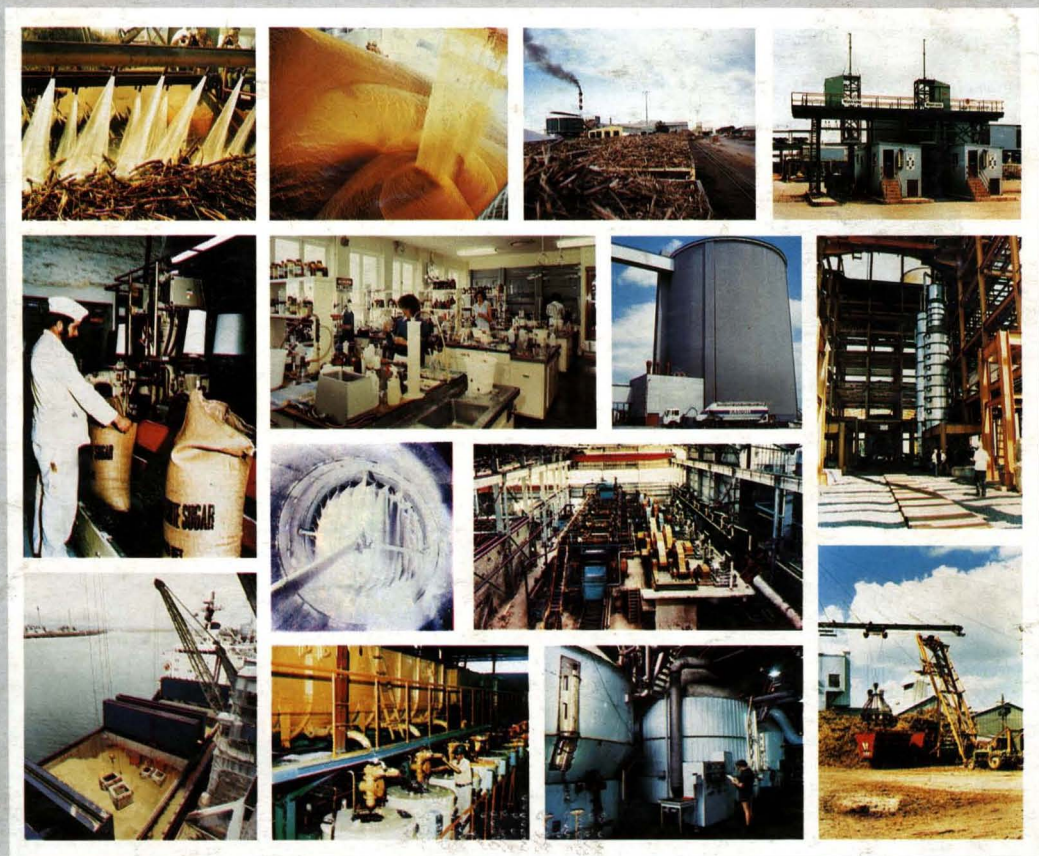


# INTERNATIONAL SUGAR JOURNAL



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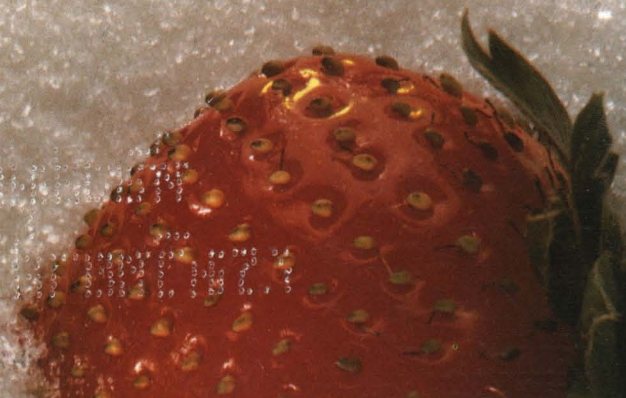
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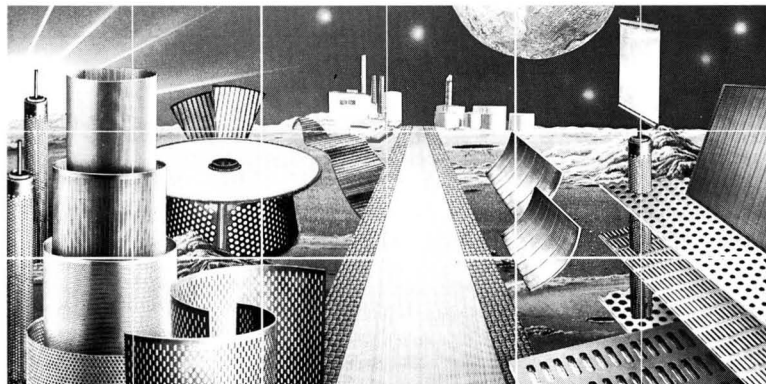
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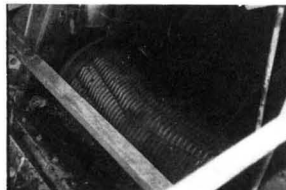
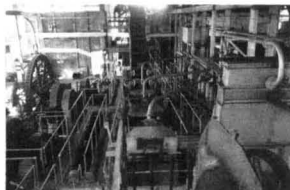
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# News and views

## World sugar production, 1988/89<sup>1</sup>

F. O. Licht GmbH have reduced their estimate of world sugar production from the current season by 900,000 tonnes to 107,336,000 tonnes, raw value, while their corrected value for the previous season is only 20,000 tonnes smaller at 104,202,000 tonnes. The reduction for 1988/89 is due to unforeseen crop problems and brings production to a level insufficient to cover global demand. In the EEC, production has been affected by virus yellows disease and is now set 2% down at 14,795,000 tonnes while the crop damage by Yugoslavia's hot summer last year has been severer than thought earlier. Significantly less sugar has been produced in Czechoslovakia and East Germany, while the absence of confirmation of good expectations for the USSR have resulted in that country's output being set 660,000 tonnes lower, giving a drop of almost 1 million tonnes for East Europe.

The US beet sugar crop estimate is raised by 140,000 tonnes and that of China by 100,000 tonnes but other changes are minor so that the total beet sugar estimate is 947,000 tonnes lower than before<sup>2</sup> at 38,029,000 tonnes.

Total cane sugar production is set 155,000 tonnes higher but this conceals the effects of a number of changes. South Africa is now expected to produce more, with its estimate raised from 2.1 to 2.26 million tonnes. The Cuban estimate is raised by 300,000 tonnes to 8.2 million but that for Brazil is cut by 350,000 tonnes to 8.5 million. The Chinese cane crop estimate is reduced from 5,545,000 to 4,210,000 tonnes while that for Thailand is raised by 450,000 to 3,550,000 tonnes.

## World sugar prices

Prices on the world sugar market showed a bearish trend during the first half of January 1989, the London Daily Price for raw sugar sliding from an initial \$276.20 per tonne to \$246.40 on January 16. Prices were influenced by liquidation of long positions by specula-

tive funds and commission houses as well as the lack of purchases by China and the USSR. In spite of reports of difficulties in both these countries which would indicate a need for imports, actual purchases had not occurred and, with adequate supplies available from raw sugar producers, weakening of prices was inevitable.

There were several bullish items which did not affect the market, including a forecast of a deficit of production from E. D. & F. Man, perhaps because of a report from Cuba that the 1988/89 crop was performing better than had been expected. The LDP hovered around the same level until January 24 when it started to slide again, reaching \$235.80 on January 27, after which it recovered, to end the month at \$242.

With steady offtake, mostly by Middle East countries from the EEC, white sugar prices did not decline as much as those for raw sugar, in spite of reports of a good crop in Thailand. After an initial drop from \$291 on January 3 to \$278 the next day, the LDP(W) stayed within a range of \$272 to \$283 for the rest of the month, ending it at \$282.50. In fact, strengthening of the white sugar market at the end of the month by reports of purchases by Indonesia and Czechoslovakia (usually a small exporter) might have been influential in raising the LDP for raw sugar.

While supplies of both raw and white sugar remain freely available the price tendencies will be downward; however, stocks are at their lowest levels since 1982 and a strengthening of demand from countries considered to be in need of sugar could result in a substantial rise in prices when purchases take place.

## Mauritius sugar expansion incentives<sup>3</sup>

The government of Mauritius aims to boost sugar production and plans to cut its export duty on sugar to 18.75% in 1989 from 23.65%, as part of a package of incentives for the industry. The government also proposes to exempt the first 3000 tonnes of any producer's

exports from duty, up from the 2000 tonnes level of last year. It proposes a system of workers' bonuses and an increase in the planters' share of sugar revenues to 76% from 74%.

In addition, the government will exempt from income tax earnings from planters' first 40 tonnes a year of output and it will also remove the molasses export duty and end the sugar milling levy. It is proposed to link the year-end sugar producers' bonus to productivity, paying bonuses at a higher rate to more productive firms.

Mauritian sugar production reached its peak in 1986/87 with nearly 750,000 tonnes, raw value. However, production fell back afterwards to 733,000 tonnes in 1987/88 and is expected to drop to 662,000 tonnes in the current season. With domestic consumption of around 40,000 tonnes, most of the country's sugar production is exported, EEC countries being the major destinations, the quota being approximately 534,000 tonnes, raw value.

## EEC sugar price proposals<sup>4</sup>

The new Commission was quick to announce the 1989/90 price package which, for sugar, proposes a 5% cut in intervention prices, justified on grounds of correcting the relative profitability of growing sugar beet against other crops, prices of which were cut last year while those for sugar beet were untouched. These proposals were accompanied by the usual assortment of agrimonetary changes which, on the whole, are aimed at reducing negative MCA's (Monetary Compensation Amounts) through green rate devaluations. MCA dismantling has been suggested for France, Greece, Ireland, Italy, Portugal and the UK; these would have the effect of increasing national currency prices by between 12 and 1.15%. These green rate devaluations will thus have a compensating effect on domestic prices. Green rate revaluations have been proposed for

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, 121, 39 - 48.

2 *I.S.J.*, 1989, 91, 1 - 2, 20.

3 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 640 - 641.

4 *The Sugar Situation*, 1989, (453), 3.

West Germany, Holland and Spain; these would have the effect of reinforcing the suggested price cut by between 0.4 and 0.9%. The Commission hopes that agreement on the price package will be reached by April, up till which time the agriculture ministers have several opportunities to discuss it.

The ACP guaranteed price has been kept in line with UK intervention prices so that it is highly likely that whatever price package is eventually agreed, it would be reflected in ACP prices. It is expected that agreement on ACP prices will take much longer as, officially, the 1988/89 prices are still provisional. ED & F. Man Ltd. feel that whilst, at the end of the day a cut in ecu intervention prices is likely, the price package as it stands may be seriously modified.

