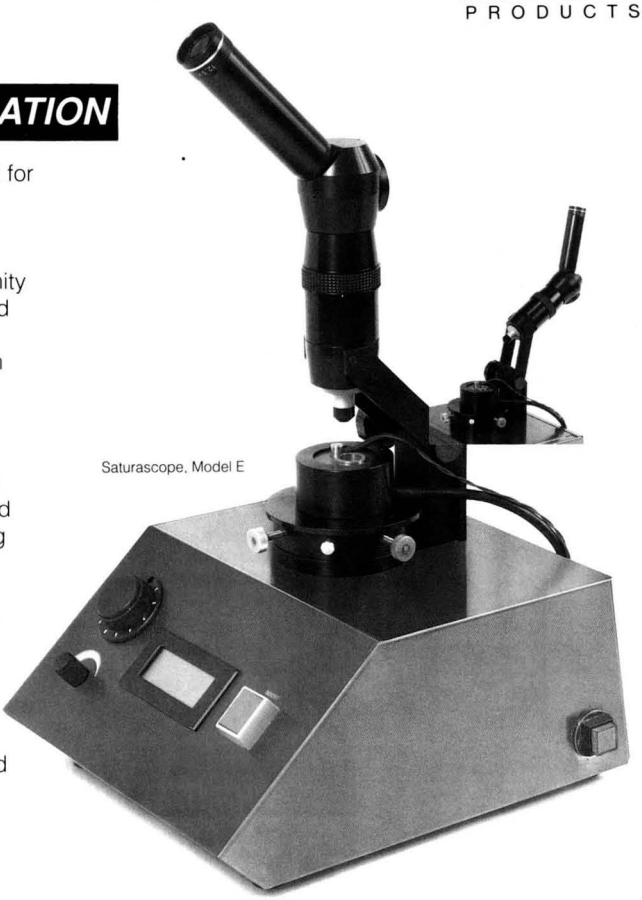
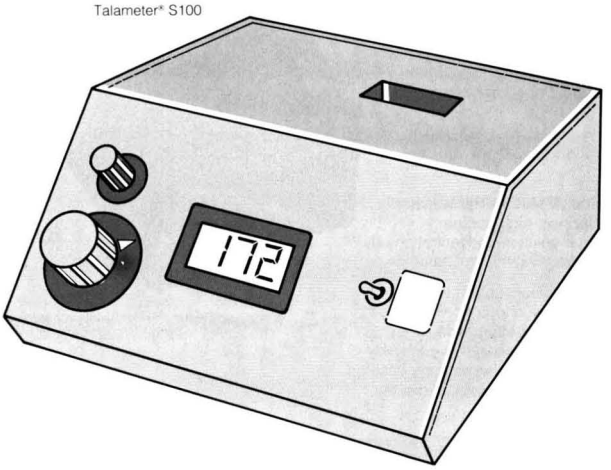


Saturascope, Model E

SUGAR COLOUR

Talameter* S100



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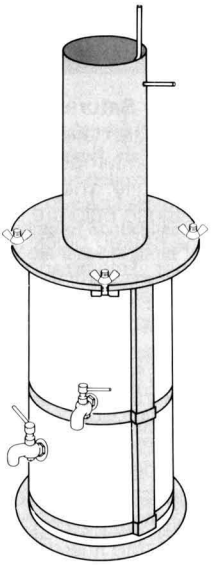

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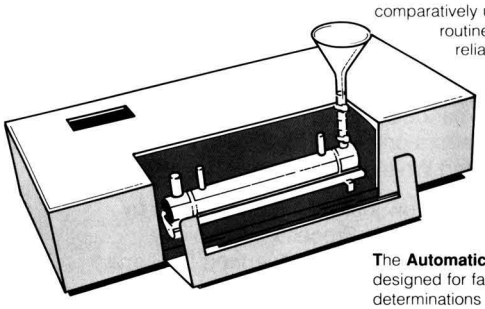
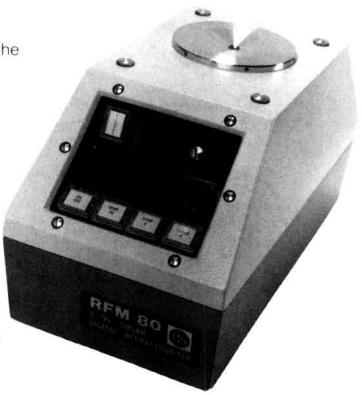


Automatic Digital Polarimeter



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ISJ Abstracts

Cane sugar manufacture

The keeping quality of sugar

R. P. Agarwal. *Bharatiya Sugar*, 1988, **14**, (1), 10 - 12.

Aspects of stored sugar deterioration discussed include sucrose inversion and invert sugar degradation, the adverse effect of micro-organisms, high relative humidity and moisture absorption, colour formation and the effect of processing on the keeping quality. Means of avoiding deterioration are recommended.

New sugar standards for India

A. P. Chinnaswamy and K. Theerthamalai. *Bharatiya Sugar*, 1988, **14**, (1), 19 - 20, 25 - 26.

A critical appraisal is given of the new sugar standards in India and a number of modifications to them are recommended, including: restricting white sugar to only one grade having an average grain size of 0.7 mm and two colour standards; retention of visual comparison for routine colour determination and use of the ICUMSA method for the standard samples; rationalization of the system of sieves; and production of a single-grade mineral (off-white) sugar for which the economics are discussed. The technological and economic benefits of producing a white sugar of 0.7 mm average size are listed.

An introduction to cogeneration basics and applications

B. G. Subhash. *Bharatiya Sugar*, 1988, **14**, (1), 131, 133, 135, 137, 139, 141, 143, 145.

Cogeneration of electricity is discussed generally and the potential for the Indian sugar industry indicated.

Improvement in sugar colour. Trial of hydrogen peroxide as bleaching agent

R. D. Jadhav, C. G. Pimpalkar and G. V. Joshi. *Indian Sugar*, 1988, **38**, 441 - 443.

Results of an experiment, in which 500 cm^3 of hydrogen peroxide diluted in 10 litres of water was added to *A*-massecuite 30 min before dropping from the pan, showed a 15% reduction in sugar colour, one of 36% in the sulphated ash content and an average 70% fall in the SO_2 content by comparison with untreated massecuite. The practice was continued, and brilliant sugar of 30 colour having a good lustre was produced.

Rotalon - an engineering material for the sugar industry

M. Maguire. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 75 - 79.

The properties of Rotalon, a special nylon formulation developed by Smith Mirrlees, are described and trials conducted at a number of sugar factories reported in which the material was used for mill scraper tips, bearings, chain rollers, beet trash scrapers and gear pinions on a white sugar granulator/conditioner as well as for crystallizer and screw conveyor bearings in refineries. Results of use over a number of years have shown that the material is as good as or even better than traditional metals in terms of wear while substantially reducing wear on mating surfaces, being much lighter in weight and having no corrosion problems. A list is presented of a number of new applications that were to be tested in the sugar industry.

Mother liquor purity changes in low-grade strikes

W. Keenliside. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 80 - 90.

Pan boiling control based on supersaturation requires knowledge of the mother liquor purity. Massecuite and molasses samples obtained from low-grade strikes were analysed for Brix and apparent purity and the crystal content and crystal growth rate calculated. While there was a trend towards linearity in the relationship between molasses purity and massecuite volume which could be used as an algorithm for supersaturation calculation, variations in massecuite consistency with massecuite and molasses Brix were found to be basically random and hence of little value as a means of control. A material balance was used to determine expected changes in purity and a mother liquor height profile derived which agreed closely with experimental data. The program is to be extended for analysis of *A*- and *B*-strikes and to investigate the applicability of supersaturation, consistency and conductivity to other materials.

Supersaturation control in pan boiling

J. F. Roane, A. Jain and W. Keenliside. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 91 - 98.

Studies are reported in which a microprocessor installed in a vacuum pan (together with sensors for temperature, pressure, Brix, consistency and conductivity) was programmed to control pan feed on the basis of supersaturation as calculated from massecuite temperature, absolute pan pressure (controlled independently) and mother liquor purity. Results demonstrated the suitability of supersaturation for pan feed control and its value in prediction of the seeding point, while other parameters had various drawbacks. A Ziegler consistency monitor was sufficiently sensitive to massecuite viscosity but suffered from excessive signal noise, while temperature fluctuations prevented repeatable values of consistency for the same supersaturation; conductivity was of insufficient sensitivity under normal conditions, but high-frequency conductivity is of greater sensitivity and is under consideration as a possible control parameter; Brix as measured by an on-line refractometric monitor was suitable up to the seeding point, but underwent no noticeable change thereafter. However, since the supersaturation was calculated using a formula based on a fixed mother liquor purity, further work is needed to compensate for a purity drop which occurred as the strike progressed, and to determine the purity profile with respect to time and massecuite level.

Use of a dextranase produced by *Lipomyces starkeyi* in a raw sugar mill

D. W. Koenig and D. F. Day. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 112 - 116.

Dextranase derived from the yeast *L. starkeyi* was used in a pilot scale test to determine its efficiency in removing dextran from mixed juice to which it had been added. Results showed that at an optimum temperature of 30 - 40°C, pH of 5.6, incubation for 40 min and a dextranase concentration of 5.4 international units/ml, approx. 96% of the initial dextran (28263 ppm on Brix) was removed. Increase in the enzyme concentration brought no further improvement in performance, and poorer results were obtained at 20° and 50°C with all other conditions constant. Analysis of the raw sugar produced from the juice indicated a 76% reduction in the dextran content; untreated juice could not be boiled or adequately purged, and the small amount of sugar that could be recovered was dark and the crystals elongated.

Mud filtration alternatives

S. J. Clarke. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 117 - 128.

Sugar losses in filter cake in Louisiana sugar factories are much higher than desirable, although there has been a steady fall in the average from 4.4% in 1983 to 4.0% in 1986. Results of a survey of filtration procedures and efficiencies are discussed, and laboratory experiments to determine the optimum quantity of flocculant (found to be about 15 ppm) to add to clarification mud before filtration are reported. The mud filter cake sweetening-off performances of six types of spray nozzle were assessed; fine bagacillo caused no problems, but larger bagasse particles caused blockage of all six. Tests were conducted on a membrane press (which used air pressure to dry the cake) and on a belt press set up to handle mud direct from the clarifier or cake from an Eimco belt filter. With addition of flocculant at 8 - 10 ppm on solids, losses were reduced to1.9% and 1.4% by the membrane press operating at 50° and 87°C, respectively, while the belt press gave a loss in the range 2.7 - 3.8% when treating filter cake and using 5 - 10 ppm flocculant; the inability to wash mud in the belt press led to a higher loss when clarifier mud was treated; despite the improved sugar recovery obtained with both systems, the costs of using either as a second filtration stage and the problems of recycling rather large volumes of very dilute filtrate suggest that they are not justifiable except where filter cake pol cannot be reduced by any other means and/or when mud disposal problems become too severe. Operation of a belt filter modified to act as a mud thickener with drainage of excess juice by gravity required good flocculation for retention of the mud solids on the screen; although satisfactory results were obtained, a system to handle mud from e.g. 200 tch would have to be somewhat large.

Options available to the raw (sugar) factory for improvement of quality and recovery

M. C. Bennett. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 136 *(Abstract only).*

The imposition of severe penalties on raw sugar quality has led to increasing interest in the improvement of purification techniques in the raw house. Methods for increasing the selective extraction of sucrose or the selective removal of impurities are briefly reviewed and examples are quoted where process modifications have also led to significant increases in overall recovery.

Milling studies

H. S. Birkett and J. M. Stein. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 136 *(Abstract only).*

The results obtained from three years of milling studies at Louisiana sugar factories are discussed. The studies included numerous mill tests in which all of the cane, juice and bagasse samples available were analysed. Brix curves and moisture profiles through the tandem were used to interpret the performance of individual mills. Cane preparation index and the ash % bagasse figures through the tandem were determined. The Brix of the last expressed juice was found to be a good indicator of the pol % bagasse. Suggestions for improving milling operations are presented.

Economies or diseconomies of scale in Louisiana sugar mills ?

R. D. Christy and B. Chapman. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 136 *(Abstract only).*

During the past two decades, the Louisiana sugar processing (milling) industry has been characterized by rapid structural change. The number of sugar factories has declined from 42 in 1960 to 21 currently, while the average capacity and the average output (raw sugar) per factory have increased significantly. This paper measures economies of scale (size) using quantitative cost functions. A multiple least squares regression model was used to estimate the relationship between average factory output and average variable cost between 1979 and 1986.

Maceration juice clarification at Cora Texas

J. Engolio. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 136 *(Abstract only).*

Cora Texas is one of two sugar factories in Louisiana that have French presses to dewater the entire bagasse flow leaving the mills. Both of these factories have experienced considerable maintenance problems with the wear on the screws and flights of the presses caused by abrasive field soil in the bagasse. In the normal milling operations, the field soil (ash) content of the bagasse does not change greatly following the mills whose juice goes to process. Any field

soil that is removed by the mills down the tandem is returned to the preceding mill with the remaceration juice flow and is trapped in the bagasse mat. It was felt that clarification of the remaceration mill juice would remove the field soil which would be sent directly to the mixed juice tank and be removed, while the clarified remaceration juice could be returned to the tandem. The most noticeable improvement was the great reduction in the wear of the screw press. Also, the bagasse burned better as a result of being cleaner and there was less wear on No. 4 and No.5 mill rollers and trash plates.

The effect of rotational speed on low-grade crystallizers

W. Keenliside and J. Stein. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 137 *(Abstract only).*

The ability to reduce the molasses purity in *C*-crystallizers is dependent on the properties of the massecuite, the cooling of the massecuite and the geometry and operation of the crystallizers. The present project was aimed at analysing the relationship between torque on the crystallizer shaft as a function of rotational speed, molasses Brix, crystal content and temperature. The subsequent experiments were used to determine the rate of change of molasses purity with time as a function of rotational speed in the crystallizer. Different massecuites at a specific cooling rate were used in this part of the experiment. The data presented and the analysis of the results are used to provide suggestions for improved crystallizer operation.

The changing world of instrumentation and controls - its applications in the sugar house

F. Z. Llorens, E. Aguirre and B. Rodriguez. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 137 *(Abstract only).*

One very important aspect of raw sugar manufacture is the ability to monitor and control properly both the process and equipment functions. It is in this very area that advances in microprocessing and microcomputer technology have provided new products which can find a wide range of applications in the sugar factory. Plant networks consisting of microcomputers working with remote processors and data acquisition systems can provide management with the tools to maximize efficiency and returns. As part of these integrated systems, programmable logic controllers are useful in managing repetitive tasks as well as providing sequencing and alarm functions. This new electronic revolution allows us to look at the process from different perspectives and provides low-cost alternatives to enhance information and production in the sugar factory.

Louisiana dextran studies, 1986

J. A. Polack, D. F. Day and D. Sarkar. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 137 *(Abstract only).*

Daily haze analyses for dextran in raw sugar were supplied by 12 Louisiana factories. Results confirmed a strong dependency on weather conditions. Dextran in sugar rarely exceeded 250 MAU when daily minimum temperatures were below 50 - 55°F, but in warmer, wet weather the average level for the state was greater than 250 MAU. While all factories followed the weather-dependent pattern, there were individual differences among factories which related to geographical location, stoppages and management practices. At one factory, core laboratory cane juice composites from each shipper were analysed daily for dextran by the ASI-II method. When the daily average dextran content in juice exceeded 1400 ppm, that in sugar rose above 250 MAU. As long as the average juice level was below 1400 ppm, that in sugar remained below 250 MAU.

Improving sugar mill roller shell life

St. J. Field. *Sugar J.*, 1988, **51**, (7), 11 - 12.

See *I.S.J.*, 1989, **91**, 3A.

The Hawaiian sugar industry: status and outlook

F. S. Morgan. *Proc. Inter-American Sugar Cane Seminar*, 1987, 17-19.

The current status and future outlook of the Hawaiian sugar industry are briefly discussed.

The Jamaican sugar industry: past and future

T. G. Mignott. *Proc. Inter-American Sugar Cane Seminar*, 1987, 20 - 28.

The current state of the Jamaican sugar industry, the economics of cane growing and the future outlook are discussed with the aid of tabulated data.

Practical aspects of the control of dextran at Atlantic Sugar Association

J. F. Alvarez. *Proc. Inter-American Sugar Cane Seminar*, 1987, 40 - 45.

Measures adopted at the 10,000 tch Florida sugar factory of Atlantic Sugar Association to reduce the dextran content in juice brought the level down by 300% and thus decreased sugar losses as well as the penalties imposed by the refiners. Details are given of the steps taken, which included restricting the time between pre-harvest burning and processing, strict attention to factory hygiene and treating *B*-molasses with surfactant to avoid high viscosities.

The sugar industry in Mexico

M. Enriquez Poy. *Proc. Inter-American Sugar Cane Seminar*, 1987, 128 - 132.

The current state of the Mexican sugar industry and measures needed to improve its performance are briefly discussed.

Recent technical developments in Jamaican sugar factories

M. G. Hylton. *Proc. Inter-Amer.ican Sugar Cane Seminar*, 1987, 197 - 202.

Since 1965, there has been a steady fall in sugar output in Jamaica, where nine

sugar factories and six distilleries were in operation in 1986. The equipment used in the factories and efforts at upgrading are outlined and details given of by-products utilization, including the use of molasses for rum and ethanol manufacture and as animal fodder and CO_2 as a distillery by-product. A West German-funded installation has been set up for cane separation and production of amorphous sugar, fancy molasses, cane juice and charcoal.

Bagasse drying for cane sugar factories

A. C. Pilgrim. *Proc. Inter-American Sugar Cane Seminar*, 1987, 220 - 238.

The development and theory of bagasse drying are presented and the various types of dryer discussed. From an evaluation, the packed-bed dryer is considered to be the most suitable, and experiments are reported in which bed depths ranged from 2 to 25 cm and the air contained 0.016 - 0.12 kg water/kg. Results showed that bagasse moisture contents of 40% could be obtained in <5 min in some instances. Mathematical models were obtained for both counter-flow and cross-flow systems.

Bagasse: key to progress in fossil fuel savings and by-products

R. E. English. *Proc. Inter-American Sugar Cane Seminar*, 1987, 239 - 243.

Bagasse drying as a means of increasing its calorific value for use as fuel and providing a maximum quantity for by-product utilization are discussed. The use of boiler flue gas as drying medium is considered.

Developments in the sugar cane separation process

H. Bourzutschky and J. Badiuk. *Proc. Inter-American Sugar Cane Seminar*, 1987, 244 - 249.

The principle of the cane separation process is discussed and a West German/ Jamaican project incorporating an earlier experimental Model C 10 separator described. The same model was also installed in a system with a screw press (to separate the juice from pith fibre) adjacent to a sugar factory in Ecuador and yielded, on average, 64% juice, 22% rind fibre, 9% pith and 4% epidermis by weight; total sugar losses were 0.8 - 0.9%. Total power consumption from cane feeding to discharge of juice to the factory was 9 - 10 kWh/tonne, of which 1 - 1.2 kWh was consumed in cane preparation, 3.1 - 3.2 kWh in separation and 5.4 - 5.7 kWh in the juice extraction press. Since the juice contained much less suspended fibre than normally found in a factory and was free from dirt and wax, it is suggested that clarification losses would be lower.

The production of syrups from sugar cane: focusing and experiences

S. F. Alvarez. *Proc. Inter-American Sugar Cane Seminar*, 1987, 269 - 279.

Artificial and natural sweeteners that compete with sugar are surveyed and the processes used in HFS manufacture from corn and cane compared to show the advantages of the cane system (smaller number of steps and a shorter overall process time). A typical invert syrup analysis is presented and an invert syrup process used at a Louisiana sugar factory described.

Analysis of the causes of recent roll shaft failures in Natal sugar mills

M. J. Reid. *S. African Sugar J.*, 1989, **73**, 22 - 25.

See *I.S.J.*, 1989, **91**, 69A.

Designing a semi-Kestner evaporator. I. The basic concept. II. Efficiency of formula. III. The new concept

R. Kumar and V. K. Jain. *Indian Sugar*, 1988, **38**, 579 - 581, 647 - 649, 727 - 729.

I. The importance of DT (the difference between the temperatures inside and outside the tube of a semi-Kestner climbing-film evaporator as used in some Indian sugar factories as a pre-evaporator or 1st effect) for flux rate is discussed, and a method described for establishing the critical value of this temperature difference based on the relationship between the heat transfer coefficient and the temperature difference in boiling water.

II. The effects on evaporator performance of scale and of DT are discussed and a simple formula described which defines evaporator efficiency as a function of DT.

III. It is shown how the mean heat transfer coefficient and the flux rate may be increased by installing condensate tapping caps throughout the length of the evaporator tubes.

Improvement in sugar colour. Trial of hydrogen peroxide as bleaching agent

R. D. Jadhav, C. G. Pimpalkar and G. V. Joshi. *Bharatiya Sugar*, 1989, **14**, (4), 51 - 52.

Addition of hydrogen peroxide solution (500 cm^3 in 10 litres of water) to *A*-massecuite 30 minutes before dropping from the pan reduced the colour, sulphated ash and SO_2 contents in the resultant sugar by an average of 15%, 36% and 70%, respectively, compared with an untreated control and gave a lustrous sugar of 30 colour.

Calorific value of bagasse in Taiwan

C. H. Chen, C. T. Peng, R. Y. Chang, W. H. Hung and Y. Y. Lu. *Rpt. Taiwan Sugar Research Inst.*, 1988, (120), 15 - 20 *(Chinese)*.

From an empirical formula for the gross calorific value of bagasse (obtained from analyses of 111 samples collected from six Taiwan factories), formulae have been derived for calculation of the net calorific values (kcal/kg) of dry bagasse (4204 - 42.9 A) and of wet bagasse (4204 - 43 A - 48 W + 0.43 AW) where A = ash content and W = water content.

Beet sugar manufacture

Main liming in the presence of active carbon

R. S. Reshetova, Z. Yu. Tlekhurai and T. V. Solov'eva. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 92 *(Abstract only).*

The effect of adding powdered active carbon to raw juice before and after liming was investigated in a series of tests which showed that the carbon reduced the amount of colouring matter so that purity rose and the colour content fell. It is recommended to recycle mud containing the carbon and mix it with juice to be limed.

The mechanism of non-sugars adsorption on calcium carbonate

R. M. Emtyl', O. V. Musienko and T. P. Trifonova. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 92 *(Abstract only).*

A model is proposed of the structure of the calcium carbonate micelle and of the conglomerate of micelles which allows a clear picture of the mechanism of non-sugars adsorption on the carbonate as it is formed. A method is presented for calculation of the components of the effect of carbonatation using, as example, data on the efficiency of molasses solution purification. A 20 - 30% increase in the efficiency of purification by adsorption is shown to be possible by creating more favourable conditions such as increasing the concentration of Ca^{++} ions or replacing some of the monovalent with multivalent anions.

The rate of recuperative heat exchange in DDS (DS) diffusers

A. V. Emel'yanenko, A. I. Fel'dman, V. M. Lysyanskii and B. A. Matvienko. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 106 *(Abstract only).*

A test unit has been developed which permits numerical values to be obtained of the coefficient of heat transfer k from steam in the jackets to the juice-cossettes mixture in DDS twin-scroll diffusers; the values are obtained from the amount of condensate formed in each jacket. It is shown that, for a DS-12 diffuser of 125 tonnes beet/hr nominal capacity, k in the first zone is 720 - 770 $W/m^2/°K$, in the second it is 280 - 350 $W/m^2/°K$ and in the third and fourth 220 - 260 $W/m^2/°K$; its value falls in the first two zones with increase in diffuser capacity.

The effect of certain antimicrobial preparations on spore-forming thermophilic bacteria in beet sugar manufacture

N. A. Tveritina, A. A. Lipets, L. R. Reshetnyak, A. I. Fel'dman and I. A. Slepinina. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 114 *(Abstract only).*

The effect of bactericides on spore-forming thermophilic bacteria is discussed. It was found that formalin currently used to inhibit micro-organisms does not have any noticeable action against the group in question, and it is recommended to use aluminium sulphate and industrial antibiotics.

Effective methods of intensifying the diffusion process in beet sugar manufacture

Yu. A. Zayats. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 115 *(Abstract only).*

A mathematical model of the diffusion process as a solid-liquid system is used to analyse methods for intensifying sugar extraction. The need to separate prescalding of cossettes from the rest of the process is indicated, and the development and application of a pressing-diffusion technique for sugar extraction from cossettes is recommended.

Development and introduction of methods and devices for normalization of thermal and hydrodynamic conditions in inclined twin-scroll diffusers

A. I. Fel'dman and E. V. Minenko. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 115 *(Abstract only).*

A study of the thermodynamics in inclined twin-scroll diffusers has shown that provision of means of feeding the cossettes and extraction liquid together stabilizes the flow of the individual streams, eliminates irregularities that normally arise in the feed zone and increases diffuser capacity. Results of tests under factory conditions are presented.

Improving the quality of yellow sugar remelt

A. I. Gromkovskii, V. A. Golybin and Yu. I. Zelepukin. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 124 *(Abstract only).*

One of the methods of raising the quality of white sugar by improving the quality of products used for *A*-massecuite boiling is examined. It involves supplementary purification of yellow sugar by affination with sulphitation juice or thick juice, purification of the affination syrup by treatment with sodium sulphite followed by carbonatation together with filtered 1st carbonatation juice, and the use of high-Brix remelt in the initial stages of the *A*-strike.

Automatic fan switches reduce sugar beet storage losses

K. D. Enghardt. *Lebensmittelind.*, 1988, **35**, 258 - 259 *(German).*

Automatically controlled fan switches for beet storage piles are described which have reduced losses and saved more than 30% of the electricity consumed in a manually controlled system. They operate on the basis of the difference between the ambient temperature and that in the pile.

Some aspects of the effect of various quantities in pure and technical lime-sugar solutions. I. The conductivity of pure lime-sugar solutions and the structure of the saccharate complex

E. Sarka. *Listy Cukr.*, 1988, **104**, 241 - 243 *(Czech).*

From knowledge of the conductivity of calcium hydroxide in water and the dependence of its apparent molar con-

ductivity on dynamic viscosity in the presence of sucrose (based on Walden's law), values are obtained of the ionic conductivity for lime-sucrose and (with calculation based on its ionic radius) for the calcium saccharate complex at 20°C. Conditions are given under which the saccharate will form with a neutral and with a positive charge.

Steam heating of remelt liquors and syrups in a sectioned tubular steam-fluid heat exchanger

P. Hoffman, P. Korecek and T. Zahradnik. *Listy Cukr.*, 1988, **104**, 251 - 254 *(Czech)*.

The performance of a horizontal twin-tubular heater having a total heat exchange surface of 5.4 m^2 is discussed. With only one of the sections in operation and at a flow rate of 0.15 - 0.42 m/sec (giving an hourly throughput of 2.3 - 6.6 m^3 or 2.9 - 8.3 tonnes) the 58 - 70°Bx syrup was heated from 64.1 - 80.5°C to 76.9 - 95.0°C at a heat transfer coefficient of 480 - 730 W/m^2/°K; with both sections in use, remelt liquor of 60 - 65°Bx was heated from 60 - 85°C to 90.0 - 100.5°C at a flow rate of about 1.4 m/sec (21 - 22 m^3 or 26 - 28 tonnes/hr) and a heat transfer coefficient of 1300 - 1600 W/m^2/°K.

Electricity economy in the sugar house

H. Weidner. *Zuckerind.*, 1989, **114**, 15 - 24 *(German)*.

Sugar house operations (crystallization, centrifugalling, melting, drying/cooling, pumping of various materials and sugar conveying) account for 20 - 25% of the total power consumption in a white sugar factory. Examination of batch centrifugal operation shows that spraying with syrup followed by washing with a reduced quantity of water gives up to 55% reduction in the energy consumption (by comparison with the use of water alone) as a result of decrease in the amount of sugar dissolved and hence in the need to recrystallize and repurge; allowance has to be made for the increased energy used to accelerate and pump the spray syrup, while the consequent reduction in massecuite quantity may lead to a substantial saving in energy used by the pan stirrer. Although the energy consumption of continuous centrifugals is much greater than that of batch machines (since the kinetic energy in the spun sugar is not retrievable), it is affected to a greater degree by massecuite quality and target quality of the sugar; the peripheral speed at the rim of the basket and the losses due to air friction are major factors influencing energy usage. A simple means of reducing the energy consumed in acceleration is to separate the syrup from the crystals as early as possible through slots in the lower half of the basket; the basket radius should also be as small as possible, and a 37.5% saving in energy can be achieved (by comparison with a basket without slots) with a massecuite of 50% crystal content and a radius at which the syrup is discharged that is half of the maximum radius. A continuous machine with more than one basket on a single shaft and hence without the normal components around it (e.g. mixer, massecuite pumps, etc.) will also allow energy savings in contrast to a foreworker followed by an affination centrifugal. The main energy component with low-grade batch machines is the much greater time the material is in the basket by comparison with continuous centrifugals, but the improvement brought about in low-grade massecuite quality by stirred evapo-crystallization permits a substantial saving in energy by comparison with a continuous machine in which acceleration is the major energy-governing factor. Condensate handling can be optimized by reducing the pressure losses in pan vapours between the pan and condenser discharge port, by raising the temperature of the cooling water and using it for heat recovery and by using more energy-efficient vacuum pumps. The electrical energy consumption and plant arrangement of a number of sugar house schemes for Class 2 white sugar are compared.

Electricity consumption in mechanical and thermal pulp dewatering

C. Voss. *Zuckerind.*, 1988, **114**, 25 - 28 *(German)*.

The comparative electricity consumption of single-screw vertical beet pulp presses and of older-style and newer, larger twin-screw horizontal units is discussed; a survey among factories in southern Germany has demonstrated the much lower consumption of the older horizontal presses than the newer types, with the vertical presses falling in between. Comparison is also made between the electricity consumption of various pulp drying, pelleting and pellet storage systems. Electricity balances are presented for factories with and without pelleting, with low-temperature pulp drying and with steam drying and pellet storage in a circular silo, while comparisons are also made on the basis of differences in the type of pulp marketed.