#### **China sugar production estimates, 1988/89<sup>5</sup>**

Recently released official estimates of China's sugar output in the 1988/89 season are between 4.8 and 5.0 million tonnes, white value. The 1988 area under beet and cane is reported to be 1.52 million hectares, an increase of 17% on 1987. However, serious drought, hurricanes and floods have lowered the sugar content, so it cannot be said for certain that the estimated production level will be reached. Chinese press reports said that China's sugar output is 3 million tonnes short of demand, despite a heavy subsidy. Output has fallen since it peaked at 5 million tonnes in 1985, while demand has increased by 700,000 tonnes a year since 1985 because of rising living standards and this has caused nationwide shortages and rationing.

The industry's key problems are low prices which have been unchanged for 25 years, currently making sugar worth less than straw in Guangdong, a major cane growing province. Factories receive less for their sugar than the production cost. Other problems include inadequate transport, causing farmers in Inner Mongolia to dump cane that could not be delivered.

#### **Brazil revaluation**

In January the Brazilian government announced its "Summer Plan" under which the currency was revalued by eliminating three zeros from amounts whereby a "new cruzado" replaced 1000 cruzados. (A similar change was brought about in 1986 when the cruzado replaced 1000 cruzeiros.) Associated measures have been taken, including a temporary freeze on the prices of some essentials to give the government time to reduce its expenditure to match its income and in the hope of reining in the galloping inflation of recent years.

C. Czarnikow Ltd. notes<sup>6</sup>: "Of more immediate concern to the industry is the government decision to erode further the price difference between alcohol and gasoline at the pump. This difference is now down to 25% and runs contrary to previous government assurances that a sizeable margin would continue to exist between the two products. (It should be explained that alcohol contains part of its own oxygen for combustion whereas gasoline, being a mixture of hydrocarbons, obtains all its oxygen from the air; thus, the energy produced and so the mileage travelled for a given weight of alcohol is around a third less than for gasoline.)

"It would appear that this move is designed to control the growth in alcohol consumption which has been steadily increasing in recent months. However, if the differential continues to narrow, it may initiate a swing back towards gasoline powered cars in the demand pattern for new vehicles." Such a reduction in alcohol demand would affect the availability of sugar from Brazil.

In the meantime, the adjustments reported earlier<sup>7</sup> to the sugar and alcohol plan have been modified further; the original proposals drew strong protests from producers in the North/North-East region faced with the prospect of exceeding the revised quota limits and not being paid for the excesses. As a consequence of the latest changes the export availability of sugar from the

1988/89 crop has been raised by some 200,000 tonnes, over half as raw sugar.

#### **White sugar premium in 1988<sup>8</sup>**

It frequently happens that the premium for white sugar over raws does little more than reflect the 8% pol difference and certainly it rarely compensates for the extra processing involved where a separate refining operation has to take place. Indeed, on occasions, the price of white sugar falls below the raw sugar quotation. These are unusual situations, however, normally highlighting particular occurrences. But in 1988 the price of white sugar, as evidenced by the London Daily Price quotations, was below the raw sugar price for a long period of the year and the average for the year showed a premium of hardly more than \$1.00 per tonne. Largely this was occasioned by the mid-year price rise when there were some doubts about the availability of raw sugar supplies at a time when China and the USSR were both active buyers. The premium also remained small at other times of the year, however, reflecting that the gradually tightening situation was more in evidence in the raw than in the white sugar market.

#### **Small-scale Australian sugar factory for Laos<sup>9</sup>**

Batstone Technology, of Maryborough, Queensland, claims it is leading world development of equipment for small-scale sugar processing. The company recently won a \$Aus 2,600,000 contract to design and build a small-scale sugar factory for Laos.

#### **New Turkish sugar factory<sup>10</sup>**

The Corum sugar factory in Turkey, construction of which started in July 1987, will be completed and put into operation in 1989. It will be able to process annually 780,000 tonnes of beet and to produce 117,000 tonnes of sugar and 39,000 tonnes of molasses.

5 F. O. Licht, *Int. Sugar Rpt.*, 1989, 121, 57.

6 *Czarnikow Sugar Review*, 1989, (1781), 3.

7 *I.S.J.*, 1989, 91, 21.

8 F. O. Licht, *Int. Sugar Rpt.*, 1989, 121, 17.

9 *Australian Cane Grower*, 1988, 10, (12), 28.

10 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 639.



# Product news

## Pacific Scientific colorimeter helps British Sugar develop new food product

The Colorgard 2000 precision colour measuring system, manufactured by Pacific Scientific, permits precise instrumental correlation with visual observation and is being used in the development of Beta Fibre, a new food-grade dietary fibre from sugar beet, developed by British Sugar plc.

The instrument specified for research studies and near-line sampling at the sugar factories was a 45°/0° geometry colorimeter. This rugged, versatile, compact, user-friendly system, which gives rapid tristimulus colour measurement, was well able to perform both in the laboratory or near the production line, achieving the high level of accuracy required.

British Sugar now have the system connected to an IBM PS/2 which gives them the added facility of hard disk storage of data. This can then be analysed at a later date to identify any possible correlations between colour or any of the other functional properties of fibre, such as its water uptake properties.

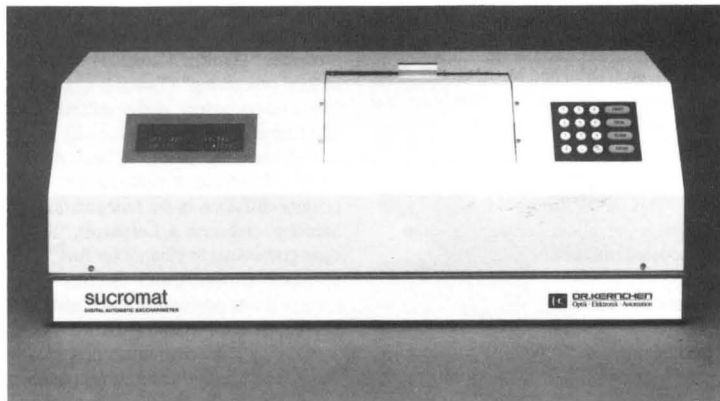
Further details:

Pacific Scientific,  
4 First Avenue,  
Globe Park,  
Marlow, Bucks. SL7 1YA,  
England.

## New automatic polarimeter

Dr. Wolfgang Kernchen GmbH, manufacturer of laboratory instruments for the sugar and food industries, has announced a new Sucromat automatic polarimeter. The instrument has a high-precision optico-mechanical system of 0.001° resolution and microprocessor intelligence to achieve an unexcelled versatility.

Five measuring ranges can be selected by means of the keyboard: these are: °Z international sugar scale; ° circular scale; % sucrose; % glucose; and purity (% sucrose / % dry substance), the latter with an automatic refractometer



interfaced to the RS-232C port. The RS-232C port may also serve for connecting a computer.

As a second standard interface, a parallel printer port is available for connecting any type of Centronics-compatible data printer. Printed records contain sample identification number, measured value, date and time, measuring range and (optionally) the sample temperature to 0.1°C accuracy. Data appear in a green fluorescence display with two lines of 20 alphanumeric characters each. The display is further used to guide the operator when measuring ranges or other instrument functions are selected.

Further details:

Dr. Wolfgang Kernchen GmbH,  
P.O. Box 20140,  
D-30166 Seelze 2,  
Germany.

## Retractable spouts for loading

These control dust efficiently while loading. The innovative design uses inner stacking cones in Rhino Hyde and are for loading enclosed vehicles or open loading of ships, barges and stockpiles. Travel is available from 2 ft to 100 ft.

Further details:

Tandem Products Inc,  
520 Industrial Drive,  
Bloomington Prairie, MN 55917,  
USA.

## Abay

A new leaflet lists and illustrates the activities of Abay S.A. of Belgium which, although best known to our readers for the supply of turn-key beet and cane sugar plants and equipment, sugar silos and distilleries, also are active in fields such as power distribution, electrical and mechanical installation, instrumentation, sound and heat insulation, water treatment, starch industry facilities, glass production, etc. The leaflet is available from:

Abay S.A.,  
Rue de Genève 4,  
B-1140 Brussels,  
Belgium.

## Sugar silos and centrifugals

Nils Weibull AB. has been a supplier to the sugar industry since the 1920's and has delivered about 130 silos around the world, ranging from the early small units to today's silos that stand up to 40 metres high and hold up to 50,000 tonnes. A new leaflet describes the standard sugar centrifugal offered by the company with a capacity range of 20 - 42 tonnes of massecuite per hour, computerized control system, extensive instrumentation for automatic control, etc. The leaflet is available from:

Nils Weibull AB.,  
P.O. Box 194,  
S-28122 Hässelholm,  
Sweden.

# New books

## **Chemistry and processing of sugar beet and sugar cane**

Eds. M. A. Clarke and M. A. Godshall. xii + 406 pp; 16 × 24.7 cm. (Elsevier Science Publishers B.V., P.O. Box 211, 1000 AE Amsterdam, Holland.) 1988. Price: Dfl. 260.00.

This publication, No.9 in the Sugar Series, is in fact the *Proceedings* of a symposium on the chemistry and processing of sugar beet held by the American Chemical Society in Denver on April 7, 1987, and of a symposium on the chemistry and processing of sugar cane held by the ACS in New Orleans on September 3 - 4, 1987. The beet section comprises 10 papers and the cane section 13 papers, although a number are applicable to both sides of the sugar industry. The titles (with their authors in brackets) are as follows: "An overview of the US beet sugar industry" (Bichsel); "Effects of plant breeding on sugar beet composition" (Smith); "Carbonation process in beet sugar manufacture" (Cleary); "An integrated juice purification system" (Andersson & Barfoed); "Ion exchange processes in beet sugar manufacture" (Shore *et al.*); "Treatment and disposal of effluents of the sugar beet factory" (Richmond & Strickland); "Ion exchange for desugaring of molasses and by-product isolation" (Ramm-Schmidt); "Ultrafiltration used in a novel flexible process to produce high-fructose syrup from different raw materials" (Hanssens & Koerts); "Utilization of fibre and other non-sugar products from sugar beet" (Tjebbes); "Analytical methods of sugar factories - new developments" (Schiweck & Steinle); "Sugar cane processing: raw and refined sugar manufacture" (Clarke); "Varietal differences in the chemical composition of sugar cane" (Legendre); "The nature of colorants in sugar cane and cane sugar manufacture" (Riffer); "Polysaccharides of sugar cane and their effects on sugar manufacture" (Kitchen); "Flavour and odour in sugar cane products" (Godshall); "Effects of impurities on degradation of sucrose

under processing conditions" (Richards); "Clarification and decolorization processes" (Trott); "Chemistry of sugar in food processing" (Tsang & Clarke); "Sweeteners: safety, utility and efficacy" (Bollenback); "Caribbean rum: its manufacture and quality" (Harris & West); "Desalting of molasses by counter-diffusion in the fermentation industry" (Johnson & Lefebvre); "Sugar cane processing to ethanol for fuel purposes" (Rossell); and "Sucrose chemistry: its position as a raw material for the chemical industry" (Khan & Jones). A list of contributors precedes the contents pages, and a subject index is to be found at the end of the book. The material will undoubtedly add to our store of knowledge on sugar matters.