Properties of beet pulp fibre components during mechanical dewatering and consequent possibilities for further development of pulp presses

T. Cronewitz. *Zuckerind.*, 1989, **114**, 30 - 39 *(German)*.

The effects of the ash, K, Na, Ca, Mg, Fe and Al contents in pulp fibre on pressing and of pH on the achievable dry solids content, on press throughput and on pulp stability are discussed and the advantages of diffusion additives in increasing the solids content of pressed pulp assessed. The relationship between applied pressure and dry solids content is examined and descriptions given of special apparatus used to determine the effect of high pressure. Advances made in pulp press design and in the dry solids contents achieved are examined and future possible prospects considered, including potential energy savings; it is felt that thin-layer high-pressure treatment holds particular promise. Because of difficulties in scaling-up pulp pressing experiments to full size, a simulator

would be of great value, and the principle of such an apparatus is described.

Influence of vibrations on the rheological properties of massecuites

M. Dziubinski and T. Kiljanski. *Zuckerind.*, 1989, **114**, 42 - 43.

Experiments were conducted in a 100 mm diameter cylindrical vessel provided with an 8-bladed coaxial vibrator in which the blades carried 5-mm perforations at 10-mm intervals; vibrations were generated at a frequency up to 21 Hz and amplitudes of 1.15 - 3.45°. Rheometric measurements of massecuites subjected to vibration showed that they exhibited nearly Newtonian properties so that the effect of the vibrations was exactly the opposite of that reported by Pérez *et al.*[1], with viscosity increasing with frequency from 6 to 21 Hz. The behaviour was attributed to crystal destruction and was not a function of the geometry of the measuring system (as demonstrated by similar results obtained with a system of two concentric cylinders, the inner one carrying out torsional vibrations).

Circulation effects in operation of vacuum pans

F. Rieger, P. Ditl, H. Weiserova, L. Beranek and M. Brandejsky. *Zuckerind.*, 1989, **114**, 45 - 48.

An industrial pan of 50 tonnes capacity, a pilot plant of 5 tonnes capacity and a 300-mm diameter model calandria were used in a study of the effect of massecuite stirring on heat transfer and crystal quality. A simple mathematical model is presented and it is concluded that stirring increases heat transfer in a low-grade pan and improves crystal quality in a white sugar pan. The results also showed that screw-type stirrers are better than standard propeller types with inclined blades in regard to circulation velocity, particularly when high-viscosity, low-grade massecuites are boiled.

The effect of increased pressing of beet pulp on the quality of press water

K. Hangyál and E. Gryllus. *Cukoripar*, 1988, **41**, 132 - 136 *(Hungarian).*

See *I.S.J.*, 1987, **89**, 110.

Comparison of Hungarian-produced anti-foam agents under laboratory and factory conditions. II

M. Tömördi and L. Németh. *Cukoripar*, 1988, **41**, 137 - 140 *(Hungarian).*

Laboratory tests with Hungarian Sugár KTC-2, Sugár KTC-4 and Glanapon DS 44 anti-foam agents added to raw juice showed that generally best results were given by dosage rates of 15 - 20 ppm, a temperature of 30°C in preference to 70°C and a pH of 4.7 as against 6.0 - 7.0, depending on state of the juice. The stability of Kemobil PC 1523 and BP emulsions proved unsatisfactory in tests conducted in December/January. In factory experiments, 5 - 10% dilution of agents added in diffusion reduced the costs by 20 - 30%.

A rapid clarifier for 1st carbonatation juice at Acs sugar factory

I. Soós and L. Hájos. *Cukoripar*, 1988, **41**, 141 - 146 *(Hungarian).*

A description is given of a Hungarian-built top-entry rapid settler having a daily capacity equivalent to 3000 tonnes of beet installed at Acs sugar factory to replace filter-thickeners and increase the juice filtration capacity. Its performance during the 1986/87 and 1987/88 campaigns is discussed; a marked difference between the two campaigns in the quality of the 1st carbonatation juice (which had an average alkalinity of 0.038% CaO w/w) was reflected in the two average settling rates of 39.0 and 27.4 mm/sec (compared with an average for the Hungarian industry of 39.1 mm/sec). The thickening ratio averaged 1:3.34, with 1:5 and 1:6 being attained on occasions. There were virtually no problems in operation of the settler or in vacuum filtration of the mud, and the clear juice required no filtration before 2nd carbonatation; the equipment required little maintenance. In tests on four flocculants, Preastol 2540 at about 12 ppm gave good results only when the juice settling properties were better than the campaign average, while Magnafloc LT-27 and Nalco 8863 were of identical efficiency (despite a better result for the former flocculant in laboratory experiments) at 23 - 24 ppm; Nalco 7863 was as good as Nalco 8863 but cost less. The costs involved in settling were lower than those of cloths in the previous filter-thickeners, and energy consumption was reduced. The use of warm water instead of juice for milk-of-lime preparation reduced fluctuations in density and helped to stabilize lime kiln operation. An identical type of rapid settler but for juice from 4000 tonnes of beet was installed at Petohaza sugar factory in 1987 and another two were planned for Hajdusag and Mezohegyes in 1988.

The results of technical progress and further tasks in the sugar industry

E. Németh. *Cukoripar*, 1988, **41**, 148 - 150 *(Hungarian).*

Advances made in sugar factory equipment, processing and automatic controls and the resultant improvements in performance and energy consumption, etc. are discussed and tasks that still face the industry outlined.

A cossettes prescalder for the A1-PDS-20 diffuser

I. A. Oleinik, A. V. Sadych, V. V. Mank and V. T. Kober. *Pishch. Prom.*, 1988, (3), 26 - 28; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (2), Abs. 2 R1426.

One way of intensifying sugar extraction in inclined diffusers is to prescald the cossettes to 70°C using saturated steam which also reduces microbial contamination and activity. A scheme, technical

1 *I.S.J.*, 1986, **88**, 156 - 158.

features and description of its operation are given for such a prescalder which is completely automatic.

The effect of parameters of raw juice purification, using polyacrylamide in preliming, on 2nd carbonatation juice purity

V. A. Loseva, Yu. S. Serbulov and O. A. Shipulina. *Rpt. Voronezh Technol. Inst.*, 1988, 12 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (2), 2 R1428.

The method of mathematical planning was used to study the interaction of parameters affecting raw juice purification with use of polyacrylamide flocculant. The qualitative properties of 2nd carbonatation juice were studied as a function of predefecation juice pH and flocculant concentration and quantity. The greatest increase in juice purity was observed with use of 1% polyacrylamide (on juice weight) at pH 9.5 and with 0.0452% flocculant at pH 11.0. The method of ridge analysis, based on the Lagrange system of indeterminate factors, was used to establish the optimum conditions.

Environment-friendly slime control

Anon. *Chem.-Anlag. + Verfahren*, 1988, **21**, (7), 96; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (3), Abs. 3 R1539.

The use of Dioxon 104 to control slime-forming bacteria at Regensburg sugar factory (having a daily slicing capacity of 11,500 tonnes of beet) is reported. The preparation is a colourless solution based on hydrogen peroxide which is fed into the cooling water closed circuit for the turbines, compressors and generators. Dioxon 104 does not harm the environment since it breaks down to water and oxygen.

Sources and level of sugar losses in beet storage and processing

A. L. Shoikhet *et al. Sakhar. Svekla*, 1989, (1), 40 - 41 *(Russian)*.

Sugar losses in storage, handling and processing of beet were analysed at Babino-Tomakhovskii factory during the three campaigns 1984/87. Details are given of measures used to minimize losses, and tabulated data are discussed which showed that 5.56% of the sugar in the beet entering the yard was lost in storage and conveying and 6.79% in processing, including a figure of 0.77% resulting from polarimetric error caused by the formation of optically active substances and other sources of measurement error. Means of minimizing losses are suggested.

Calculation of the length of the beet storage period

V. A. Knyazev and M. P. Vasil'chuk. *Sakhar. Svekla*, 1989, (1), 42 - 44 *(Russian)*.

A set of formulae is presented for calculation of the optimum average beet storage period and maximum recommended quantity of stored beets under Soviet conditions. It is stressed that the values depend not so much on the length of the campaign as on the supply of beet needed to ensure operation of the factory for a given time in the initial part of the campaign as well as on the date when harvesting finishes. Hence, the minimum storage period of 19 days and the smallest amount (47% of the beet supply) correspond to initiation of harvesting on October 1 in the major zones and at least 15 days of factory operation, but 66% of the beet supply may have to be stored for an average of 30 days to guarantee 90 days of processing.

SOT pumps

B. P. Efanov, N. F. Bobrakov, M. G. Shumakova, V. A. Tarbokov and V. I. Mishchenko. *Sakhar. Svekla*, 1989, (1), 45 *(Russian)*.

Details are given of modifications to a single-stage centrifugal juice pump to improve lubrication and eliminate sugar losses in the form of juice leakage through the stuffing box seals.

PR 15/20 rotary juice screens

B. P. Efanov, N. F. Bobrakov, M. G. Shumakova and V. A. Tarbokov. *Sakhar. Svekla*, 1989, (1), 46 *(Russian)*.

An electrically operated rotary screen for raw juice is described.

Operational determination of molasses exhaustion

T. P. Khvalkovskii. *Sakhar. Svekla*, 1989, (1), 47 - 48 *(Russian)*.

A method of determining molasses exhaustion is based on the difference in Brix between the factory and standard molasses and the amount of sucrose remaining dissolved in the excess water as a result of deviation from the optimal final temperature in low-grade crystallization. A variant of the method uses the ratio of purity to Brix and the melassigenic coefficients of non-sugars and water. Campaign average sugar loss and purity differences between factory and standard molasses for each of three successive campaigns as calculated by the Silin and the proposed method are compared showing very close agreement in two campaigns but much greater differences in the other. A number of benefits of the suggested method are indicated, including greater accuracy and rapidity.

Modernization of operating complexes of beet sugar factories

J. Dyntar and A. Kyncl. *Czechoslovak Heavy Ind.*, 1989, (2), 10 - 14.

Descriptions are given of Czechoslovakian-built beet sugar factory equipment.

Remote-controlled beet fluming equipment

M. Hubka. *Czechoslovak Heavy Ind.*, 1989, (2), 15.

Details are given of an automatic water cannon designed for application where beet is stored on concrete areas having a slope of 2 - 4% towards the flume. It throws a jet of water 35 - 40 m at 0.3 - 0.5 MPa pressure and can be swivelled through 180° and the nozzle tilted from +15 to -45° to the horizontal.

Centrifuges for the sugar and chemical industries

B. Koros. *Czechoslovak Heavy Ind.*, 1989, (2), 16 - 18.

Descriptions are given of the ARO 80-850 and ARO 80-1250 automatic centrifugals and of the OKK 1400 M continuous machine which is designed to handle *B*- and *C*-massecuites and for affination.

Electrical energy consumption in beet unloading, storage and washing as well as flume and wash water treatment

U. Curdts. *Zuckerind.*, 1989, **114**, 107 - 116 *(German)*.

Electricity consumption in beet and flume/wash water handling was analysed using a model factory operating a 75-day campaign and slicing 8000 tonnes of beet daily. Consumption is highly dependent on the systems used and is subject to considerable fluctuations. Dry systems of beet unloading and conveying consume much less electricity than wet systems. Jet spray washers use less energy than rotary paddle and drum types and thrower-type leaf trash separators and drum-type stone catchers use little energy. The question of electricity consumption in beet pile ventilation is discussed. Analysis of energy consumption in the flume and wash water sector shows how it increases with the number of separate operations for separation and disposal of soil and sand and treatment of waste water, for which multi-stage anaerobic/aerobic processes are becoming more popular. The energy consumption in beet soil and waste water treatment is tending to increase, so that the aim should be to deliver cleaner beets of better quality and use greater care in their handling.

Centrifugal pumps in the sugar industry - a survey

H. Ries. *Zuckerind.*, 1989, **114**, 131 - 134 *(German)*.

Centrifugal pump applications in the beet sugar factory and their materials of construction are surveyed.

Optimization of diffuser draft and sugar loss in pulp by means of isocost charts

K. Andersen. *Zuckerind.*, 1989, **114**, 136 - 138.

The system used by De Danske Sukkerfabrikker to optimize juice draft is described. It is based on the use of isocost charts in which straight lines link the horizontal draft axis with the vertical sugar loss axis; each line represents the total cost of juice draft (i.e. the cost of evaporation) and sugar lost in the exhausted cossettes. The economically optimum draft is indicated by the point of contact between a tangent (drawn parallel to the straight lines) and a curve of sugar loss *vs.* draft superimposed on the chart.

The coupling of a countercurrent cossette mixer with a RT diffuser

J. Dodd. *Zuckerind.*, 1989, **114**, 140 - 141.

A BMA countercurrent cossette mixer was installed as prescalder preceding the RT diffuser at Carlow sugar factory in Ireland in 1980. Details are given of the arrangement and its automatic control. After a number of teething problems (solved mainly by the installation of a computer), the system operated satisfactorily and now provides a cold raw juice that is consistently 15°C above the temperature of the incoming cossettes (28 - 33°C) with very little attention or supervision. The juice is subsequently heated to 65 - 70°C with low-grade steam and condensate. Thermophilic and mesophilic bacteria in the prescalder are controlled by shock doses of formalin and by spraying the beets with a quaternary ammonium salt biocide as they enter the factory.

Scale prevention in a sugar industry evaporator by addition of polymers

M. Tömördi, A. Vojtek and L. Németh. *Cukoripar*, 1989, **42**, 18 - 23 *(Hungarian)*.

Results from the use of three anti-scale agents (the main one being Antiprex SSC, an Allied Colloid product) plus inhibitor at Hajdúság in 1987/88 are discussed. The polymers were added, using three different types of doser, in the thin juice tank before the preheater, between the 2nd and 3rd effects of the quintuple-effect evaporator and between the 3rd and 4th effects. Although 6 - 8 ppm is the generally recommended dosage for Hungarian beet, up to 20 ppm was added, depending on the quality of the beet, and a maximum of 40 ppm at the end of the campaign. Despite a greater daily slice and a higher juice draft, so that more thin juice of lower Brix was fed to the evaporator than in the preceding year, the Brix of the thick juice leaving the evaporator was higher and the steam consumption per 100 kg beet lower, and it was possible to operate with only 4 effects throughout the entire campaign. The costs of treatment are indicated.

Type SE electronic regulators

M. Gusek. *Listy Cukr.*, 1988, **104**, 275 - 277 *(Czech)*.

Descriptions are given of the various electronic regulators in the SE series manufactured in Czechoslovakia and used in sugar factory computerized control systems.

Control circuits with SE regulators

J. Záruba. *Listy Cukr.*, 1988, **104**, 278 - 280.

The use of SE regulators (see preceding abstract) in computerized control circuits is described with mention of specific applications in Czechoslovakian sugar factories.

An automatic control system for the sugar industry

M. Legner and J. Pruska. *Listy Cukr.*, 1988, **104**, 281 - 283 *(Czech)*.

Details are given of a computerized control system developed for the sugar industry; one specific application mentioned is automatic control of a falling-film evaporator station at Ceske Mezirici[1].

Investigation of the recrystallization process during massecuite boiling in an electric field of industrial frequency

S. I. Potapenko, I. S. Gulyi, A. I. Ukrainets and I. S. Shubin. *Dokl. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1988, 9 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (5), Abs. 5 R1577.

A quartz glass cylindrical vessel with flat bottom was used as vacuum pan in an experimental unit. Massecuite was heated by two plane parallel electrodes. For comparison of the results, tests were also conducted in which massecuite was heated with a tubular thermoelectric heater. When the massecuites were heated in an electric field of industrial frequency, the effectiveness of using electro-energy by comparison with thermoelectric heating rose with increase in the solid phase as a result of relative increase in the specific volumetric heat flux. Intensification of the recrystallization process occurred as a consequence of optimum temperature conditions and uniform vaporization within the massecuite.

Effect of the phase relationship on the intensity of the massecuite recrystallization process

S. I. Potapenko, I. S. Gulyi, A. I. Ukrainets and I. M. Grinchuk. *Dokl. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1988, 8 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (5), Abs. 5 R1578.

The amount of water acting as solvent in the mother liquor governs the degree to which sucrose participates in its redistribution between crystals. It was found that increase in the massecuite crystal content was accompanied by a reduction in recrystallization which was directly proportional to sucrose solubility in the water of the mother liquor. Under massecuite boiling conditions, growth in the solid phase leads to a decrease in the amount of water in the mother liquor needed per unit crystal surface area, which explains the fall in recrystallization rate.

Cukroprojekt pre- and main cold limer

D. Kwiatkowska. *Gaz. Cukr.*, 1988, **96**, 174 - 175 *(Polish)*.

The advantages of the unit described earlier[2] are restated and its performance at Tuczno sugar factory analysed to show the improvement in juice purification by comparison with the Brieghel-Müller unit previously employed at the factory.

Examination of the efficiency of purification schemes in terms of quantitative removal of different forms of nitrogen from the juice

E. Walerianczyk and A. Butwilowicz. *Gaz. Cukr.*, 1988, **96**, 175 - 177 *(Polish)*.

The juice purification schemes used at three Polish sugar factories were compared in terms of removal of nitrogenous compounds (total N, protein N, total and specific individual amino-acids and amides). Scheme (i) was the conventional system with an average total lime addition of 1.45% CaO on beet. In (ii) the total CaO usage was 1.50% on beet, external recirculation was used in 1st carbonatation, some of the 1st carbonatation mud was recycled to preliming, 2nd carbonatation mud was returned to raw juice before preliming and milk-of-lime was added at a number of points. Scheme (iii), also involving a lime usage of 1.5% CaO, was one developed by Oglaza & Walerianczyk in which prelimed juice was immediately followed by agglomeration carbonatation at 86°C with subsequent rapid settling; the clear juice was heated to 86 - 87°C, limed, subjected to structural carbonatation and settled (the mud being recycled to liming), followed by simultaneous carbonatation (with possible addition of 0.2 - 0.3% CaO on beet) and crystallization of lime salts in a separate vessel into which a soda solution was also possibly fed, the muds from these last two processes being recycled to raw juice. Analyses showed that system (iii) gave the best results, followed by (i).

A study of methods for purification of raw juice containing dextran

S. Zarzycki. *Gaz. Cukr.*, 1988, **96**, 178 - 179 *(Polish)*.

Dextran of 100,000 and 200,000 molecular weight was added at 200 - 1000 mg/dm^3 to raw juice which was then purified by the conventional process and by a modified scheme which included preliming to pH 10.5, precarbonatation and settling followed (if the dextran content exceeded 500 mg/dm^3) by liming to pH 9.0 - 9.2, settling and filtration or (if the dextran content was below 500 mg/dm^3) by liming to pH 10.5, settling, supplementary liming, 2nd carbonatation to pH 9.0 - 9.2, settling and filtration, mud being recycled to various points in the scheme. Comparison of the two schemes showed that the modified system gave a higher thin juice purity with lower contents of loosely bound N, α-amino acids, total acids, dissolved ash and lime salts than the traditional process.

Purification of milk-of-lime

M. Kwasniak. *Gaz. Cukr.*, 1988, **96**, 179 - 180 *(Polish)*.

A two-stage system for milk-of-lime treatment at Swidnica sugar factory involves a large hydrocyclone from which the overflow passes via a separator to a mixer tank while the underflow is transferred via the same separator to a classifier for sand and grit removal, after which it flows to a settling tank and thence to the mixer tank where it is added to the overflow. The scheme prevents blockage of the outlet nozzle previously encountered with a hydrocyclone of normal dimensions and has a number of other merits which are listed.

1 Pruska *et al.*: *I.S.J.*, 1989, **91**, 92A.
2 Ginal: *ibid.*, 83A.

Sugar refining

Storage and raw material transport

D. Reimelt. *Zucker- und Süsswaren Wirt.*, 1988, **41**, 173 - 178; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (24), Abs. 24 R742.

Refined sugar transport by railway, unloading by pneumatic conveying or under gravity, etc. are discussed. Pneumatic systems can convey up to 22.65 tonnes/hr. Requirements of sugar silo construction and of ancillary equipment for maintenance of suitable conditions in the silo and protection of the environment are examined. It is recommended to empty a silo completely every 4 - 6 months and clean it thoroughly by dry or wet means. To minimize sugar crystal abrasion in pneumatic pipelines the flow rate should be between 9.14 and 18.28 m/sec and the ratio between radius of curvature and pipe diameter should be 10 - 50.

Sucrose crystallization in small droplets of sugar solution in a spray drying process

A. V. Zubchenko and G. O. Magomedov. *Izv. Vuzov, Pishch. Tekh.*, 1988, (5), 114 *(Abstract only)*.

Crystallization of very small droplets of sugar solution was investigated with the aim of controlling the structure of powdered sugar as intermediate product obtained by spray drying. It was found that an amorphous sugar can be obtained by spray drying parallel streams of sprayed particles and a gas, while sugar having an amorpho-crystalline structure is obtainable by priming from without and using a vortical, mixed stream of sprayed particles and gas.

A line for grouping and boxing packets of white sugar

V. Irishchepa and N. G. Rudenko. *Sakhar. Svekla*, 1989, (1), 48 - 50 *(Russian)*.

At Odessa refinery, 1-kg packets of sugar pass in two parallel lines along a continuous 1.5 m long conveyor provided with guide rails; a section acting as extension to the conveyor has an end buffer plate which stops further progress of the packets and a pneumatically operated plate which pushes 2 lines of 4 packets onto a belt conveyor at right angles to the first conveyor. The batch of 8 packets is carried forward a small distance and held for a sufficient time to allow a second 8-packet batch to be brought into contact with it; the complete 4×4 batch moves forward to a point at which a cardboard box is placed manually over it and adhesive tapes applied, after which the box passes over a series of manipulator plates which invert it so that the other end can be sealed and sent to the warehouse. The economic advantages of the 3-man system are indicated.

Production of plantation white sugar in a semi-refined/raw sugar plant

B. S. Gurunathan. *Sugar J.*, 1988, **51**, (7), 13 - 14.

Under a previous system used at the raw sugar factory of Kilombero Sugar Co. Ltd. in Tanzania, the single-cured *C*-sugar was used for raw sugar boiling while the *A*- and *B*-sugars were melted and sent to the refinery section. However, although the semi-refined sugar obtained was of excellent quality, its production costs were too high as a result of excessive consumption of steam, fuel oil and consumables such as lime and sulphur. It was therefore decided to produce plantation white sugar from the *A*- and *B*-strikes in a 4-boiling scheme and cure the sugar in the refinery automatic batch centrifugals; since these machines do not have light and heavy molasses separators, the molasses from the *A*-massecuite was of too high a purity and the *B*-strike was introduced to control the low-grade boiling purities. The molasses from the *B*-strike is recycled to the raw sugar factory to be used in the *B*- and *C*-strikes. The previous high consumption levels are considerably lower in the new scheme, and the amount of water evaporated in the pans has been reduced by about 100 tonnes/day. The load on the continuous centrifugals previously used for raw sugar is 60% lower now that the white sugar is cured directly for bagging. The scheme has been used successfully for three seasons.

Decolorization of sugar cane solutions with active carbon

A. B. Sosa, A. M. Jándula, N. A. de Molineri and M. L. G. de Soria. *Taiwan Sugar*, 1988, **35**, (6), 23 - 27.

Experiments are reported on decolorization of 20, 40 and 60°Bx raw sugar solutions with active carbon at 20, 50 and 70°C; initial colour levels were 1919 and 2750 ICUMSA units and performance rose with temperature of treatment, best results being obtained with treatment of 20°Bx solutions at 70°C (59 - 82% colour reduction at 0.2 - 5.1 bed-volumes).

Weighing in packaging systems at BC Sugar

G. Belic. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 15 pp.

Details are given of the equipment used at the Vancouver refinery of BC Sugar in Canada in the weighing and filling of sugars and syrups, including mechanical and electronic bucket scales, a vertical auger filler with feedback weight control, electronic belt checkweighers, load cell platform scales, liquid fillers, quantity control platform scales and large I-beam load cell scales. Appropriate Canadian Weights and Measures Regulations are presented as well as a list of all container sizes and their types, and the economic importance of the accuracy of a filler is underlined.

Packaging maintenance at Savannah sugar refinery

J. H. Dean. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 5 pp.

The staff responsible for maintenance of the packaging plant at Savannah and operation of the system are described.

Laboratory studies

Nitrogenous colorants

L. D. Bobrovnik and V. N. Rudenko. *Sakhar. Svekla*, 1988, (6), 46 - 48 *(Russian)*.

While earlier work indicated that colouring matter isolated from factory products was identical to model systems of sucrose caramelization products, sugars alkaline degradation products and melanoidins, later work cast doubt on this finding. Glutamic acid was added to a model aqueous solution of sugars alkaline degradation products, the pH adjusted to 9 with CaO and heating conducted for 10 hr on a boiling water bath, during which time samples were taken for U.V. spectrophotometry. The patterns of the spectra before and after heating were identical, with only slight difference in optical density. Colouring matter was isolated by treatment of the solution with active carbon and elution with aqueous pyridine; analysis of the vacuum-dried fraction gave 44.53% C, 4.69% H, 3.28% N and 47.05% O. However, infrared spectra of an alkaline degradation fraction as occurs during processing and of colouring matter produced by heating the fraction with glutamic acid revealed the presence of nitrogenous compounds, demonstrating the invalidity of the model solution. A detailed analysis is given of the spectra and the reactions and compounds associated with glucose and fructose dehydration in an alkaline medium are suggested, starting with the formation of dicarbonyl derivatives.

Comparison of methods for determining the water content in crystal sugar

J. Copikova, P. Kadlec, I. Kosovicova, T. Chaloupka and A. Stechova. *Listy Cukr.*, 1988, **104**, 244 - 250 *(Czech)*.

Comparison was made between six methods for determination of water in sugar: (1) determination of surface moisture by drying for 1.5 hr at 105°C, (2) determination of moisture loss by drying for 3 hr at 105°C, (3) determination of weight loss after 21 days in a desiccator at 25°C, (4) determination of total moisture after 21 days in a desiccator at 25°C and final drying for 1.5 hr at 105°C, (5) Karl Fischer titration with dissolution of the sugar in unsaturated methanol, and (6) as (5) but using formamide. Statistical analysis of the results showed correlations between the methods ranging from r = – 0.218 to r = +0.891 with nine values between 0.4 and 0.5. Despite the official recognition of water loss determination by drying, this method is not considered sufficiently accurate, and a number of the methods are both inaccurate and time-consuming. The Czechoslovakian DST-2/MB-1 Karl Fischer titration unit is found to have more disadvantages than advantages, and some modifications are suggested.

Use of capillary isotachophoresis in sugar factory analysis

F. Kvasnicka, J. Copikova and E. Sterzikova. *Listy Cukr.*, 1988, **104**, 255 - 259 *(Czech)*.

Details are given of (K + ammonium), Na, Ca and Mg separation and determination by isotachophoresis in sugar beet, juices and molasses and of the same cations but with K and ammonium separate in sugar, molasses, etc. Sulphuric acid (0.005 mole/litre) or KOH + L-histidine (0.005 + 0.02 mole/litre) was used as leading electrolyte, and lithium citrate (0.005 mole/litre) as terminating electrolyte. Each analysis took about 15 min. Good agreement was obtained with results obtained by atomic absorption spectrophotometry. Advantages of isotachophoresis include the ability to determine a number of cations together in one analysis and the lack of need to reduce the sucrose content or remove it as in AAS or chromatographic methods. The absence of disturbance by sucrose allows solutions of 60% solids concentration to be analysed.

Analysis of pol and sucrose in burnt, stale cane

Anon. *Ann. Rpt. Mauritius Sugar Ind. Research Inst.*, 1987, 42 - 43.

In tests to see if the formation of dextran in stale cane (kept for 6 - 20 days after harvest) could inflate the polarimeter reading and apparent purity, the direct purity values were generally either the same as or lower than the gravity purities and tended to decrease after about 10 days despite increase in dextran. While addition of dextran to a fresh juice increases the pol markedly because of the lack of effect of other constituents, dextran formation is not the only change in deteriorating cane, and an increase in the reducing sugars content causes a decrease in the pol reading, which may counteract the effect of dextran.

Quantitative HPTLC of sugars. I. Separation and derivatization

K. Patzsch, S. Netz and W. Funk. *J. Planar Chromatogr.-Mod. TLC*, 1988, **1**, (1), 39 - 45; through *Anal. Abs.*, 1989, **51**, Abs. 1D111.

Glucose, fructose, lactose (or maltose), sucrose and raffinose were separated by high-performance thin-layer chromatography on Si 60, Si 50,000 and NH_2-phase plates. The mobile phases were 85% aqueous acetonitrile for the silica plates and 16:3:2 acetonitrile:water: phosphate buffer of pH 5.9 for the NH_2 phase. Eleven different post-chromatographic derivatization and detection methods (full details given) were evaluated for each carbohydrate. Detection limits were <10 - 50 ng per spot.

Electrophysical properties of sucrose solutions

V. A. Domaretskii, I. A. Romanovskii, V. N. Vendichanskii and T. I. Romanovskaya. *Pishch. Prom.*, 1988, (3), 49 - 50; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (2), Abs. 2 R1434.

The electrophysical parameters of sucrose solutions are governed by concentration and temperature and depend on the wavelength of the electromagnetic field in which they are measured. Results obtained may be used to calculate energy dispersion when solutions are

treated in a high-frequency electromagnetic field and may also be applied in the field of electrohydrometry.

Colour determinations on raw sugars - a method comparison

R. P. DeStefano. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 105 - 111.

The colour content of 149 raw sugars from a number of Florida sugar factories and from different crop years was measured by ICUMSA Method 2 (which employs a pH of 7, a wavelength of 560 nm, an affined sample of 50°Bx but no correction for turbidity) and modified Savannah Method 4 as used for Contract No.14 raw sugar by the New York Coffee, Sugar & Cocoa Exchange (employing a pH of 8.5, a wavelength of 420 nm, an unaffined sample of 25°Bx and an affined sample of 50°Bx, and a correction for turbidity). While a high correlation (r = 0.81) was found between the two methods for colour of the affined sample (compared with r = 0.71 for the unaffined samples), poorer correlation (r = 0.56) existed between the colour of the affined and unaffined samples as measured by the modified Method 4, indicating that the darkening of the molasses layer on the outside of the crystals had little effect on the occluded colour not removed by affination. An examination of the economic consequences of the re-defined colour premium/penalty schedule in Contract No.14 showed that the modified Method 4 essentially eliminates all premiums (as against sizeable premiums under Contract No.12 using the ICUMSA method), whereas sugars of very high colour content are less penalized than under the older system.