## **International sugar economic year book and directory, 1988**

Ed. H. Ahlfeld. 395 + 98 pp; 20.6 × 29.1 cm. (F. O. Licht GmbH, P.O. Box 1220, D-2418 Ratzburg, Germany.) 1988. Price: DM 155.00.

The Licht yearbook makes its welcome reappearance towards the end of each year and the 1988 edition is in the familiar format. Within the stiff covers is a well-printed fund of information, supported by a considerable amount of advertisements; these are to be welcomed since they permit the book to maintain its regular appearance. The editorial section is, as usual, divided into sections of which the largest, occupying nearly half of the book, is the country-by-country sugar directory. This lists national authorities, institutes, organizations, trading companies, major sugar companies and sugar factories, refineries, autonomous distilleries and starch-based sweetener manufacturers, giving for most of these details of addresses, telephone numbers, personnel, etc., with daily processing capacities for most sugar factories and refineries.

Other sections provide details of international organizations, product information from some of the major European suppliers to the sugar industry, a Buyers' Guide with the book's adver-

tisers listed under their products; this section also includes a Spanish-English directory of product names. A series of articles is included grouped under "Sugar Economics" and concerned with the world sugar market as well as in Australia, India and the US. Dr. E. W. Krause surveys new equipment and processes in the sugar industry, while Dr. Helen G. Smith writes on sugar beet virus yellows and Mr. D. R. Ridge surveys current trends in sugar cane mechanization.

As in previous editions, a pocket in the back contains a separate booklet of statistical information. This is introduced by a survey of the world market in 1987/88 and an analysis of production, consumption and trade, with a short assessment of the outlook for 1988/89. Tables are given of European campaign results up to 1987/88 and of the world beet and cane sugar production and balances in total and by countries, net trade, raw and white sugar trade and imports and exports of selected countries, prices and per caput consumption data, and molasses production and trade. The new Yearbook is up-to-date, comprehensive and a valuable addition to the sugar library.

## **The ALM guide to lactose properties and uses**

Eds. K. K. Rajah and D. E. Blenford. 53 pp; 15 × 21 cm (Association of Lactose Manufacturers, P.O. Box 85868, 2508 CN The Hague, Holland.) 1988.

Lactose or milk sugar is D-galactosyl glucose and is only found in the milk of mammals, unlike the sucrose of vegetable origin. It is thus produced in very much smaller quantities and has characteristics which allow its utilization for pharmaceutical purposes as well as in a variety of foods. This small book, produced by the Association of Lactose Manufacturers, has been published to bring to the attention of readers the properties of this sugar, both chemical and physical, and provides data on physiological attributes, on lactose derivatives and its applications.



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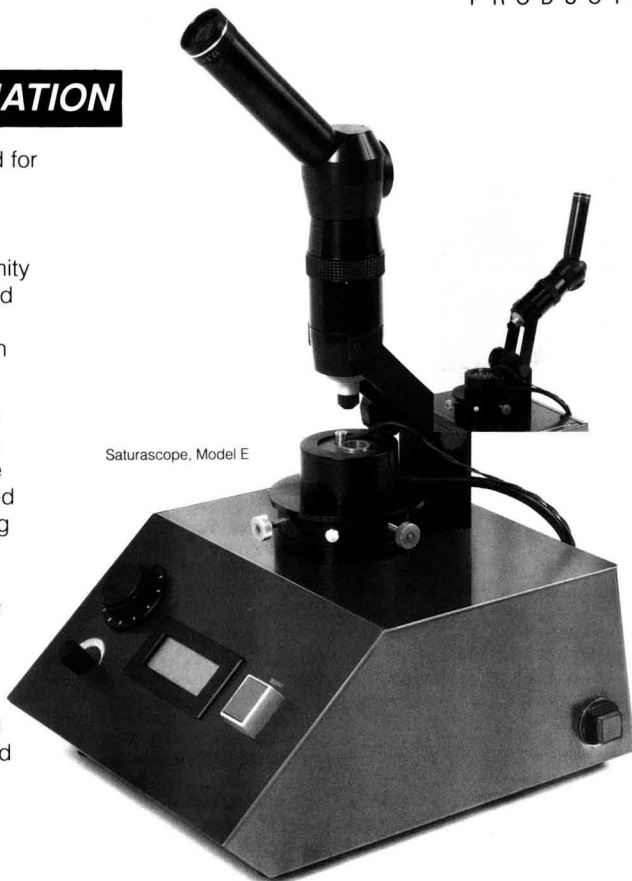
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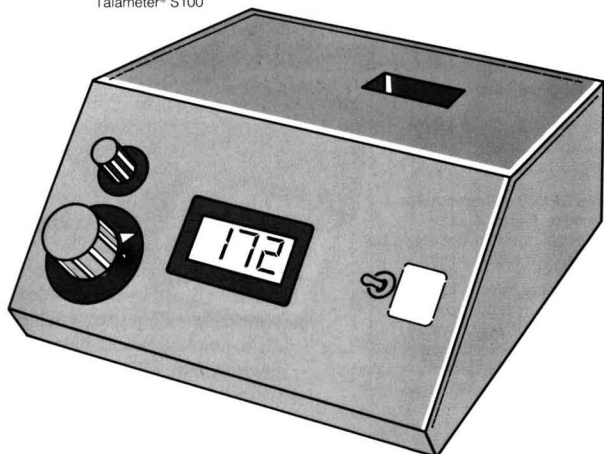
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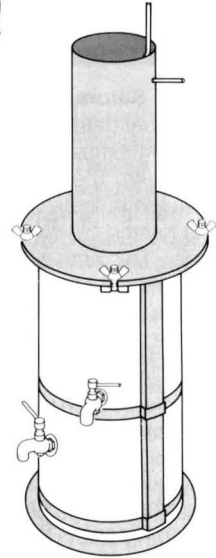
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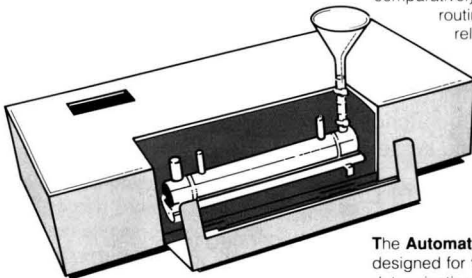
Moisture Teller



Deerr Type Bagasse Digester

## JUICE ANALYSIS

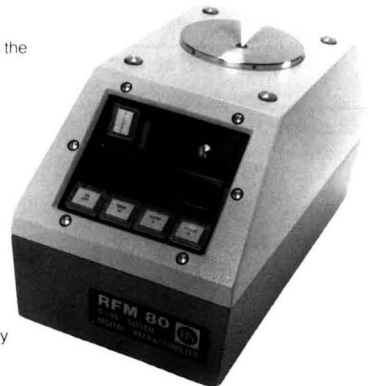
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Automatic Digital RFM80 Refractometer

# A simple direct colorimetric method for assay of starch in plantation white sugar

By S. M. Chavan, A. Kumar and S. J. Jadhav

(Department of Sugar Chemistry, Deccan Sugar Institute, Manjari Bk., Tal. Haveli, Dist. Pune, India 412307)

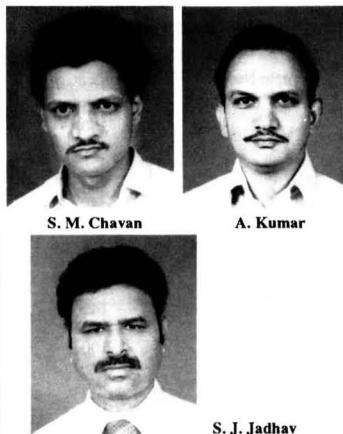
## Introduction

The adverse effects of starch on sugar processing have long been recognised. The presence of starch in sugar cane juice is known to increase turbidity in clarified juice and syrup, increase viscosity of fluids, retard the rate of sucrose crystallization and reduce the exhaustibility of final molasses. It is the most detrimental impurity in affined sugars, so far as the filtrability of carbonatation slurry is concerned.

In the past, there have been various methods suggested for determining the concentration of starch at various stages of sugar manufacture, some based on the original method of Balch<sup>1</sup>. Matic<sup>2</sup> compared various methods of estimating starch and introduced a new method based on precipitation of starch from sugar samples with absolute alcohol, followed by development of the blue starch-iodine complex and its colorimetric determination. The need to use about 100 ml of absolute alcohol for one sample makes this procedure very expensive in a country like India, where the cost of absolute alcohol is about Rs. 950/- per litre. Furthermore, there is a risk of partial or incomplete precipitation of starch, which may introduce a systematic error in the analysis. Since precipitation is essential both for standard and sample estimation and the cost of absolute alcohol is relatively high, the Matic method is both cumbersome and expensive.

It was, therefore, decided to seek a method for estimating the starch contents in plantation white sugar which eliminates both these difficulties and also yields rapid and reliable results. One such method investigated is that of Sang *et al.*<sup>3</sup> in which the starch content is determined by dissolving the sugar sample in water to 10 - 20% w/v and directly measuring the colour intensity of the solution after addition of KI, acetic acid and KIO<sub>3</sub> solutions with varying strengths and volumes.

Sang *et al.* reported that the best results could be obtained with the following conditions: 25 ml 10% sugar solution (w/v); 0.5 ml 10% KI; 2.5 ml



10% acetic acid; and 5 ml 0.01N KIO<sub>3</sub>, making up with water to 50 ml. The measurement of colour is made at 570 nm. In the present study, we have essentially adopted the method of Sang *et al.* but with certain modifications intended for simplicity, convenience and reliability.

## Materials and methods

The reagents used in the present investigation were essentially the same as used by Sang *et al.* However, their concentrations and volumes or quantities differed. This decision was justified on the basis of recovery of starch obtained as demonstrated in the later part of this

paper. The reagents used during the investigation were 1.2 ml of 2N acetic acid, 0.25 ml of 10% KI, 2.5 ml of M/600 KIO<sub>3</sub> solutions and pure potato starch from Merck. The solution of KIO<sub>3</sub> was prepared by dissolving oven-dried reagent in water.