HPLC analysis of raw sugar: a rapid method

W. S. C. Tsang, M. A. Clarke, M. Valdes and A. V. Bailey. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 138 *(Abstract only).*

In the past, direct HPLC analysis of raw sugars has not been practical for factory use. Available methods have required post-column derivatization or non-durable columns or the use of organic solvents to obtain analyses of sucrose and reducing sugars. A recently developed method, using water as a solvent for analysis of invert in raw sugar in under 8 min, is reported.

On-line HPLC analysis for sucrose

R. Sutton. *J. Amer. Soc. Sugar Cane Tech.*, 1988, **8**, 138 *(Abstract only).*

A new on-line analyser for sucrose is described and the accuracy and precision of results obtained are discussed.

The effect of surface tension and viscosity of the liquid phase on absorption of pure CO_2 and SO_2

G. Vazquez, F. Chenlo and F. Paleo. *An. Quim. A/Real Soc. Esp. Quim.*, 1988, **84**, (3), 398 - 404; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (3), Abs. 3 R1540.

The absorption of pure CO_2 and SO_2 gases by aqueous sugar solutions (32.1 - 107.1 g/litre) was studied at 25°C in the presence of Na lauryl sulphate (5×10^{-3}%) in a graphite column formed from 8 spheres 18 mm in diameter and 8 cylinders 5.8 mm in diameter and 6.8 mm high. A relationship showing the dependency of the absorption rate constant on surface tension and viscosity of the liquid phase was obtained.

Near-infrared spectroscopy in sugar analysis

G. Vaccari, G. Mantovani and G. Sgualdino. *Sugar J.*, 1988, **51**, (7), 4 - 8.

See *I.S.J.*, 1989, **91**, 53A.

Polarimeters and refractometers: a market survey

Anon. *Zuckerind.*, 1989, **114**, 117 - 125.

Details are given of 19 polarimeters and 26 refractometers and of their suppliers. The data include application, dimensions, technical specifications and special features (in English and/or German).

Rapid determination of the glucose content of molasses using a biosensor

J. Bradley, A. J. Kidd, P. A. Anderson, A. M. Dear, R. E. Ashby and A. P. F. Turner. *Analyst*, 1989, **114**, 375 - 379.

The feasibility of using a ferrocene-mediated glucose oxidase biosensor to determine the glucose content in beet and cane molasses (intended for use as substrate in e.g. alcohol, yeast and citric acid manufacture) was investigated. The biosensor had a response reproducibility better than that of a HPLC procedure and comparable to that of GLC of acetic anhydride derivatives while not needing the sample preparation involved in GLC. It was also free from the interference by certain sugars that has been found with a Yellow Springs Instrument Co. glucose analyser and may be used directly in a flow stream for routine quality control. The biosensor is described.

Colouring matter in white sugar

I. F. Bugaenko, A. A. Yasin and V. D. Shcherbukhin. *Pishch. Prom.*, 1989, (1), 48 - 50; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (9), Abs. 9 R1460.

Tests are reported on isolation of colouring substances from white sugar and investigation of their nature. It was found that the colorants were condensation products formed during the manufacturing process. The absence of a carbohydrate complex in fraction A was due to the fact that the colorants in this fraction were formed by condensation of monosaccharide alkaline thermal degradation products and amino-acids; fraction B colorants did include a carbohydrate component, namely monosaccharides and their degradation products plus amino-acids. From the presence of carboxyl groups in both fractions, the almost negligible decolorization that is effected by oxidants and reducing agents, the effectiveness of colouring matter removal by Ca carbonate and the high degree of affinity, it is concluded that molecules of these colorants contain some carboxyl groups.

By-products

Continuous fermentation technology developed at NCL for ethanol production from molasses

A. P. Pendse. *Bharatiya Sugar*, 1988, **13**, (11), 65, 67 - 68.

In a process developed at the National Chemical Laboratory in Poona, yeast strain ATCC 26602 is grown in one of pair of fermenters on sterilized, diluted molasses containing about 9% fermentable sugars; an overflow in the form of a broth containing 4% w/v alcohol is fed to the second fermenter which also receives additional molasses and yields an overflow containing 5.5 - 6.0% alcohol. Some air is continuously bubbled into both vessels. Water used to scrub CO_2 generated by the process may be used for molasses dilution. Fermentation efficiency is 80 - 90% and total residence time is 8 - 10 hr, yielding up to 280 litres ethanol per tonne of molasses of 50% total and 47% fermentable sugar content. These results were obtained with two 150-litre fermenters that had been in operation for 2.5 months.

Effective use of manufacturing wastes

A. F. Ponomarev and I. A. Boiko. *Sakhar. Svekla*, 1988, (6), 14 - 16 *(Russian)*.

Experience in pressing, drying, storage and ensilage of beet pulp at factories in the Belgorod region of the Russian Federation and its use as cattle feed are discussed and a flow diagram presented of a pulp drying scheme.

Plant for preparation of filter cake for calcination

A. A. Savun *et al. Sakhar. Svekla*, 1988, (6), 35 *(Russian)*.

Laboratory and factory-scale experiments on calcination of filter cake are reported in which powdered lime containing 80% CaO and particles no larger than 0.15 mm was thoroughly mixed with it at 10 - 12% by weight and the mixture then formed into 80 - 100 mm long briquettes which were then hardened and dried; after storage under weight for 7 - 10 days the material was kept for at least 1 month. Lime of high CaO content (85.7 - 90.0%) was obtained by calcining 27.5 tonnes of lime-filter cake mix in an experimental kiln. The economic benefit of regenerating filter cake at a factory of 3000 tonnes daily slice is indicated.

Improvement of animal feeds production from molasses, and progress in bagasse pulp and paper making

Y. T. Liu. *Taiwan Sugar*, 1988, **35**, (4), 17 - 20, (5), 19 - 26.

L-lysine used as animal fodder is now produced in large quantities from molasses in Taiwan. In experiments to increase fermentation yields, a mutant of *Brevibacterium lactofermentum* was able to produce 48 g of L-lysine HCl per litre of medium (containing 10% sugar), but the growth rate of the mutant was greatly reduced by multi-stage mutation; however, fusing the mutant with one that produces L-glutamic acid gave a higher lysine yield without loss of growth rate. Recent advances in the manufacture of bagasse pulp and paper as reported in the literature are described.

Use of 3CR12 in sugar and ethanol production

C. M. Wenman. *S. African Sugar J.*, 1988, **72**, 401 - 402.

An account is given of the use of 3CR12 stainless steel for equipment exposed to raw juice at Triangle sugar factory in Zimbabwe where mild steel was exhibiting high rates of corrosion. Detailed information is given on the use of 3CR12 for two fermentation vats in which ethanol is produced from molasses in a 48-hr cycle. Within months of commissioning a mild steel fermenter in 1980, corrosion became evident and weld repairs became necessary after 2 years; since mild steel is commonly used for fermenters, it was concluded that the problem was due to defects in the particular batch of steel plate used and to poor welding, but use of thicker plate and careful attention to the welding in the construction of a second vat failed to solve the problem. Because of the absence of corrosion of 3CR12 steel in the new vessels it was decided to use this material for another 3 fermenters.

Commercial potential of bagasse as a cattle roughage

P. A. Inkerman, G. D. Tudor, N. J. Ashbolt, C. F. Brown, S. R. Lucas and M. Webster. *Sugar J.*, 1988, **51**, (5), 4 - 10.

See *I.S.J.*, 1989, **91**, 76A.

Screening of yeast strains for production of ethanol from molasses

P. S. Shinde, R. B. Natu and S. J. Jadhav. *Bharatiya Sugar*, 1988, **14**, (1), 87 - 88.

Thirteen yeast strains were isolated from cane juice and molasses and tested for ethanol production together with eight NCIM and NRC strains. Alcohol yields in the range 8.34 - 8.98% (250 - 269 litres/tonne of molasses) were obtained with certain selected strains under laboratory conditions.

Continuous ethanol fermentation by immobilized yeast cells

R. B. Natu, P. S. Shinde, C. S. Shinde, S. V. Patil and S. J. Jadhav. *Bharatiya Sugar*, 1988, **14**, (1), 89, 91, 93, 95.

See *I.S.J.*, 1988, **90**, 113A.

The composition and technological properties of mud in molasses storage

E. S. Mints, V. P. Kuklina and T. A. Pozdnyakova. *Pishch. Prom.*, 1988, (8), 36; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (2), Abs 2 R1444.

A survey was conducted at factories producing citric acid to obtain data on the amount of mud formed during molasses storage in tanks. The quantity of mud was in the range 0.7 - 15.0% depending on molasses composition, storage and other factors. It was recom-

mended to use the mud for citric acid manufacture either mixed with the molasses or separately (for preparation of supplementary feed material).

Scope for modernization and upgrading of distilleries in India

H. C. Bhandari. *Bharatiya Sugar*, 1988, **14**, (1), 97, 99 - 100, 105, 107 - 108.

The current status of the distillation industry in India is examined and measures to overcome the problem of under-utilization of the available capacity are suggested. Adoption of a number of improved techniques in alcohol fermentation of molasses is advocated, including the use of yeast strains that tolerate high temperatures and high alcohol concentrations, control of microbial contamination, temperature control, molasses pre-clarification, yeast recycling, replacing batch with continuous and semi-continuous processes, use of immobilized yeasts and of suitable instrumentation, improvement in molasses quality and proper treatment of vinasse.

An integrated approach to the sugar industry problems of the Latin American and Caribbean countries

N. Rivero. *Proc. Inter-American Sugar Cane Sugar Cane Seminar*, 1987, 9 - 16.

The international sugar situation and major problems within the sugar industries of Latin American and Caribbean countries are discussed and aspects of cane, bagasse and molasses by-products utilization examined.

Development of new industrial processes with special reference to the cane sugar industry

M. Filippi. *Proc. Inter-American Sugar Cane Seminar*, 1987, 29 - 35.

The stages in development of a new industrial process, particularly one based on cane sugar derivatives as raw material, are described; they include creation of an idea; a pre-feasibility study and laboratory and pilot plant experiments, with evaluation of each set of results and consequent decision taking; a study of the possible impact on the environment and measures to protect it; and follow-up studies.

Cane sugar products: new technological developments

R. Katzen and G. D. Moon. *Proc. Inter-American Sugar Cane Seminar*, 1987, 36 - 39.

Molasses and bagasse by-products utilization and sucrose derivatives are surveyed with the aid of a diagram.

Biodegradation of filter muds

C. R. Morales. *Proc. Inter-American Sugar Cane Seminar*, 1987, 80, 83 - 85.

Filter cake was treated with a solution of enzymic digester at the rate of 100 cm^3/tonne as the cake was being unloaded from a trailer for storage in a 3-tonne heap. Analysis of the cake up to 60 days after treatment showed that the N content was unaltered, the P, Ca and Mg contents rose and the K fell slightly by comparison with untreated cake; there was also a marked decrease in the height of the pile (from 1.63 to 0.70 m). The cake was thus a valuable source of nutrients for cane crops.

High-test molasses - an alternative raw material for the production of Puerto Rican rum

A. Belardo. *Proc. Inter-American Sugar Cane Seminar*, 1987, 91 - 105.

Rum accounts for 12 - 14% of the gross annual income of Puerto Rico, but with a fall in sugar production in Puerto Rico it has been necessary to import the blackstrap molasses (BM) traditionally used as raw material, the proportion needed rising from 42.4% in 1977 to 85.8% in 1986. Since 1980, research has been conducted on the possible use of high-test molasses (HTM) (partially inverted cane syrup of approx. 85°Bx) as an alternative raw material. Comparative tests demonstrated the need for additional nutrients; however, although addition of ammonium sulphate, potassium phosphate and yeast extract to the HTM increased the fermentation rate and alcohol yield, yeast extract is expensive. Further experiments showed that BM supplemented with ammonium sulphate was the best nutrient source, while Yeastex 61 (which is less costly than yeast extract) plus ammonium sulphate has also provided high fermentation rates. Comparison of distillates from BM and HTM showed higher concentrations of propyl, *iso*-butyl, *iso*-amyl and *n*-amyl alcohols in the former while the latter contained only traces of *n*-amyl alcohol but higher concentrations of ethyl and *iso*-amyl acetates, acetaldehyde and *n*-butyl alcohol; the effect of BM in a BM-HTM mixture on the composition of the distillate is indicated. The ageing of HTM distillates and the costs of treatment of vinasse from HTM rum are also discussed.

High-test molasses: a new source of liquid sugar

O. C. Lopez. *Proc. Inter-American Sugar Cane Seminar*, 1987, 106 - 111.

Details are given of an ion exchange process developed by Applexion S.A. in which high-test molasses is diluted to 40°Bx with sweet-water and phosphoric acid, lime and flocculants added. After filtration, the liquor is delimed and subjected to two demineralization/decolorization stages; in the first, colloidal matter is removed on adsorbent and cation exchange resin followed by removal of anions and colouring matter on adsorbent and anion exchange resin, while the second stage involves passage through cation exchanger followed by anion exchanger and adsorbent resin. After a final decolorization by ion exchange, the solution is treated with a mixed bed of cation + anion exchange resin to remove all traces of ash and the liquor sterilized by filtration. The liquor is then evaporated to yield a 75 - 77°Bx liquid sugar of 30 ICUMSA colour units containing approx. 43% sucrose, 28% glucose, 24% fructose and 4% raffinose.

A RANGE OF QUALITY INSTRUMENTS

SUMA PRODUCTS

CRYSTALLIZATION AIDS

The **Crystaloscope** offers efficient viewing of the boiling process. With over 200 presently in use it has proved an important economically priced addition to our range.

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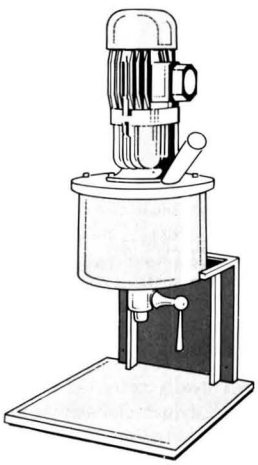
This mill will produce after 5 hours grinding about 95% nuclei of below 10 micron.[1]

1. Report of Crystallographic Laboratory University of Utrecht, Holland.



Slurry Mill

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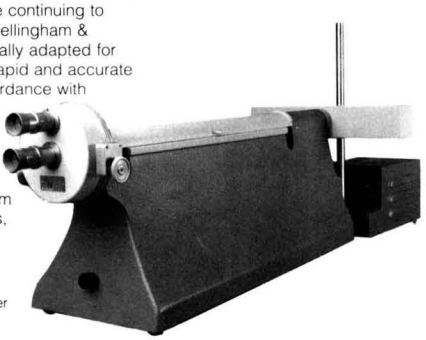

Saccharimeter

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2 E. Hugot - Handbook of Cane Sugar Engineering. 1960. p. 517

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SUMA PRODUCTS

eratures to indicate the pattern other than schematically. In a separate calculation with my own results of $R = 3 \times 10^{-6}$ at 70°C and $\sigma = 0.1$, I estimate $\delta = 60$ μm.