## Standard curve

For obtaining a standard curve for starch, it was essential to dry 1 g of starch at 105°C in an oven for about 1½ hours. A standard solution was then prepared by dissolving 50 mg starch in 50 ml of water. This slurry was boiled for about 1 minute and the volume of the solution then made up to 100 ml in a volumetric flask. Aliquots of 0.1, 0.2, 0.3 ml, etc. to 1 ml were pipetted out and their volumes were adjusted to 1 ml with the addition of water. To these were added 1.2 ml of 2N acetic acid, 0.25 ml of 10% KI and 2.5 ml of M/600 KIO<sub>3</sub> solution, and the mixtures shaken vigorously. The optical densities (O.D.) of the solutions were then measured at 570 nm against the reagent blank using a Shimadzu spectrophotometer UV 240. It is necessary that the time interval between making up to volume and measuring the optical density is as short as possible. A graph was plotted between O.D. and µg/ml of starch. Figure 1

- 1 Sugar J., 1952, 15, (8), 11 - 15.
- 2 Proc. 14th Congr. ISSCT, 1971, 1434 - 1443.
- 3 *ibid.*, 1426 - 1433.

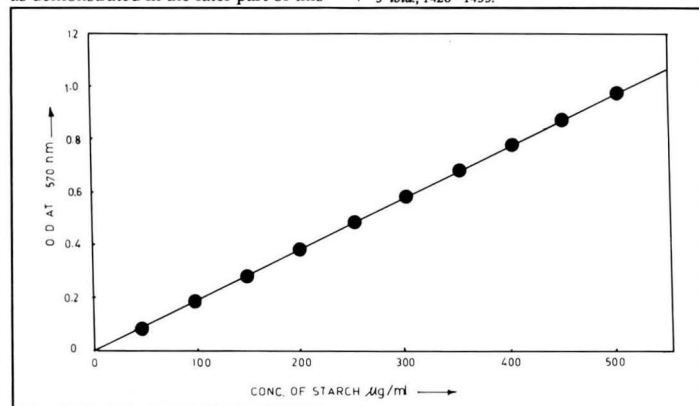


Figure 1. A standard curve plotted between optical densities (O.D.) and concentration of starch (µg/ml)

depicts such a standard plot, which is an excellent straight line. The measured O.D. and concentration of starch in  $\mu\text{g/ml}$  are correlated with an expression of the form.

$$\text{O.D.} = 2.0 \times 10^{-3} \times \text{concentration.}$$

Obviously, the line passes through zero at zero concentration and the average error of the standard curve is 0.002 units of O.D.

The reagent blank was prepared by mixing 1 ml water, 1.2 ml 2N acetic acid, 0.25 ml 10% KI and 2.5 ml of M/600  $\text{KIO}_3$  solution in a test tube of 15 ml capacity.

#### Analysis of samples

In order to measure the starch contents in the samples of plantation white sugar, 5 g of the sugar was weighed into a 100 ml beaker and 5 ml of water added to it. This was boiled for 1 min, filtered and then the volume was adjusted to 10 ml in a volumetric flask. Of this solution, 1 ml was placed in a test tube and 1.2 ml 2N acetic acid, 0.25 ml 10% KI and 2.5 ml M/600  $\text{KIO}_3$  were added. The mixture was vigorously shaken and the optical density recorded as above against the reagent blank.

The optical densities of the samples thus measured were introduced into the standard curve equation and the concentrations of starch (in ppm) were determined. All samples were analysed in quadruplicate and an average was considered as the final reading. The experimental optical densities were reproducible to within 0.003 unit and thus the combined error in the estimation appears to be  $\pm 3$  ppm.

#### Results and discussion

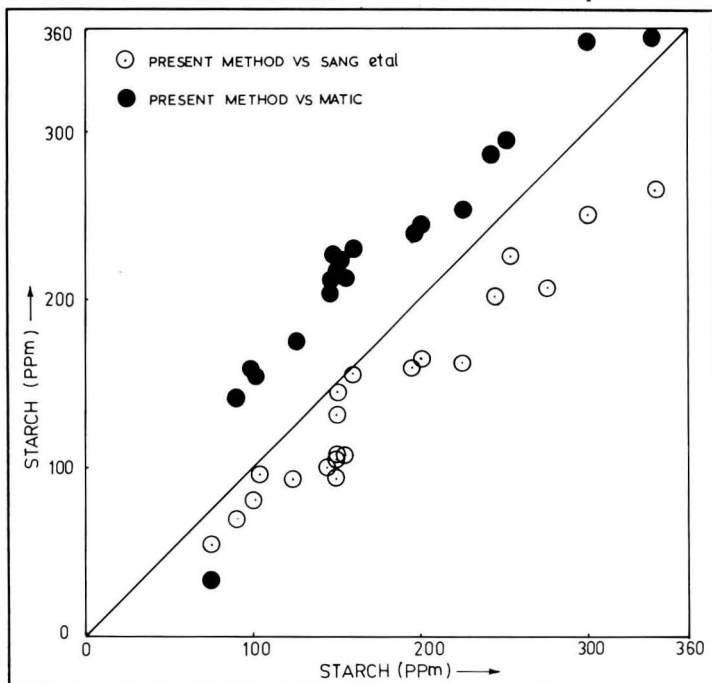
Although we analysed 88 samples of sugar crystals collected from the factories in the State of Maharashtra, for the sake of clarity and convenience, we present in Table I results on starch contents of 21 samples exhibiting a wide range. In Figure 2 are plotted starch contents as obtained by the present method, when compared with those obtained by the procedures of Sang *et al.* and of Matic. Examination of these

**Table I. Starch contents in plantation white sugar**

Sample No.	Starch content, ppm
1	195
2	160
3	150
4	225
5	300
6	255
7	105
8	275
9	125
10	150
11	145
12	150
13	100
14	75
15	150
16	155
17	155
18	90
19	340
20	200
21	245

average of about 21%) and consistently lower than those based on the Matic method. In order to sort out such differences, we repeated the original method of Sang *et al.* and obtained a recovery of 74.8% as compared with their reported value of 97.3%. Considering this recovery of starch obtained by our method and the average residuals (21%), this accounts for the deviations. Similarly, our results deviate from those of Matic by about 50 ppm on average. This real difference may be due to the different sources of starch used in obtaining the standard curve. Referring to the optical densities at maximum adsorption as shown by Matic in Figure 1 of his paper for different starches, the difference of 30 ppm on an average can easily be explained.

It may be noted that our standard curve for starch is accomplished without



**Figure 2. A graph plotted for the starch contents as obtained by the present method against those of Sang *et al.* and Matic**

results indicates that our values are consistently higher than those obtained by the method of Sang *et al.* (by an

any sucrose solution. Matic and other authors have added sucrose in starch solution and obtained the optical



densities. We, in our laboratory, measured optical densities of pure starch solutions both with and without sucrose (sources: Loba and S.D. Fine Chemicals). Figure 3 depicts the differences between O.D. values obtained with and without sucrose and starch in ppm. It is clear from this figure that the residuals ( $\delta$ ) are random and that a standard deviation of 0.006 O.D. unit (13 data points) and a maximum deviation of 0.012 O.D. unit are obtained. The standard deviation values of 0.006 and 0.012 O.D. in turn give the difference in starch estimation certainly not exceeding 6 ppm, which is an excellent achievement. It is therefore considered justifiable to prepare the standard curve without addition of sucrose solution. It should be emphasised that any starch content already present in commercially available sucrose is likely to add a systematic error in the starch estimation of a given sample. To prove this, we added a slightly inferior quality sucrose and found the starch contents of the 50% sucrose solutions to be about 50 ppm. Thus, if one used this sucrose from Loba, the final estimation of starch in the sample could be high by at least 50 ppm. Thus, the use of starch alone for the standard curve preparation gives more reliable results.

Matic has argued the need for sucrose addition in the preparation of a standard curve. Using the results shown in Figure 2 of his paper, one obtains the value of a given sample as 400 ppm with a difference of 20 ppm with and without sucrose addition. This 5% difference is not considered significant. Moreover, other differences were found of approximately 0, 7, 14, 20, 36 ppm at 100, 200, 300, 400, and 500 ppm starch contents, respectively, indicating an average difference of 4%. It is interesting to note that optical densities at 500 ppm as shown by Matic differ by about 0.062 unit for determinations with and without sucrose. This in turn gives a difference of 36 ppm in starch estimation, a deviation of about 7%.

An additional support of this claim could be an examination of

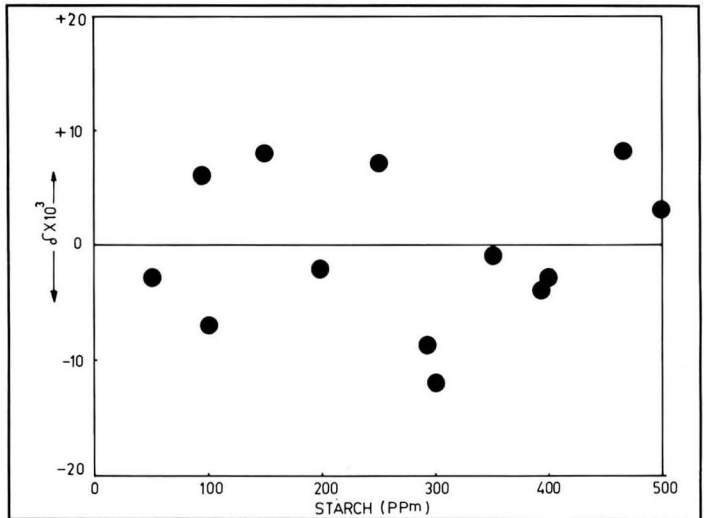


Figure 3. The difference ( $\delta$ ) between O.D. obtained without and with sucrose and starch in ppm

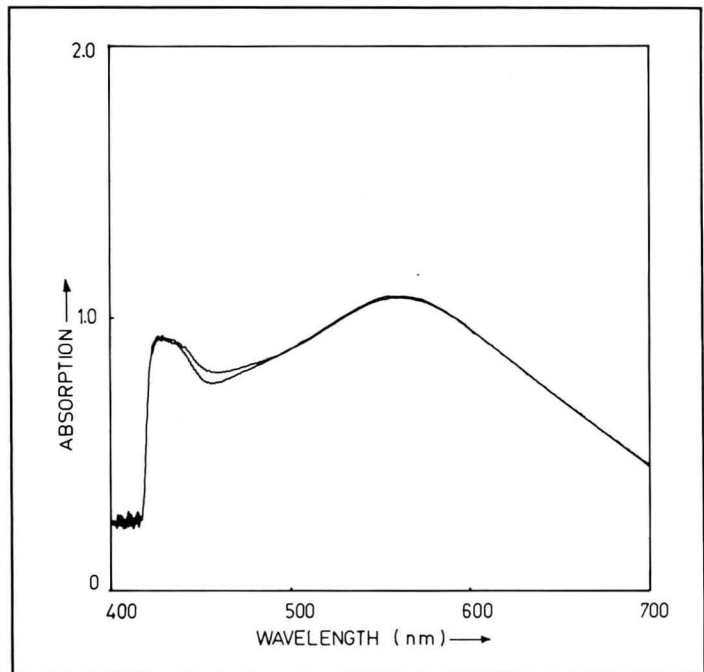


Figure 4. Absorption curve of starch measurement with and without sucrose added

wavelengths for maximum absorption with and without sucrose. Figure 4 demonstrates that such absorption peaks are virtually the same and measurements were therefore made at 570 nm.