(B) *Ordinary temperature, 30°C*

Here we can resolve the determined R into its diffusion and surface integration components as well as utilize R_{Diss} directly. In the first instance the E/T curve, Figure 2, indicates a 3:1 ratio of diffusion to surface integration while the directly determined ratio is at least 2:1[11]. Taking Mantovani's values[14] at $\sigma = 0.1$ of $R_G = 1.1 \times 10^{-6}$, $c - c_s = 0.040$ and $D = 0.3 \times 10^{-6}$ gives $\delta = (0.8/3) \times 0.04$ or 100 μm, as before.

(C) *Gels*

Diffusion, growth and dissolution in gels are informative since free and forced convention are eliminated or at least minimized. In a preliminary experiment at 30°C a crystal grew at the rate of 0.78×10^{-6} g/cm²/sec in a 70°Brix syrup to which 2 g of agar per 100 W had been added, while without the agar the rate was 0.80×10^{-6} g/cm²/sec. At 68.5°Brix virtually no growth or dissolution occurred but at 68.1° dissolution took place at rates of 0.1 and 0.8, respectively, both $\times 10^{-6}$ g/cm²/sec. At 67°Brix the ratio was again the same at rates of 0.4×10^{-6} g/cm²/sec in the presence of agar and 0.8×10^{-6} without. The gels were firm but elastic and no swelling or synerisis was observed during the time of the experiment.

Much firmer, almost glass-like, but still soft gels were obtained at 4 g agar/100 water. The growth and dissolution rates were similar, i.e.

		$R \times 10^{-6}$ g/cm²/sec	
Brix	g S/100W	Gel	Solution
70°	233	0.24	0.45
69°	223	0.12	0.2
68°	213	−0.12	−0.2
67°	203	−0.87	−0.8

Again, these are close one to another within a factor of two, thus suggesting an unchanged pattern of growth and dissolution in these gels and pure solution. The solubility is, apparently, changed very little, <<2% at this higher concentration of agar and pH 7 - 8. As dissolution proceeds the rate in syrup increases more rapidly than in the gel, probably on account of greater mobility due to free convection, etc. In the presence of agar, reticulated surfaces appear[15].

The movement of small molecules and electrolytes through gels is about the same as free diffusion but larger molecules are apt to be impeded[16], especially in stronger gels. The only information available on sucrose is that of Friedman & Kraemer[17] and of Brown & Chitumbo[18], both giving values in gels from 1/2 to 1/5 the free water values. In two separate extractions of sucrose from 68°Brix syrups containing 2 g agar/100 water effective diffusion coefficients of 2.6 and 6.1×10^{-6} were found. These are somewhat higher than the 0.9×10^{-6} calculated from Schliephake's equation but upon repeating with fresh 4% gels in varnished tubes[17] comparable results were obtained. These only slight changes of R_G, R_{Diss} and D, all within a factor of two of aqueous solution values, suggest that the previous estimate of $\delta = 100$ μm remains effectively unchanged.

A few qualitative observations with gelatin were similar. Here, careful regulation of pH must be attained. Only weak silica gels formed with trimethyl siloxane at high sugar concentrations; besides this, the uncertainty of the attending methyl alcohol production and consumption of water in the hydrolysis detract from this method of making silica gels. It is planned to look into water glass and other gels.

14 Mantovani: *Proc. 13th Congr. C.I.T.S.*, 1967, 279.
15 VanHook: *Sugar Tech. Rev.*, in press.
16 Tuwiner: "Diffusion and membrane technology", (ACS Monograph) 1962.
17 *J. Amer. Chem. Soc.*, 1930, **52**, 1295.
18 *Trans. Faraday Soc.*, 1976, 1974.

Sugar grain size calculation methods

Part II. Comparison of results with raw sugar

continued from page 219
difficulty in drawing the graph.

Conclusions

(1) Dispersion in obtaining the MA and CV (or n) values allows the reporting of results with three and two significant figures, respectively, using the Butler, Rens, numerical RRB and Powers methods.

(2) The Butler method and its corrected variant yield mean aperture (MA) values significantly higher than the other four procedures reviewed, viz. the Rens, numerical RRB, and Powers methods and the numerical variant of the last.

(3) No significant differences are found between the CV values obtained by the methods of Rens and Powers in their two variants and the corrected Butler method. There is significant inverse correlation between the values of coefficient n and the coefficients of variation (CV) yielded by the first three above-cited techniques.

(4) Through the correlation coefficient obtained from the graph of cumulative percentage versus aperture, it was possible to find that, although the principle of the RRB methods adjusts itself, with higher accuracy, to the crystal size distribution of Cuban sugars (0.9825), the procedures of Rens (0.9797) and Powers (0.9798) are as good as the first for this purpose.

Zimbabwe sugar exports, 1988[1]

	1988	1987
	tonnes, raw value	
Botswana	44,308	42,326
Canada	49,818	61,654
EEC	64,105	117,143
Mozambique	800	29,060
US	11,208	17,894
USSR	0	144,761
Zaire	0	60
Unknown	27,276	0
	197,515	282,898

1 *I.S.O. Stat. Bull.*, 1989, **48**, (3), 39 - 40.

Effect of iron on sugar crystals during storage

By M. Prasad, P. K. Jain and G. D. Nigam
(Physical Chemistry Division, National Sugar Institute, Kanpur, India)

Introduction

Deterioration in the sugar store has been known to occur for a long time. The problem was severe in India during the 1950's and many cases were reported by factories from different part of the country which were producing carbonatation white sugar. Some factories experienced acute storage problems. The causes of sugar deterioration in the stores were not known satisfactorily and so were investigated by Ramaiah & Sundaraman[1]. After elaborate studies in the laboratory and factories they suggested that caramelization occurs in the sugar crystal, catalysed by traces of alkali, particularly potassium carbonate, embedded in the crystal. Recently (1987), a factory (A), producing white sugar by double carbonatation and double sulphitation, reported that the colour of the sugar in its stores deteriorated within six to eight weeks. Such fast discoloration of crystal sugar appeared surprising. Deterioration of sugar by alkaline caramelization is known to be much slower and perhaps could not be the cause in this case. An attempt was made, therefore, to investigate physico-chemical factors which might have influenced brown colour development in the stored crystal sugar.

Several reactions causing development of colour in stored sugar have been suggested including: (i) slow caramelization[2,3], (ii) formation of melanoidins[4,5], (iii) formation of polyphenolic colorants[6-8], (iv) excessive moisture adsorption by the crystal, and (v) the presence of humus compounds in the sugar crystals[9,10].

Other unknown unestablished causes may, of course, be the reason for the colour. The effect of iron in the sugar refinery was studied by Riffer[11], who observed that the iron content affected the quality and colour stability of the sugar crystal. There have not been many reports on the elimination of iron during carbonatation. However, it was reported by Anjal *et al.*[12] that a major portion of the iron, i.e. about 80%, is removed during clarification. They also

M. Prasad P. K. Jain

G. D. Nigan

reported that mill rollers do not add any substantial amount to the soluble iron content of the mixed juice.

The effect of inorganic cations, viz. Fe^{++}, Cd^{++} and K^{+}, on crystal shape, size and growth was investigated by Hernández *et al.*[13] who found that the rate of crystal growth decreases in the presence of these impurities while the crystal shape was deformed. Tiwari[14] also investigated the effect of Co, Mn and Zn salts on the rate of crystallization; he observed that Mn salts seemed to increase the rate of crystallization. To investigate the rapid deterioration of our white sugar colour, the authors visited the factories concerned in the off-season as well as during the crushing period. During the crushing season juice, syrup, massecuite, magma, melt and sugar samples were analysed in order to determine the extent of the elimination of iron during the various stages of juice processing. During the off-season samples of deteriorated sugar from different regions of the stores were analysed for iron to assess its relationship with sugar deterioration, the data collected being shown in Table I.

Materials and methods

Sampling: For analysis of mixed

1 *Proc. Sugar Tech. Assoc. India*, 1975, **25,** 153, 161, 227.
2 Ramaiah & Sundarman: *ibid.*, 16, 257.
3 Ramaiah & Nemade: *Proc. 13th Congr. ISSCT*, 1968, 385 - 394.
4 Fleming *et al.*: *ibid.*, 1781 - 1800.
5 Agarwal *et al.*: *Proc. Sugar Tech. Assoc. India*, 1972, **38,** M-38.
6 Gupta *et al.*: *ibid.*, 1970, **36,** 1.
7 Sharma *et al.*: *ibid.*, 1978, **44,** M-123.
8 Idem: *Proc. 17th Congr. ISSCT*, 1980, 2137 - 2144.
9 Jackson: "Soil chemistry analysis" (Constable, London) 1958, p. 142.
10 Prasad & Dubey: *Proc. Sugar Tech. Assoc. India*, 1982, **46,** C-1.
11 *Proc. 1984 Conf. Sugar Processing Res.*, 1986, **50,** 231 - 251.
12 *Proc. Sugar Tech. Assoc. India*, 1974, **40,** M-85.
13 *Centro Azúcar*, 1985, **12,** (1), 139 - 144; (2), 113 - 118.
14 "Study on kinetics of crystallization of sucrose" Ph.D. thesis (Kanpur University), 1980.

Table I. Iron in quickly deteriorating sugar crystals at Factory A

Store No.	Layer	pH of 50% solution Before boiling	After boiling	Fe_2O_3, mg/kg
6	T	5.70	5.95	2.43
6	M	5.40	5.61	5.91
6	B	5.70	5.84	4.77
3	T	6.20	–	11.91
3	M	5.72	6.32	7.14
3	B	6.08	6.33	7.14
230	T	6.11	6.27	13.08
230	M	6.09	6.19	7.14
230	B	6.11	6.28	7.14
231	T	6.18	6.28	7.14
231	M	6.14	6.34	5.94
231	B	6.22	6.25	9.51
233	T	6.12	6.26	2.43
233	M	6.09	6.40	11.91
233	B	6.20	6.53	9.51
234	T	5.23	5.80	–
234	M	6.02	6.12	7.14
234	B	6.10	6.26	7.14

T = top; M = middle; B = bottom

juice, first and second carbonatation juice, syrups and massecuites, composite samples were obtained by collecting the appropriate samples from their respective check valves at intervals of two minutes over a period of twenty minutes.

Estimation of iron: Iron in mixed juice, first carbonatation juice, second carbonatation juice, sulphited juice, sulphured syrup, unsulphured syrup, massecuite, magma, melt and sugars was estimated spectrophotometrically by the procedure described by Jackson[15]. A brief description of the procedure is as follows:

A 1.0 ml sample of known dilution, the iron content of which is to be determined, is taken in a 25 ml volumetric flask and about five to six drops of dinitrophenol added. As soon as the yellow colour appears 4 drops of 1M H_2SO_4 is added and the acid then neutralized with 2M Na_2CO_3 until the colour disappears. 2 ml of 10% hydroxylamine hydrochloride and 1 ml of 1.5% orthophenanthroline are added and the contents of the flask shaken well. Finally the solution is made up to the mark with distilled water. An orange-purple colour develops having maximum absorption at 490 nm.

A similar procedure is adopted to make a standard curve and the concentration of iron in unknown samples is determined with the help of this standard curve.

Estimation of phosphate content: Phosphate contents in mixed juice, clear juice, sulphured and unsulphured syrup were estimated spectrophotometrically by the procedure[9] described below:
A 1.0 ml of known dilution is treated in a 50 ml volumetric flask with 2 - 4 drops of 2,4-dinitrophenol (0.25%) until a yellow colour appears, when 2 - 4 drops of 1 M H_2SO_4 is added. Addition of 2 ml of sulphomolybdic acid, 35 ml distilled water and 0.5 ml chloro-stannous acid turns the solution deep purple within 3 - 4 minutes, this solution having maximum absorption at 660 nm. A similar procedure is adopted to make a standard curve and the phosphate concentration in unknown samples determined as P_2O_5 with the help of this standard curve.

Table II. Effect of phosphate on removal of iron from mixed juice during the peak crushing season at Factory A

P_2O_5 (ppm) in mixed juice	F_2O_3 (ppm) in clear juice	Removal of iron, %
300	76.16(*)	–
300	6.18	91.89
325	6.18	91.89
350	5.71	92.50
375	5.23	93.13
400	5.00	93.43
425	5.18	92.98

* Iron in mixed juice.

Use of phosphoric acid for iron removal: Removal of iron from mixed juice to clear juice by phosphoric acid treatment was accomplished at the factory laboratory in a series of samples. First the P_2O_5 content was determined in mixed juice and found to be about 300 ppm. Different doses of orthophosphoric acid were added to raise the P_2O_5 content to levels up to 425 ppm in the mixed juice. Each sample of this P_2O_5-enriched mixed juice was clarified by the standard method, in order to see whether the phosphate content made any significant contribution to iron removal. The results appear in Table II.

Brix, pol and purity: These were determined in the usual manner.

During a first visit in the off-season to sugar factory A, deteriorated sugar samples were collected from different sugar stores and from different bags stacked at the top, in the middle and at the bottom. Samples were made up to 50% sugar solution with distilled water and the pH measured before and after boiling the sugar solutions. The iron content in respective sugar samples was also determined (Table I).

Results and discussion

Visual examination of the deteriorated samples revealed that crystals were of different colour in each bag. Exposure

15 "Soil chemistry analysis" (Constable, London), 1958, p. 390.

Table III. Iron in juice, syrup, and sugar crystals at Factory A, peak season

Sample	Brix	Pol, %	Purity, %	Fe_2O_3 ppm	Fe_2O_3 ppm/100 Brix	P_2O_5, ppm
Mixed juice	14.94	11.86	79.38	95.20	637.21	377
	14.83	11.87	79.64	57.12	385.16	325
	14.77	11.38	79.96	58.00	392.68	326
	14.80	11.79	79.66	67.77	457.90	366
	14.92	11.91	79.83	86.72	581.24	
1st carb. juice	–	–	–	3.33	–	–
2nd carb. juice	–	–	–	4.05	–	–
Clear juice	12.30	10.37	84.31	9.52	77.39	66
					8.67	–
					7.32	–
					6.30	–
					8.69	–
Unsulphured syrup	56.40	47.56	84.32	45.60	80.85	100
Sulphured syrup	58.84	51.64	87.80	43.80	74.44	100
Magma	–	–	–	3.10	–	–
Sugar	–	–	–	1.43	1.43	
				2.38	2.38	
				2.86	2.86	
				2.59	2.59	
				0.59	0.59	
				0.65	0.65	
				1.13	1.13	
				1.89	1.89	
				2.36	2.36	

of the sugar crystals to heat treatment at 50°C for about an hour, appeared to improve the colour. However, when exposed to air at about 90 RH, the colour of such crystals became darker.

The pH of the 50% solutions was in the range of 5.4 - 6.2; however, on boiling, the solution pH rose by 0.2 - 0.3 unit. The conductivity of the boiled sugar solution was found to be higher than expected for normal sugar solution.

The colouring matter present in the deteriorated sugar samples from different stores was investigated. Caramel formation was suspected since the U.V. spectrum of the sugar solution showed maximum absorption in the range 270 - 275 nm. However, several samples also showed the presence of a new colorant having λ_{max} ~ 240 nm.