Recovery of starch was thoroughly examined in order to have confidence in our experimental method and results are listed in Table II. We examined the recovery by adding the known amounts of starch to a solution, the starch content of which was already known. In general, average starch recovery was 99.1%. In Figure 5 are plotted the amounts of starch added and the amounts recovered by our method, indicating excellent recovery.

Similarly experiments were conducted with varying concentrations and volumes of reagents and 99% starch recovery found with 1.2 ml 2N acetic acid, 0.25 ml 10% KI, and 2.5 ml M/600 KIO<sub>3</sub>.

The technique is thus shown to be a very simple, economical and reliable direct colorimetric method for estimating the starch content in plantation white sugars. Since the method is rapid, it may be used for routine starch analysis at the factory level.

#### Acknowledgements

The authors thank Dr. D. G. Hapase, Director, and Mr. Hambirao Mohite, Chief Executive of this Institute, for their generous support throughout this investigation.

#### Summary

A simple direct colorimetric method for determination of starch in plantation white sugar has been described. This method is essentially based on that of Sang *et al.* which uses the measurement of optical densities of the blue starch-iodine complex, but with certain modifications including elimination of sucrose addition in the preparation of a standard curve. The recovery of starch by the present method is 99.1% and it is noteworthy that this method avoids precipitation of starch with alcohol.

Starch added, ppm	Starch recovered, ppm	Recovery, %
50	49.5	99.0
100	98.5	98.5
200	199.0	99.5
500	496.0	99.2
1000	991.0	99.1
Average recovery, %		99.1

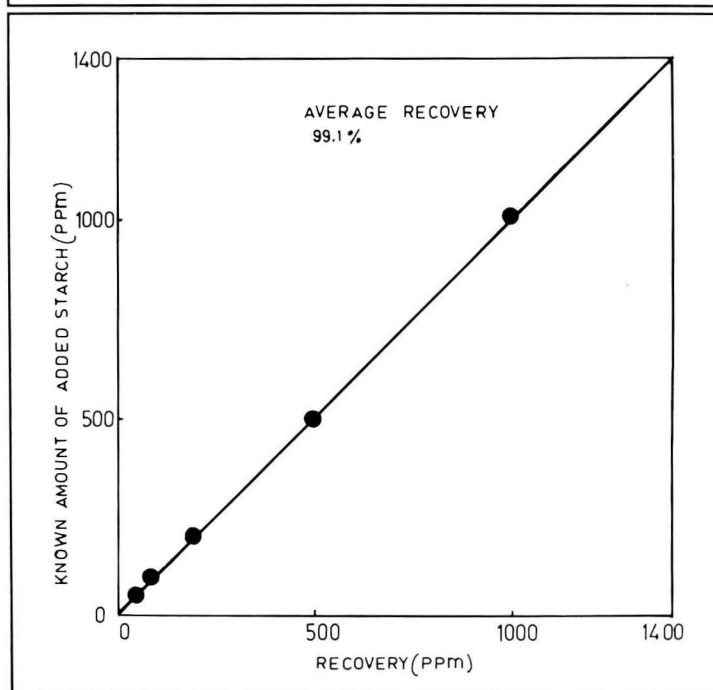


Figure 5. Recovery of starch (%) by the present method

#### Un método colorimétrico directo y simple para el ensayo del almidón en azúcar blanco

Se describe un método colorimétrico directo y simple para la determinación de almidón en azúcar blanco. Este método está basado esencialmente en el trabajo de Sang y otros quienes usan la medición de densidad óptica del complejo azul formado de almidón con yodo, pero con ciertas modificaciones, una de las cuales es la eliminación de la adición de sacarosa en la preparación de la curva de calibración. La recuperación del almidón por el método actual es de

99.1% y es notable que este método evita la precipitación del almidón con alcohol.

#### Un simple méthode directe colorimétrique pour la détermination des amidons dans les sucres blancs d'usine

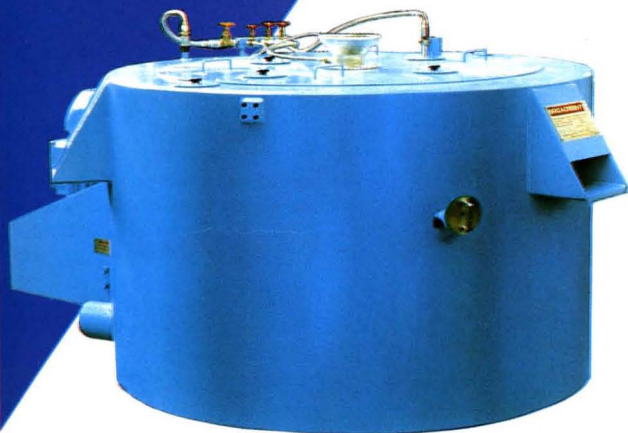
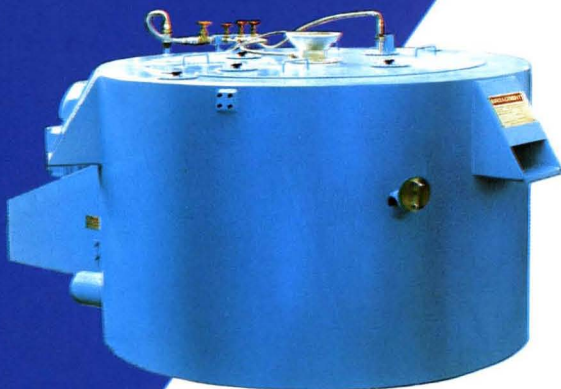
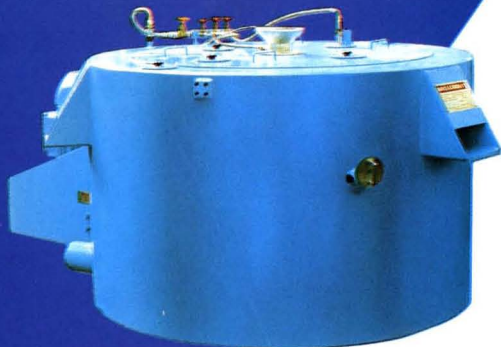
On décrit une méthode simple, basée sur une mesure directe de la coloration et qui permet de déterminer l'almidon dans le sucre blanc d'usine. Cette méthode est en fait basée sur celle de Sang *et al.* qui met en oeuvre la mes-

*continued on page 60*



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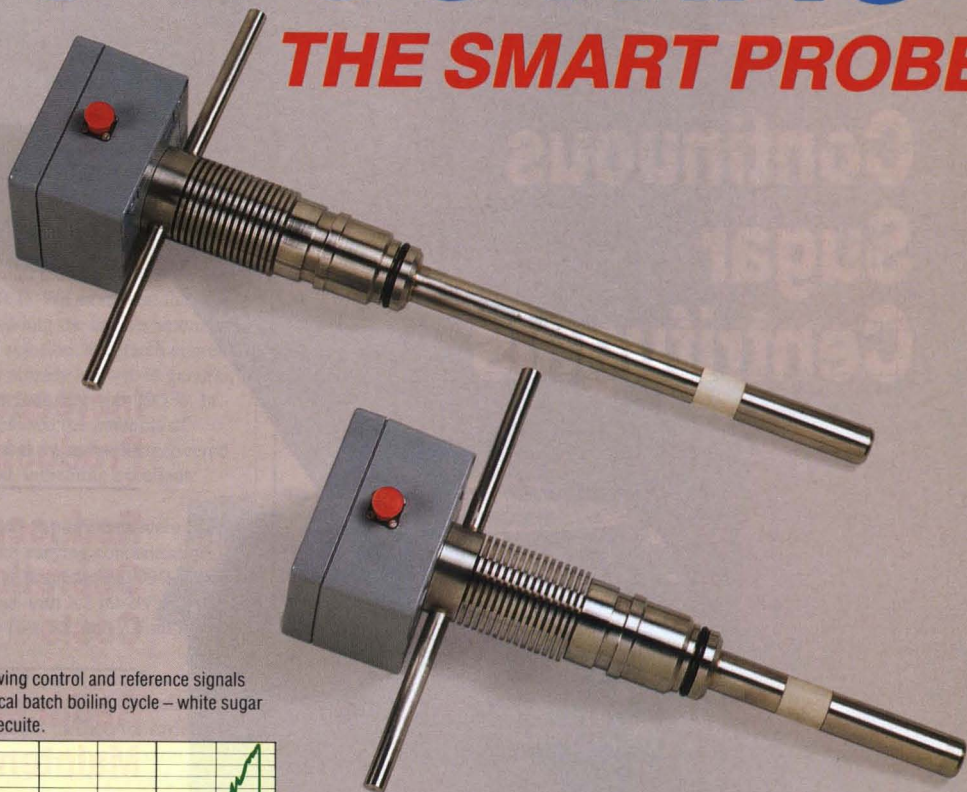
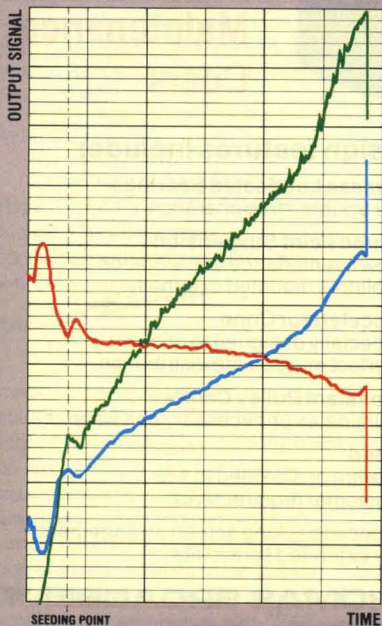


Chart showing control and reference signals over a typical batch boiling cycle – white sugar beet massecuite.



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# Electrical conductivity control of calcium sulphite precipitation in cane juice clarification

By Mahendra Prasad, R. Chandra\* and G. D. Nigam

(Physical Chemistry Division, National Sugar Institute, Kanpur, India)

## Introduction

The clarification of sugar cane juice by any process is primarily controlled by maintaining optimum pH. A large number of Indian sugar factories use bromothymol blue paper to check pH at completion of the clarification reaction, but the use of a pH meter has been gaining popularity in recent years. Control of the clarification using BTB paper is not precise and an excess of lime is invariably found in the clarified cane juice. This causes several problems, such as low recovery, poor keeping quality and excessive scaling in the evaporators, in addition to other effects associated with excess CaO.

Estimation of pH with BTB paper can easily deviate up to 1.0 unit from the optimum value. It is difficult to realise the importance of such deviation and its impact on the overall clarification process. However, this small change in pH, which is practically ignored, corresponds to a considerable CaO content remaining in the clarified cane juice.

The importance of the small deviation of pH is realised only when measurements are made simultaneously of CaO content, pH, conductivity and colour during cane juice clarification. We have carried out some experiments in which these parameters are measured in both sulphitation and carbonation processes in our laboratory<sup>1</sup>. The results of the carbonation studies were published earlier<sup>2</sup>. A review of the literature revealed that a number of workers have studied measurement of conductance in different solutions; Smith *et al.*<sup>3</sup> studied the mixed but concentrated electrolyte; Kendall *et al.*<sup>4</sup> demonstrated the application of conductance for complex formation in aqueous medium; Smith & Gortner<sup>5</sup>, Stearn<sup>6</sup> and Van & Nutting<sup>7</sup> studied the conductivity of mixtures of salt solutions; and Rysselberghe & Van Pierce<sup>8</sup> and Bremner *et al.*<sup>9</sup> reported measurements for a number of mixtures containing bivalent ions. However, work pertaining to the application of conductivity measurement to ensure the



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completion of the precipitation reaction in a sugar system is scanty.

The idea of controlling cane juice clarification by measuring colour and conductivity resulting from this investigation has been briefly tested in a few sugar factories. Some of the results obtained in the laboratory and in the factories are communicated in this paper.

## Materials and methods

Chemicals used in this investigation at factories and in the laboratory were lime water, SO<sub>2</sub>, buffer solution (BDH), EDTA disodium salt (BDH), Eriochrome Black T, etc. Cane juices from Co 1148, CoJ 64 and CoS 767 varieties were used in this work.

Apparatus used included a Bausch & Lomb "Spectronic-20" spectrophotometer, a Century digital conductivity meter Model CC-601, a Toshniwal digital pH meter Catalogue No. C146 NRDC and a thermostat type NBE Gr. Nr. Model 24019. During the factory investigations, pH, conductivity and temperature were measured using a Model CK710 portable water analysis kit.

## Precipitation of calcium sulphite during clarification of cane juice

Experiments at 25°C were carried out using a mixture of 400 ml cane juice (freshly crushed) and 60 ml lime slurry

(13°Bé). Initial pH and conductivity of the mixture were determined. After passing SO<sub>2</sub> into the limed cane juice for five minutes, pH and conductivity were measured simultaneously. From the reaction mixture a 10.0 ml portion was withdrawn, filtered through Whatman No. 1 filter paper, and the CaO and absorbance determined. The pH and conductivity of the filtered clarified juice were also checked from time to time, and found to be in agreement with the values determined on unfiltered juice. This procedure of passing SO<sub>2</sub> and measuring pH, conductivity, CaO and absorbance was continued till a clear minimum was obtained. Similar measurements were also made at 55°C.

## Results and discussion

The conductivity and pH measurement during sulphitation of limed cane juice at 25°C are shown in Figure 1. Comparing these results at 25°C with that of 1st carbonation<sup>2</sup>, identical behaviour is observed. CaO, specific conductivity and colour data show almost superimposing minima after about 10 minutes of SO<sub>2</sub> saturation. The minima in the CaO and conductivity curve correspond to pH 9.75. During the initial stages of SO<sub>2</sub> saturation, the absorbance curve is also similar to that of carbonation<sup>2</sup>, but when the juice is excessively saturated with SO<sub>2</sub>, the nature of the curve is different from that with CO<sub>2</sub>. In sulphitation, after the minimum the absorbance increases for up to 35 minutes, after which it suddenly drops e.g. from 1.9 to 0.85 after 40 minutes of SO<sub>2</sub> gas.

Observations of the sulphitation process at 55°C were similar to those at 25°C and the data are shown in Figure 2. At 55°C the minimum lime contents

\* Present address: Oil and National Gas Commission, Assam, India.

- 1 Chandra: Ph.D. Thesis (Kanpur University, Kanpur), August, 1982.
- 2 Prasad & Chandra: *I.S.J.*, 1985, **87**, 31 - 37.
- 3 *J. Amer. Chem. Soc.*, 1907, **37**, 321.
- 4 *ibid.*, 1921, **43**, 1416.
- 5 *J. Phys. Chem.*, 1933, **37**, 79 - 86.
- 6 *J. Amer. Chem. Soc.*, 1922, **44**, 670 - 678.
- 7 *ibid.*, 1934, **56**, 1435 - 1437.
- 8 *ibid.*, 1937, **59**, 333.
- 9 *ibid.*, 1938, **60**, 2616.

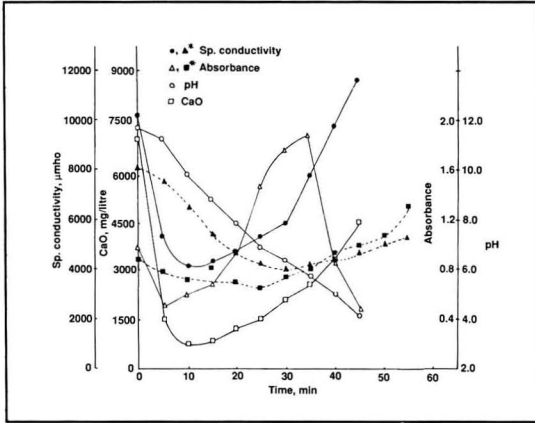


Fig. 1. Precipitation of  $\text{CaSO}_3$  in cane juice at  $25^\circ\text{C}$  (\* carbonation<sup>2</sup>)

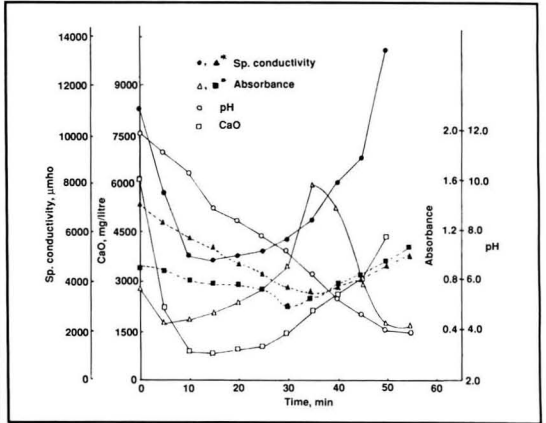


Fig. 2. Precipitation of  $\text{CaSO}_3$  in cane juice at  $55^\circ\text{C}$  (\* carbonation<sup>2</sup>)

were found to be at pH 9.0 and 9.75 in sulphitation and carbonation, respectively. Minimum calcium content in the sulphitation process was about 860 mg/litre at both temperatures.

Having observed clearly in the laboratory the minima in each curve, viz., conductivity, colour, CaO content in both carbonation and sulphitation reactions of cane juice clarification,

investigations were made in commercial sugar factories to determine whether conductivity measurement was sensitive enough to ascertain the completion of the precipitation reaction during cane juice clarification.

In a double sulphitation factory of 3000 t.c.d. crushing capacity, ten 100 ml samples of the juice being clarified were collected in flasks at intervals of two

minutes from a check valve of a liming and sulphitation tank. The samples were filtered through Whatman No. 1 filter paper separately. Conductivity and pH of the filtered juice were measured at  $25^\circ\text{C}$ .

pH and conductivity *versus* time curves are shown in Figures 3 and 4 for two different commercial factories. Data from both factories indicate clear

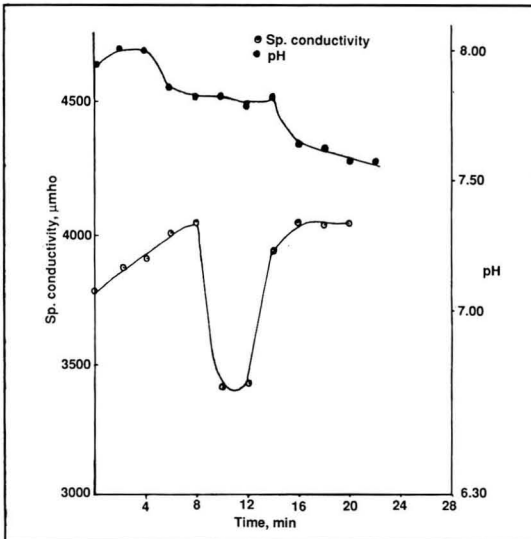


Fig. 3. Conductivity and pH *versus* time; cane juice clarification at Kichha sugar factory, Nainital, U.P.

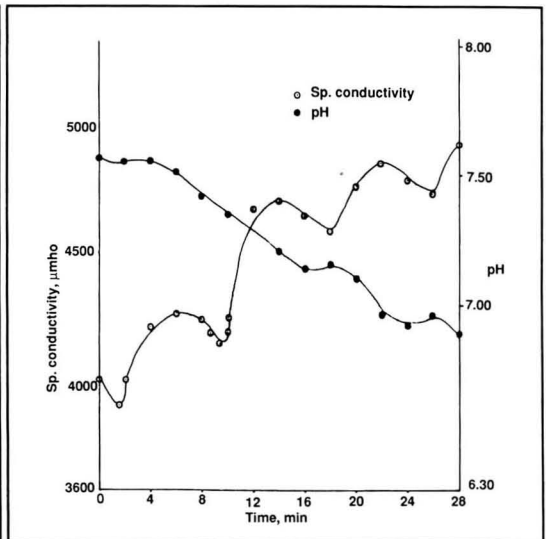


Fig. 4. Conductivity and pH *versus* time; cane juice clarification at Kesar Enterprises Ltd., Baheri, U.P.



# Cane sugar manufacture

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## Use of pulverized coal in industrial boilers

F. J. Ceely. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-11 - F-19.

Aspects of boiler operation on pulverized coal are discussed.

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## Hopper evacuation scrubbers for bagasse-fired boilers

A. Barron. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-20 - F-25.

Errors in the design and installation of bagasse boiler dust separation systems and their components are discussed and problems encountered in specific sugar factories examined. Of scrubbers needed to clean the dust-laden gas stream leaving the hopper of a collector, the best is a venturi throat used in a 2-stage system; efficient separation of moisture droplets from the gas stream is a crucial factor.

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## Pioneer mill cooling tower

R. P. DeMille. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-26 - F-27.

A cooling tower is described that was built to handle warm condensate from the boiling house intended for use in drip irrigation. Problems with pan entrainment are mentioned.

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## Mill hydraulic drive

F. Ratliff. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-28 - F-32.

The advantages of hydraulic drives for cane mills are indicated and their operating characteristics, installation and maintenance discussed.

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## The mechanics of corrosion

J. C. Tverberg. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-33 - F-39.

The five basic forms of corrosion that

cover most cases encountered (uniform, galvanic, intergranular, stress cracking and bacterial) are discussed and advice given on corrosion prevention by use of suitable resistant materials.

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## Control of emissions: coal- and bagasse-fired boilers

M. Borenstein. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-40 - F-42.

Control of particulate emission by means of cyclones and possibly suitable secondary systems such as bag filters, electrostatic precipitators and wet scrubbers is discussed.