Samples collected from different sugar stores were analysed for iron content while other constituents such as K_2O, Na_2O, CaO, P_2O_5 and nitrogenous matter, etc., were determined in a few samples. Iron was found to be in the range of 5 to 14 ppm while in two cases the values were as high as 22 ppm. Such values are not expected in plantation white sugar.

Comparative physico-chemical analysis of the deteriorated and undeteriorated sugar suggests that the colour formation be treated as a case of faster than usual deterioration of the sugar crystal. Although the colorant absorption seems to match that of caramel, the deterioration certainly does not appear to be the slow caramelization catalysed by potassium carbonate. It would seem more likely a fast caramelization or development of brown colour, perhaps catalysed by ferric compounds. Strong evidence in favour of this suggestion is given by our observation that the sugar darkens when it is exposed to air at RH ~ 90 but bright lustrous crystals reappear when it is stored at 50°C in an oven.

Further observations at factories A, B, and C

Mixed juice, first and second carbonatation juice, sulphured and unsulphured syrup, massecuite, magma, melt and sugar were analysed for iron content. Analytical data obtained at the factory laboratory are shown in Table III. Since iron was the prime suspect as the cause of deterioration of crystal sugar, the extent of its removal during clarification was considered vital.

During the crushing season the iron content in mixed juice at factory A was found to be in the range of 57 - 95 ppm. However, towards the end of the season its concentration in mixed juice rose significantly, to 98 - 116 ppm. Removal from mixed juice to clear juice recorded in carbonatation factories during the peak crushing season was 90 to 95%, whereas slightly less was removed towards the end of the season as may be seen in Tables III, IV and V. In a sulphitation factory (C), however, only 80% seems to be removed, as is shown in Table VI.

Table IV. Iron in juice, syrup and sugar crystal at Factory A, end of season

Sample	pH	Brix	Pol, %	Purity, %	Fe_2O_3 ppm	Fe_2O_3 ppm/100 Brix
Mixed juice	5.52	15.06	12.10	79.29	98.13	651.60
	5.56	15.01	11.73	78.15	106.67	710.65
	5.41	15.54	10.41	80.57	116.00	746.46
1st carb. juice	10.42	13.80	11.36	82.32	1.34	9.71
		10.35	12.52	9.94	79.39	
2nd carb. juice	8.82	13.62	11.31	83.03	4.10	30.10
		8.75	12.22	9.71	79.45	
Clear juice	7.16	13.81	11.53	83.49	9.21	66.69
		7.10	12.32	9.98	81.00	
Unsulphured syrup	7.10	61.68	51.52	83.53	37.63	51.86
	7.08	61.72	51.76	83.86		
Sulphured syrup	5.02	62.08	52.44	84.47	31.99	60.62
		4.97	60.52	49.20	81.29	
A-massecuite	–	95.31	81.00	84.98	77.05	80.84
	–	95.81	81.20	84.75	67.74	70.70
A_1-massecuite	–	95.81	77.60	80.99	55.85	58.30
	–	95.56	78.40	82.04	91.51	95.51
Magma	–	90.77	86.00	94.74	8.27	9.11
	–	92.45	88.20	95.40	13.95	15.10
Melt	–	70.90	65.00	91.62	8.75	12.34
	–	64.10	58.90	91.88	21.52	33.60
Sugar crystal*	6.20				1.48	1.48
	to				1.48	1.48
	6.40				1.48	1.48
					0.94	0.94
					0.54	0.54

* 50% solution

Removal of iron by different doses of phosphate

In order to determine whether the addition of extra phosphate in mixed juice would be helpful to increase the removal of iron, different doses of phosphate were added in several mixed juice samples with predetermined phosphate in them. The mixed juice contained 300 ppm phosphate and 92% of the iron was found to be removed without addition of phosphate. Addition of phosphate from 300 ppm to 425 ppm did not seem to enhance the removal of iron significantly (Table II).

The major part of the iron present in cane juice is removed during the clarification process; however, it is not known whether and at what stage it is contributed from the equipment to the juice during processing. In order to have some information in this respect, iron

Table V. Iron in juice, syrup and sugar crystals at Factory B, end of season

Sample	pH	Brix	Pol, %	Purity, %	Fe_2O_3 ppm	Fe_2O_3 ppm/100 Brix
Mixed juice	5.56	15.31	12.40	80.99	64.60	421.95
1st carb. juice	9.94	13.82	11.75	85.02	0.872	6.309
2nd carb. juice	8.93	13.32	11.38	85.44	2.41	17.43
Clear juice	7.27	13.52	11.51	85.13	6.85	50.66
Unsulphured syrup	–	–	–	–	–	N/A
Sulphured syrup	7.68	44.40	9.48	85.41	41.68	166.72
	6.04	58.28	12.52	85.93	23.14	92.56
A-massecuite	7.24	95.47	10.50	80.53	51.69	54.14
B-massecuite	6.93	157.70	164.76	95.71	8.47	71.24
C-massecuite	6.39	99.73	6.95	56.09	320.62	321.48
C-magma	6.75	99.20	8.00	80.65	93.59	94.34
A-sugar*	6.30	–	–	–	1.73	1.73
	6.44				2.94	2.94
B-sugar*	6.33	–	–	–	4.40	4.40
	6.55				2.14	2.14
C-sugar*	6.72	–	–	–	4.40	4.40
	6.62				4.40	4.40

* 50% solution

Table VI. Iron in juice, syrup and sugar crystals at Factory C, end of season

Sample	pH	Brix	Pol, %	Purity, %	Fe_2O_3 ppm	Fe_2O_3 ppm/100 Brix
Mixed juice	5.30	16.04	11.91	74.91	68.59	427.62
Clear juice	6.90	16.15	12.44	77.03	12.80	78.26
Unsulphured syrup	6.97	63.22	42.64	67.21	46.67	73.82
Sulphured syrup	5.72	59.24	39.92	67.16	48.92	82.58
A-massecuite	5.68	95.25	76.60	80.50	76.35	80.16
Sugar M 30	6.22	–	–	–	3.08	3.08
Sugar S 30	5.93	–	–	–	0.376	0.376

was determined in mixed juice, first and second carbonatation juice, clear juice, unsulphured syrup, sulphured syrup, massecuite, magma, melt and in crystal sugar.

Iron present in second carbonatation juice was found to be more than twice that in first carbonatation juice. Uptake of iron in the juice sulphiter was found to be 40 - 60%, and clearly significant. It is suspected to be due to reaction between iron and sulphur dioxide gas leading to a higher iron content in the sulphited juice. Uptake of iron at the double sulphitation factory C was found to be as high as 25 to 30% between mixed juice and clear juice.

Uptake of iron also occurred at the unsulphured and sulphured syrup stages and even in massecuite. In the peak crushing season at factory A it was observed that iron present in *A*-, A_1-cured sugar and magma were 2.38, 2.86 and 3.16 ppm respectively, which averages 2.78 ppm and compares with the 1.4 - 1.8 ppm of iron present in the sugar crystal. In the later part of the crushing season iron present in *A*- and *B*-massecuite was 54 - 77 ppm and 55 - 90 ppm and, in the sugar crystal, was found to be ≤ 5 ppm.

Evidence of new colouring compounds

From data obtained at different sugar factories (A, B and C) for iron in mixed juice, first and second carbonatation juice, clear juice, syrups, massecuites and magma, it appears that uptake of iron in the boiling house is several times more than that observed in mixed juice to clear juice. Excessive iron uptake is perhaps due to some polyphenols which are thought to be present in higher concentration towards the end of crushing season.

U.V. spectra of a number of sugar samples were recorded which show, in addition to caramel, some new peaks at lower wavelength about 250 nm. Such spectra were previously observed by Prasad & Dubey[10,16]. They seem to correspond to humic acid and polyphenolic compounds which, in the presence of ferric iron, develop brown compounds. Experience tells that moisture catalysed brown colour formation, and it was observed that a moisture-free environment helps in retaining the lustre and colour of the sugar crystal.

Now, it is becoming clear why the sugar produced in the later part of the season darkens; the polyphenol and iron contents in the middle of the crushing season may not be the critical factors. It is also observed that inorganic constituent concentrations increase as the season nears its end. Getting rid of the iron or polyphenol is the prime object. As long as iron remains in Fe^{++} form, it will not combine with the polyphenolic compounds. Therefore a precautionary measure is to reduce Fe^{+++} to Fe^{++}. Though this is achieved in the sulphitation reaction during clarification, where Fe^{+++} is to be reduced to Fe^{++} we should ensure the completion of this reaction.

Conclusion

The presence of abnormal ferric iron in sugar crystals is associated with faster colour deterioration of sugar in storage. Though a major percentage of iron present in cane juice is removed during clarification, the uptake of iron in the juice sulphiter is alarming. As a preventive measure an attempt should be made to employ steel piping, while coating the SO_2 gas pipe line with P.T.F.E. appears to be another alternative to minimize uptake of iron.

16 *I.S.J.*, 1986, **88**, 113.

Acknowledgment

We express our sincere thanks to Professor Ram Kumar, Director, National Sugar Institute, Kanpur for his keen interest in this work. We also thank the management of Saraswati Sugar Mills, Yamunanagar, Rai Bahadur Narain Singh Sugar Mills Ltd., Lhaksar and L.H. Sugar Factories Ltd., Kashipur, Nainital, for providing experimental facilities and hospitality during this investigation at their factories.

Summary

Sugar stored at a commercial sugar factory was found to develop brown colour within a few months of its manufacture. Physico-chemical investigation of colour deteriorated sugar revealed that iron was present in the sugar crystals in the range of 5 - 14 ppm. Development of brown colour is seemingly enhanced by iron and moisture. Sources of iron in the juice under process at various stages of sugar manufacture and in different sugar factories are examined.

Efecto del hierro sobre los cristales de azúcar durante el almacenamiento

Se encontró que el azúcar almacenado en una fábrica azucarera comercial desarrolló un color pardo después de unos pocos meses de su fabricación. La investigación físico-química del azúcar deteriorado por el color reveló que el hierro estaba presente en los cristales de azúcar en un rango de 5 - 14 ppm. El desarrollo del color pardo parece ser aumentado por el hierro y la humedad. Se examinan las fuentes de hierro en el jugo procesado en varias etapas de la producción azucarera y en diferentes fábricas.

L'effet du fer sur les cristaux de sucre au cours de stockage

Dans une sucrerie commerciale on avait remarqué que le sucre stocké développait une coloration brune quelques mois après sa fabrication. Une recherche physico-chimique du sucre ainsi déterioré révélait qu'entre 5 et 14 ppm de fer fut présent dans les cristaux de sucre. Il semble que le fer et l'humidité sont à l'origine du développement de la coloration brune. On examine les sources de fer dans le jus au cours des différents stades de la fabrication du sucre et dans les différente sucreries.

Einwirkung von Eisen auf Zuckerkristalle bei der Lagerung

Gefunden wurde eine Braunfarbe bei gelagertem Zucker, die sich innerhalb eines Paar Monate nach Erzeugung des Zuckers bildete. Eine chemi-physikalische Studie von Zucker mit verschlechterter Farbe zeigte die Gegenwart von Eisen in den Zuckerkristallen im Bereich von 5 bis zu 14 ppm. Es scheint, dass die Gegenwart von Eisen und Wasser begünstigt die Bildung der Braunfarbe. Quellen von Eisen im Prozesssaft bei verschiedenen Stufen der Zuckerherstellung und in verschiedenen Zuckerfabriken werden untersucht.

Facts and figures

Japan sugar production, 1988/89[1]

Japanese sugar production in the 1988/89 crop year totalled 984,000 tonnes, raw value, of which 705,000 tonnes were beet sugar and 279,000 tonnes cane sugar. Production in the 1989/90 crop is estimated at 970,000 tonnes, of which 707,000 tonnes are from beet and 263,000 tonnes from cane.

Babinda sugar factory bids[2]

A bid has been received from London-based Simitron International, a commodity trading company, to buy the shares of Babinda Cooperative Sugar Milling Association Ltd. as part of a $Aus 30 million package which includes spending $Aus 8 million on capital upgrading, repaying a levy on the 1987 crop and a bonus payment for 1988 cane. The Board of Directors of the Babinda cooperative of cane growers is taking the bid seriously; it tops a narrowly rejected bid by Bundaberg Sugar Company. According to an independent consultant to the Board, deregulation of the Australian sugar industry was clearly a consideration behind the high-priced offer ($Aus 5.50 per share against the $Aus 4.80 offered by Bundaberg Sugar). Meanwhile another proposal for consideration by the Babinda growers is a $Aus 4.50 offer from three other cooperative factories in the area – South Johnstone, Mulgrave and Mossman. This includes an offer to crush some of Babinda's cane to guarantee a harvest season of no longer than 20 weeks.

Sugar thefts in Mozambique[3]

Swaziland and Zimbabwe are having increasing difficulties with sugar exports via the port of Maputo in Mozambique. At least 30,000 tonnes of export sugar from the two countries has been stolen from the port during the past three years and this has cost Mozambique some $1.7 million in lost port and railway income. Swaziland has been obliged to divert 150,000 tonnes of sugar a year to the South African port of Durban, which is far more distant than Maputo. If both Swaziland and Zimbabwe were to discontinue sugar exports through Maputo, Mozambique would lose $5 million a year in revenue.

Indonesia sugar consumption increase[4]

Indonesia's sugar consumption in calendar year 1988 totalled 2,252,000 tonnes, white value, up from 2,137,000

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 345.
2 *Australian Canegrower*, 1989, **11**, (9), 1.
3 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 335.
4 *Czarnikow-Rionda Trading Co. Inc. Rpt.*, April 27, 1989.

tonnes in 1987, according to the Indonesian Sugar Council. Consumption in 1989 is expected to rise to 2,350,000 tonnes and in 1990 to 2,470,000 tonnes. The Council estimates 1989 sugar production at 2,390,000 tonnes.

Tanzania mini sugar factory plans[5]

Tanzania has sought India's cooperation in setting up mini sugar factories. Tanzania has five factories with a production capacity of more than 100,000 tonnes whilst potential demand is placed at 400,000 tonnes. The country feels that Indian entrepreneurs could take advantage of Tanzania's new liberalization policy to launch joint ventures particularly in the small-scale sector. Tanzania has exploited so far only 6% of its 40 million hectares of arable land. Transport bottlenecks and poor roads have hampered the movement of agricultural produce. The Tanzania government believes the setting up of mini sugar plants and other units in the agricultural sector could give the necessary thrust to the economy which of late has shown signs of steady recovery.

Fiji sugar expansion[6]

The Fiji Sugar Corporation is embarking on a capital development program expected to cost $130 million in the next five years. It will increase production capacity to 600,000 tonnes of sugar a year. The program will include massive rehabilitation and upgrading of factory equipment, transport infrastructure and the communication system Upgrading in the next 12 months will amount to $28 million, about $20 million of which will be borrowed locally.