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## Diagnosis of wear mechanisms

A. Hollinger. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-43 - F-45.

The five types of wear most commonly found in sugar machinery are described with the aid of photographs: severe adhesion or scuffing, abrasion, contact fatigue, corrosive wear and fretting corrosion.

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## Fundamentals of fluid lubrication

G. R. Trabert. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-46 - F-48.

Advice is given on lubrication, including oil vs. grease, and the industrial viscosity classification system used is explained.

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## Interpretation of oil analysis

G. C. Brindley. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-49 - F-51.

Sampling and analysis of oil and interpretation of the data are described.

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## Finned tube heater installation and performance at Kekaha Sugar Company

D. Okihara. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-52 - F-53.

Problems with massecuite reheating at Kekaha are described and details given of a finned tube heater, as used in the Australian sugar industry, installed to replace the earlier system. The result was more rapid and more uniform heating with shorter residence time.

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## Steam distribution control system at HC & S, Paia

J. R. Kwok and R. P. Lawler. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-54 - F-56.

Details are given of a Fisher automatic system for control of steam flow to the various users in the factory while maintaining power generation at a maximum level. Operation of the scheme has reduced fluctuations in boiler steam demand. Future plans are indicated.

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## Use of filtration efficiency in the evaluation of HiGrade operation

K. Onna. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-57 - F-59.

HiGrading is the processing of the relatively clean upper part of windrowed cane without washing. While it provides the potential for a significant increase in sugar yield it also presents serious clarification and filtration problems arising from the high soil levels in mixed juice. Measurement of filtration efficiency proved an effective means of evaluating filter and clarifier performance and indicated the following requirements for HiGrade cane processing: a mixed juice soil content no higher than 2.5%, increased clarifier/filter capacity to handle a threefold increase in juice soil, and a filtration efficiency (i.e. retention of clarifier mud solids by the filter cake) of about 90%.

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## The economics of RO concentration of cane juice

T. A. Hsu. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-60 - F-67.

An economic analysis of mixed juice



concentration by reverse osmosis revealed substantial benefits in the form of steam saved (the calculations being based on the corresponding extra amount of electricity sold or the reduced payments for fuel oil); however, if clarified juice were to be treated, the economics would be very much less favourable.

#### Painting your equipment to last

W. J. Zabolski. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-71 - F-75.

Application of corrosion-resistant coatings to equipment is discussed and the various types of protective materials are described.

#### Adjustment of the mills of a sugar factory to obtain maximum extraction

M. C. Hernández C. and J. R. Abreu G. *Centro Azúcar*, 1985, 12, (2), 3 - 8 (Spanish).

A method has been devised for adjusting cane mills to obtain maximum extraction which is based on a computer program relating the various mill parameters including load, velocity and apertures.

#### Experimental methodology for the evaluation of bagasse diffusers

E. M. Sevilla P. *Centro Azúcar*, 1985, 12, (2), 9 - 18 (Spanish).

Measurement of temperature, Brix, sucrose % and pH are measured along the diffuser and the characteristic curves obtained are compared with those provided by the constructor in order to assess the diffuser's performance and what to do to improve its efficiency.

#### Controlability of the pan boiling process

F. Herrera F. and G. Machado B. *Centro Azúcar*, 1985, 12, (2), 19 - 26 (Spanish).

Determination of properties relative to control of the boiling process was investigated and some results are

presented in the form of graphs and matrices corresponding to controlability, observability and stability values around fixed values obtained using linear and non-linear mathematical models.

#### Kinetics of linear growth of sugar crystals in the production of fine grain strikes

A. Márquez S. and V. G. Tregub. *Centro Azúcar*, 1985, 12, (2), 27 - 33 (Spanish).

By means of experimental data obtained under industrial conditions it was possible to obtain an equation to describe the kinetics of linear growth of sugar crystals in fine grain strikes and the relationships to determine the constants of this equation. It is shown that two of these constants, the shape constant and the time constant, can be determined by means of equations similar to those used for calculation of the shape and time constants of the kinetic equation for sugar crystallization. The remaining constant, the maximum crystal size, is a function of the duration of the process and the initial crystal concentration in the massecuite. Using the equation it is possible to predict at any moment the average size of the crystals during the production of fine grain strikes.

#### The essence of Crystal 600

L. Carrazana R. *Centro Azúcar*, 1985, 12, (2), 35 - 42 (Spanish).

Recrystallization of sucrose from a ternary system sucrose-water-ethanol is widely used in Cuba for the preparation of seeding slurry (Crystal 600); however, it has only poor stability and reproducibility. Studies have shown that the interactions between the components of the system make it impossible to obtain a seeding means which gives acceptable uniformity.

#### Calculation of the specific enthalpies of sugar fluids

J. L. Díaz R. and O. Gozá L. *Centro Azúcar*, 1985, 12, (2), 49 - 54 (Spanish).

A calculation algorithm is presented for

evaluation of the specific enthalpies of the different sugar fluids in the various forms in which they are encountered, including massecuites. A main program and a sub-program have been written, which need only as initial data the temperature, total Brix and purity of the particular fluid to make the necessary calculations. The results are considered satisfactory.

#### Possibility of modelling process systems using regression models

N. Valdés A. and V. González. *Centro Azúcar*, 1985, 12, (2), 55 - 60 (Spanish).

Using regression analysis a study has been made of the possibility of modelling the manufacture of raw sugar. Taking as a base the linear statistical correlations between the input and output variables for each of the stages into which the process is divided, it is possible to model each of these. A program is developed which, by means of a general calculation sub-routine permits the principal variables at the output of each stage to be obtained as a function of input parameters and variables easily obtained or output from previous stages. With the program it is also possible to analyse the effects of different variables on the system operation.

#### Preliminary study on the obtaining of a dynamic model for second strikes

M. Rodríguez B., M. García A. and J. A. González T. *Centro Azúcar*, 1985, 12, (2), 61 - 68 (Spanish).

An existing proven model for A-masse-cuite is adapted to give a dynamic mathematical model of a B-masse-cuite. The characteristics of the latter - viscosity and purity - are very different but the model is shown by initial results to be capable of describing second strikes provided the necessary changes are made in the coefficients and parameters in accordance with the new conditions. The correspondence between the values obtained with the model and real

data, especially for trends in the variables, lead to the belief that the model can be used as a starting point for developing a definitive model.

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#### **Application of simulation-response techniques to industrial cane juice clarifiers**

C. Díaz R., M. A. Barly and J. Guerra D. *Centro Azúcar*, 1985, 12, (2), 69 - 74 (Spanish).

Conventional and function F(t) methods, previously used to evaluate the hydraulic efficiency of laboratory-scale prototypes, have been applied to the results obtained in tracer experiments with industrial clarifiers.

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#### **Evaluation of the work efficiency of some evaporation schemes in sugar centrals**

S. Machado B., M. J. Carrillo A. and A. Díaz M. *Centro Azúcar*, 1985, 12, (2), 87 - 92 (Spanish).

The algorithms implicit in the thermo-energetic balance method developed at the Las Villas Central University were applied to results of different evaporator schemes employed at sugar factories in central Cuba in order to develop a comparative analysis of their efficiency.

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#### **Continuous massecuite supersaturation meter**

F. Pantuso N. and J. Sánchez B. *Centro Azúcar*, 1985, 12, (2), 93 - 98 (Spanish).

A new instrument has been developed which employs a computational scheme based on an 8080 microprocessor and a transducer providing a display indicating the supersaturation which is measured in terms of the conductivity of the mother liquor.

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#### **Multiple linear regression analysis of the Reto boiler**

M. Cortés, J. Castellanos and P. Olivares. *Centro Azúcar*, 1985, 12, (2), 99 - 106 (Spanish).

Multiple linear regression analysis was

applied to measurements of superheated steam flow, temperature and pressure of exit steam, feed water temperature, air pressure and temperature at the exit of the air heater and gas temperatures at the inlet and exit of the air heater. Relationships were developed which allowed recommendations to be made for improvement of boiler operation.

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#### **Evaluation of the system of automatic control on the pan floor**

J. Artiles S., R. Moreno, M. Nápoles and A. M. Cornell G. *Centro Azúcar*, 1985, 12, (2), 107 - 112 (Spanish).

In order to adjust the feedback system in the automatic control of boiling at a Cuban sugar factory, stepwise disturbances were made at the control valve and the response recorded, whereby working parameters were obtained for the derivative integral proportional regulator installed for control of conductivity in the pan.

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#### **Study of Tensol as a surfactant in the exhaustion of third massecuites**

M. Ugarte, R. González, L. Ramos S. and E. Ramos O. *Centro Azúcar*, 1985, 12, (2), 119 - 124 (Spanish).

Tensol is a by-product from vegetable oil refining and its effect has been studied in laboratory-scale crystallization experiments, in which the viscosity, surface tension and reducing sugars in the massecuites were measured as well as colour and granulometry of the sugars produced, and the optimum level of Tensol determined.

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#### **Industrial wastes. A current problem**

M. T. Hernández. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 10, 54, 70, 78, 112, 120 (Spanish).

The history of sewage treatment is summarized, particularly for developing countries, and reference made to the use of biological purification of sugar industry effluents, most effectively after

mixing the waste water with filter-cake to add nutrients for the micro-organisms concerned.

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#### **Influence of different alkalinizing agents on the purification of sugar juices**

B. Melnikov, N. Martínez, T. Prieto and T. Fernández. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 21 - 32 (Spanish).

Cane juice samples of 15°Bx and at boiling point were brought to pH 6 with lime and then to pH 7.2 - 8 with lime or NaOH, maintained for 3, 7 or 9 minutes in the presence or absence of added CaCO<sub>3</sub>, the test tubes inverted and the rate of settling and clarity of the supernatant measured. Lime was the better agent, giving regular and faster settling than NaOH, with similar juice clarity. The optimum amount of added CaCO<sub>3</sub> was between 0.5 and 1.0 g per 600 ml of juice. Positive results were given whether the CaCO<sub>3</sub> was added at liming or just before sedimentation.

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#### **Influence of the variety and fertilizer levels on the cane juice settling process**

N. Martínez A., S. Castillo, O. Yedra and J. Alomar. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 43 - 53 (Spanish).

From an analysis of sedimentation of juices from a number of varieties and different fertilizer regimes, those giving the best purification performances were identified.

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#### **Preliminary experience with progressive liming of cane juice**

J. C. Bango, R. Fernández, J. Galindo and P. Zagorodni. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 55 - 69 (Spanish).

Cane juice was heated to temperatures between 40° and 90°C and limed to pH 7.8 either in one stage or in several stages extending between 2 and 20 minutes in order to precipitate separately

the different impurities in the juice. It was found that the progressive liming gave a higher settling rate than the traditional method and also a 20 - 30% smaller mud volume. With increasing temperature the time required for defecation became less and separation of colouring matter increased.

#### **Integral thermomagnetic balance of a sugar factory with distillery**

M. J. Carrillo A., R. Espinosa P. and M. C. León. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 71 - 77 (Spanish).