Guatemala sugar exports, 1988[7]

	1988	1987
	tonnes, raw value	
Bulgaria	0	54,891
China	38,000	0
Ecuador	29,661	18,405
Jamaica	26,463	10,108
Morocco	10,820	0
Peru	0	7,860
El Salvador	13,209	246
Sri Lanka	14,069	27,064
Trinidad	29,826	20,216
USA	30,912	73,448
USSR	179,096	37,643
Venezuela	9,200	8,832
Other countries	9,500	40,509
	390,756	299,222

Philippines sugar production, 1988/89[8]

Milling operations in the Philippines have made good progress in the closing stages of the 1988/89 season and final production is likely to close at some 1.55 million tonnes. This marks a pronounced recovery from the low point of the two previous crops and also means that, instead of having to make small imports to ensure that domestic consumption and the US quota are fully covered, there will be ample supplies to meet these requirements. The reforms and rationalizations of the past few years were intended to streamline the Philippine industry and stabilize production at around 1.8 million tonnes. Adverse weather conditions, combined with the extent of the changes required to put operations back on a sound footing, led to a decline below that target level. It now appears that the industry is set to recover and, following area increases, the crop next season is tentatively expected to reach some 1.7 million tonnes.

China sugar production, 1988/89[9]

Total sugar production in the 1988/89 crop year is set at 5,297,000 tonnes, raw value, up from 4,706,000 tonnes produced in 1987/88 but below the 1986/87 output of 5,730,000 tonnes. A decrease is expected in the 1989/90 season because both cane and beet areas have been reduced against last year.

India sugar imports and exports, 1988[10]

	1988	1987
	tonnes, raw value	
Imports		
Brazil	0	280,494
Bulgaria	0	28,034
Cuba	0	121,988
EEC	46,513	411,084
Korea, South	0	88,020
Thailand	0	13,582
	46,513	943,202
Exports		
EEC	10,804	10,804
Maldives	0	432
Nepal	18,232	7,066
USA	5,294	6,969
	34,336	25,271

Indonesian sugar imports, 1989[11]

The Indonesian Sugar Council has increased the amount of sugar to be

5 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 356.
6 *Reserve Bank of Fiji News Review*, 1989, (21).
7 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S331.
8 *Czarnikow Sugar Review*, 1989, (1787), 108.
9 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 419.
10 *I.S.O. Stat. Bull.*, 1989, **48**, (6), 20 - 21.
11 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 371.

Commission Internationale Technique de Sucrerie

19th General Assembly, 1991

Following the invitation of British Sugar, the 19th General Assembly of the C.I.T.S. will be held in Cambridge, Great Britain, during June 24 - 28, 1991. The subjects to be priority themes for papers to be presented and discussed are "Progress in the technology of sugar crystallization" and "Technical aspects of data acquisition and data processing for process control and decision making".

Papers on other subjects regarding sugar manufacture and allied themes may also be proposed and accepted for presentation and discussion. Titles of papers, with a summary of the contents, should be sent to the Secretary of CITS before the end of 1990. Further details will be given in due course regarding registration and the exact program of the Assembly. More information may be obtained from Dr. Robert Pieck, Secretary CITS, Aandorenstraat 1, B-3300 Tienen, Belgium.

imported this year to 621,000 tonnes[12], up from 180,000 tonnes in 1988. Of this amount 271,000 tonnes has already been imported. The Council estimates sugar production in 1989 to reach 2,160,000 tonnes, white value, against 1.9 million tonnes in 1988. Demand is estimated at around 2.4 million tonnes, which would leave stocks of 1.09 million tonnes at the end of 1989, up from 672,000 tonnes at the start of the year. The Council estimates 1990 output at 2.58 million tonnes, domestic consumption at 2.47 million tonnes and imports at 282,000 tonnes, which would given stocks of 1.48 million tonnes by the end of 1990. Indonesia is also to expand cane plantations in Sulawesi, East Timor and Irian Jaya to meet targeted production levels. Indonesia is expected to increase the price it pays farmers for sugar cane by nearly a quarter.

Ethiopia sugar and alcohol complex[13]

Further details of the Finchaa complex[14] in western Wellega region have been released by the state-run Sugar Corporation. The 4000 t.c.d. factory is to produce 85,000 tonnes of sugar a year by 1995, with the possibility of expansion to 6000 t.c.d. and an output of 125,000 tonnes, as well as 8000 tonnes of alcohol.

Cuba sugar production, 1988/89[15]

The 156 sugar factories in Cuba produced 8,124,000 tonnes of sugar from the 1988/89 cane harvest, according to *Agra Europe*, or 24,000 tonnes above the official level. According to the Ministry of Sugar, the crop would have been larger if the rainy season had not started early, hindering harvesting and transport. 68% of the crop was harvested mechanically against the planned 70%.

Iran sugar expansion[16]

Sugar production in Iran is expected to increase by 700,000 tonnes annually over the next six years, according to the country's Minister of Agriculture, who added that 70,000 hectares will soon be put under sugar cane cultivation and seven new processing plants constructed to meet the increased crop.

Liberia sugar complex contract[17]

A consortium headed by WIIL in cooperation with Engineers India has secured a contract for establishing a sugar complex in Liberia at a cost of 260 million rupees. The project envisages the cultivation of cane on 10,000 acres and the manufacture of sugar and alcohol. The crushing capacity of the factory will be 1250 t.c.d. and the distillery will produce 32,000 gallons of alcohol per day. Plant and machinery will be imported from Brazil and India and it is claimed that the payback period will be 7 years. The alcohol will be produced from cane molasses and will be used for mixing with gasoline thereby reducing foreign exchange expenditure on import of petroleum products.

Bagasse pulp plant possibility in Australia[18]

The state government is considering a plan from a Perth entrepreneur, Nedpac Ltd., to build a $Aus 125/150 million chemical pulp plant in Queensland at Mackay or Innisfail. The plant, which would produce pulp from more than 200,000 tonnes of bagasse a year, is environment-friendly, according to the developer, Paper and Pulp International Pty. Ltd. and will exports its output to south-east Asia for manufacture into paper products.

Brazil sugar export quota, 1989/90[19]

The Brazilian Sugar and Alcohol Institute (IAA) has set the sugar export quota for the 1989/90 crop year at 645,000 tonnes, whereas the Institute had earlier said that export availability would amount to 1.2 million tonnes. The reduction is said to be necessary to meet a higher than expected domestic demand. The figure of 645,000 tonnes available for exports from the 1989/90 crop appears high because the production plan for the crop provides for an output of 7.43 million tonnes, raw value. If domestic consumption were to increase by only 4%, against a 16% increase in 1988/89, this would require 7.3 million tonnes leaving a surplus of only 130,000 tonnes.

Irrigation for sugar beet in Morocco[20]

Plans to irrigate more than 100,000 hectares in the Gharb Valley, as well as producing 390 million kW of electricity, will be the result of one of the largest dam projects in Africa, according to Reuter. The Mjara Dam will be sited on the Ouergha River, some 220 km north-east of Rabat and amongst other crops it is planned to produce some 200,000 tonnes of sugar a year. Contracts have been signed with companies in Spain and Italy, while the Soviet Union will supply and install turbines and generating equipment. Finance for the project, which is estimated to cost some $1000 million, will be provided by Spain, Italy, the Abu Dhabi Fund, the Kuwait Fund and the Saudi Fund. Loans would extend over some 20 to 30 years, at interest rates which would average 4%. Construction work is due to start at the end of the year and is planned to be completed in 1997.

Spanish beet campaign results, 1988/89[21]

In the 1988/89 campaign a total of 8,890,452 tonnes of beets were sliced, with an average sugar content of 16.28%. Sugar production at 985,000 tonnes was 38.012 tonnes higher than in the previous year and included 226,000 tonnes of C-quota sugar. Of this, 167,000 tonnes will be carried forward and 59,000 tonnes exported.

12 See *I.S.J.*, 1989, **91**, 99.
13 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 384.
14 *I.S.J.*, 1989, **91**, 82.
15 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 432.
16 *Islamic Republic News Agency* (Iran), July 21, 1989.
17 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 432 - 433.
18 *Australian Canegrower*, 1989, **11**, (11), 1; (13), 3.
19 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 447.
20 *Czarnikow Sugar Review*, 1989, (1787), 108.
21 *Zuckerind.*, 1989, **114**, 684.

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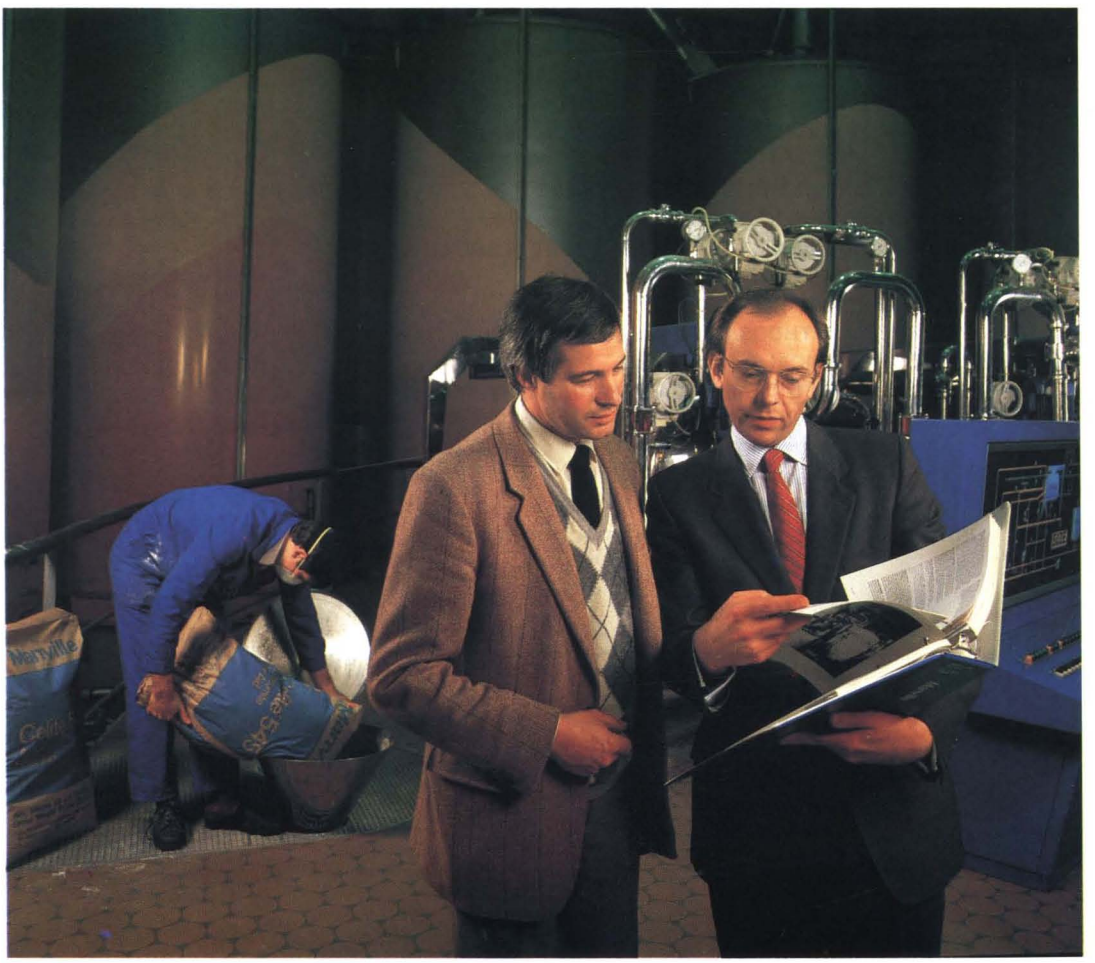

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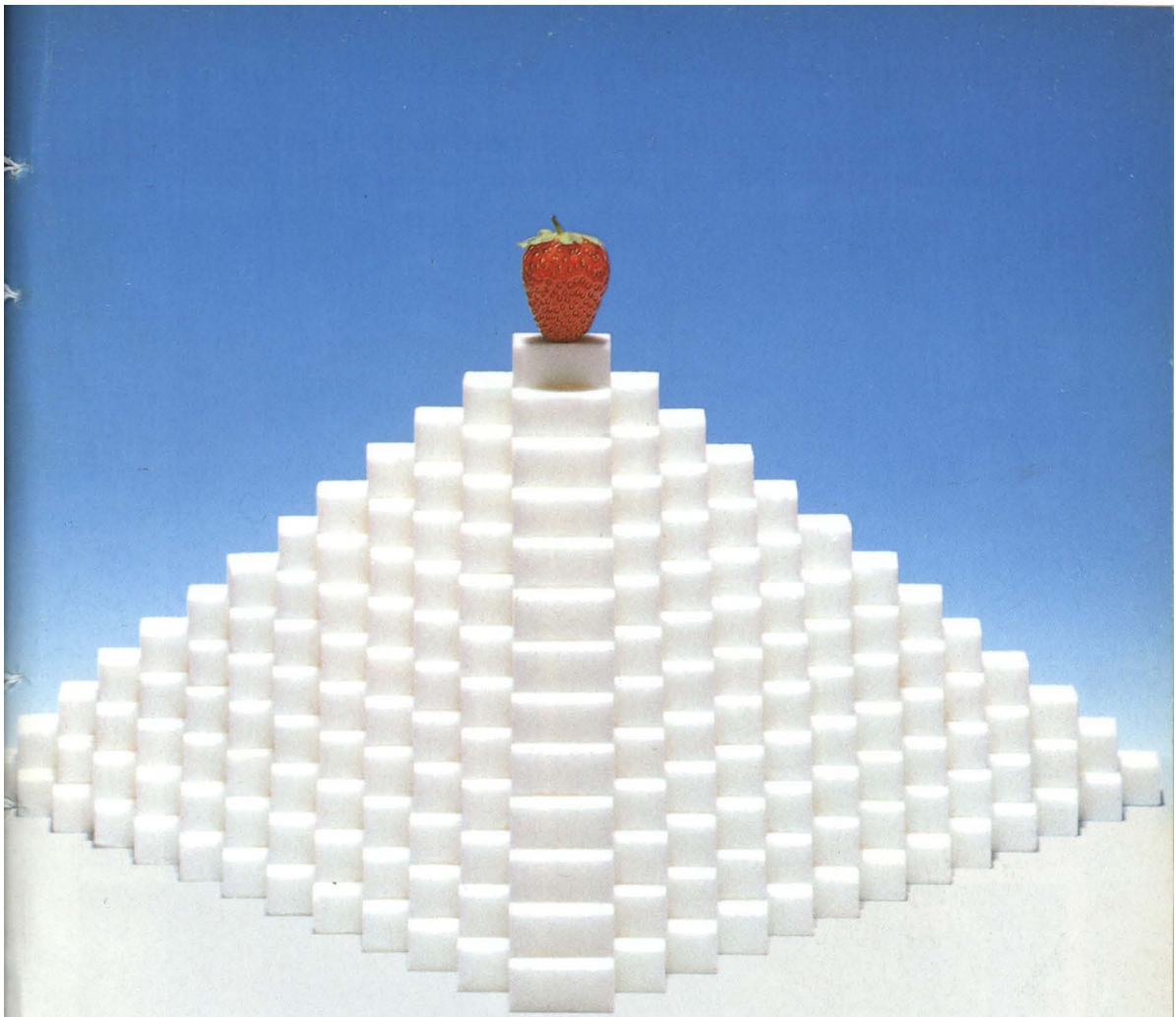

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