Tables show the minimum, average and maximum proportions of live and exhaust steam utilized by various equipment (turbines, evaporators, etc.) in Cuban sugar factories and these are discussed, with recommendations for improving performance so as to avoid the use of supplementary fuel.

#### **Influence of different parameters on the design of recovery surfaces**

M. Lapido R. and P. Arano A. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 89 - 96 (Spanish).

A computer analysis has been carried out to determine the effects of gas velocity, tube diameter and bagasse moisture on the performance of three types of boiler used in Cuban sugar factories with the aim of determining the most efficient design.

#### **Sulphur content in bagasse**

W. A. Mansol. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 97 - 104 (Spanish).

Examination of records from different Cuban sugar factories at different times show that the sulphur in bagasse varies widely with geographical area and time but appears to have increased since 1969.

#### **Dependence of bagasse combustion on particle size, velocity and**

#### **air temperature**

P. R. Roque D., J. Suárez C., A. M. Rubio G., C. Quintana P. and R. Berines C. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 105 - 112, 120 (Spanish).

Variation of the title parameters in an experimental apparatus enabled trends to be shown but not the optimum values for highest bagasse combustion efficiency.

#### **Considerations on the operational evaluation of an evaporator station**

J. Castellanos A., M. Trujillo and N. Gil L. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 121 - 130 (Spanish).

Analysis of the performance of the individual effects of a quadruple-effect evaporator with vapour cell showed that, because of inequalities, the overall performance was only 82% of theoretical, and recommendations are made (retubing three effects, relocating calandria baffles, etc.) to improve performance.

#### **Analysis of the "efficacy" of evaporator stations**

J. Castellanos A., L. Martínez D. and M. Trujillo H. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 131 - 135 (Spanish).

Efficacy is defined as the ratio of actual heat transfer rate to the maximum possible rate. Its application to an actual evaporator showed the defects and opportunity for correction.

#### **The economics of efficient sucrose extraction: a comparison of milling and diffusion technologies**

R. Gray. *Paper presented to British Soc. Sugar Cane Tech.*, October 1988.

The potential savings in operating and maintenance costs for a diffuser installation relative to a milling plant are discussed, as are the key ancillary plant and process operation. Diffusers can

reduce the foreign exchange costs of maintenance and improve the medium to long term economic viability of a sugar project. Diffusers can be economically incorporated into milling factory rehabilitations, and can show rapid returns on investment by reduced operating and maintenance costs, and in most cases, improved revenue due to increased sucrose extraction.

#### **Hamakua Sugar Company factory consolidation**

J. W. Bersch. *Rpts. 45th Ann. Conf. Hawaiian Sugar Tech.*, 1986, F-1 - F-4.

A consolidation program for Hamakua Sugar Co. involving expansion of Haina sugar factory and closure of Ookala factory is outlined; besides installation of extra processing and power plant equipment, it includes yard alterations to allow improved cane haulage with larger transport units, and modifications to the boiling and crystallization schemes: boiling high-purity A-strikes (the only ones for commercial sugar) on a footing of B-sugar magma with feeds of syrup and C-remelt, using low-grade crystallizers to cool A- and B-masseccutes to improve purity drops, and installing a new low-grade boiling and curing station.

#### **The road to automation**

R. P. Lawler. *Rpts. 45th Ann. Conf. Hawaiian Sugar Tech.*, 1986, F-8 - F-9.

Direct digital control of factory operations and the possibility of optimization are discussed with mention of examples from the author's sugar company.

#### **New innovations in slurry pump design**

S. Nierenez. *Rpts. 45th Ann. Conf. Hawaiian Sugar Tech.*, 1986, F-14 - F-17.

The design of pumps suitable for handling abrasive slurries is discussed, including impeller inlet and shroud, casing, dry centrifugal and water-flushed seal features and pump maintenance.

# Beet sugar manufacture

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## Comparison of two techniques for sugar production in terms of colouring matter concentration

M. Spanar, M. Kovac and Z. Jancekova. *Bull. Potravin. Vysk.*, 1987, 26, (2), 163 - 172; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (12), Abs. 12 R422.

Comparison was made between the colour of the products obtained by extracting sugar from cossettes using water by the conventional method and using an acetone-water mixture in a new technique. The juices obtained by both methods were purified by carbonation. It was found that the semi-products obtained with the new technique were less coloured; this was attributed in part to the fact that extraction with acetone-water is carried out at a lower temperature.

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## The RT5 diffuser: conception, installation and operational results

W. P. H. Loop. *Listy Cukr.*, 1988, 104, 127 - 134 (Czech).

The salient features of the three generations of RT rotary diffuser (RT2, RT4 and RT5) are described and a more detailed account is given of the RT5 with its modified transport/screen system and of the RT5-E with built-in pre-scalders as installed at Ste. Emilie factory in France for a daily throughput of 12,000 tonnes of beet (making it the largest beet diffuser in the world). Dimensions are given of the RT5 and RT5-E units for 2000, 3000 and 4000 tonnes/day throughput. Factors to be considered in the installation and operation of RT diffusers are discussed and results obtained from 16 RT diffusers in French sugar factories during the 1986/87 campaign are analysed.

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## Continuous sugar centrifugals: a market review

Anon. *Zuckerind.*, 1988, 113, 565 - 575 (English, German).

Details are given in tabular form of continuous centrifugals manufactured by

13 firms, including basket dimensions and construction, operational data, capacities and fields of application, motor power consumption, lubrication and special features.

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## Examples of the application of vapour turbocompression in sugar factory evaporator stations

O. Bia. *Ind. Sacc. Ital.*, 1988, 81, 96 - 102, 104, 106 (Italian).

A vapour recompression system installed at San Quirico and Contarina sugar factories is described and its performance at the former factory discussed with the aid of steam diagrams. The scheme includes a Tosi S 90 centrifugal compressor which in the 1987 campaign raised the pressure of exhaust steam from 2.52 to 3.1 kPa/cm<sup>2</sup> and fed it at 112 tonnes/hr to a battery of three evaporator effects of 1600, 1600 and 1200 m<sup>2</sup> heating surface (in series on the juice side and in parallel on the steam side) used to pre-concentrate thin juice to 18°Bx.

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## Remote-controlled wet reclaiming of beets

M. Hubka. *Listy Cukr.*, 1988, 104, 159 - 163 (Czech).

A nozzle similar to the Elfa system for wet reclaiming of beets from storage piles is described and its operation by remote control aided by closed-circuit television explained. In trials with a prototype at one Czechoslovak sugar factory, inadequate water pressure of 0.25 MPa (as against a design value of 0.3 - 0.5 MPa) caused the jet of water, directed at an angle of 15° from the horizontal, to reach only 66 - 75% of the nominal distance of 35 - 40 m, but it was still sufficient (with a nozzle diameter of 70 mm) to reclaim beets at a rate of 85 - 90 tonnes/hr. The TV cameras failed to arrive in time for the trials.

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## A solution to the problem of pipeline routes

J. Bejtlerova and E. Jirat. *Listy Cukr.*,

1988, 104, 164 - 165 (Czech).

Pipelines to carry effluent from the sugar factory to treatment plant such as clarifiers may be routed underground or overhead; in an arrangement at Lovosice, pairs of columns were erected at intervals and two pipelines suspended between them at a given height above the ground, a larger diameter pipe carrying flume-wash water and a smaller bore pipe below it carrying condenser water.

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## A Chemadex biological clarifier

K. Duffek, F. Fejt and S. Svatek. *Listy Cukr.*, 1988, 104, 165 - 168 (Czech).

The performance of waste water treatment plant at Wroclaw sugar factory in Poland is discussed. The effluent, containing 3000 - 4000 g/m<sup>3</sup> BOD<sub>5</sub>, was treated anaerobically for 13 hr at 35°C to reduce the BOD by 70% (as against a guaranteed 75%), after which aerobic treatment in two oxygenation tanks (to which separated mud was recycled after regeneration) reduced it by a further 25 - 29% to a maximum of 50 g/m<sup>3</sup>. The treatment is criticized for the low efficiency of the anaerobic stage (attributed to blockage by Ca carbonate formed from the Ca in the effluent and the CO<sub>2</sub> liberated by the fermentation process), which resulted in a greater pollution load to be removed in the energy-consuming aerobic stage, for the failure to control the pH of the effluent feed (which was in the range 5 - 6 instead of 7 as required for effective anaerobic treatment) and for the out-of-date approach used for both stages.

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## An idea for alteration of the heat economy in beet sugar factories

E. Otorowski. *Gaz. Cukr.*, 1988, 96, 56 - 61 (Polish).

The levels of fuel consumption in the form of oil and the revenue from pressed and dried pulp (of 24% and 90% dry solids, respectively) are compared for different factory arrangements, starting with a factory that does not dry any of



its pulp and proceeding via factories that dry all or only half of their pulp to 24% dry solids with flue gas as heating medium, to factories that use superheated vapour from the evaporator in a special pressure dryer, after which the vapour is cleaned in a special superheater and returned to the evaporator or used for other purposes in the factory; this last arrangement, with an evaporation rate of 105% on beet and sale of pulp of 90% dry solids, is shown to be the most profitable where a gas turbine is employed to generate the heat used for vapour superheating as against an electric heater applied in the next most profitable scheme where the evaporation rate is 110% on beet. (It is assumed that the pulp has a monetary value which is about 35% of the sugar value.)

#### The first year of operation of biological treatment of waste water at Melno sugar factory

K. Marciniak and S. Laskowski. *Gaz. Cukr.*, 1988, 96, 64 - 66 (Polish).

Continuous treatment of factory effluent and domestic waste water plus waste from various buildings in the vicinity is reported. Anaerobic treatment is followed by two-stage aerobic treatment with activated sludge in aeration tanks, mud from Stage 2 being recycled to Stage 1 and any surplus being recirculated to the anaerobic fermenter; Stage 1 is a high-load mud tank of 1930 m<sup>3</sup> capacity in which the waste water is retained for 10 hours, while residence time in Stage 2 low-load tank of 3175 m<sup>3</sup> capacity is 16.5 hr. The capacity of the fermenter is 61,000 m<sup>3</sup>, allowing for a daily waste water input of 4620 m<sup>3</sup> at a BOD<sub>5</sub> that should not exceed 166.3 kg O<sub>2</sub>/day, although the maximum daily throughput in 1986 was only 3400 m<sup>3</sup>. The treated effluent is discharged to a drainage ditch and finally, via a small river and two lakes, enters the river Vistula. Both pollution load and performance of the plant varied widely in 1986.

#### Analysis of the possibility of utilizing a vibrator flowmeter in

#### the sugar industry

M. Turkowski. *Gaz. Cukr.*, 1988, 96, 66 - 69 (Polish).

With a flowmeter as described, the stream of liquid is split into two parts which cause the element behind the splitter to vibrate. A mechanical equivalent would be a sprung vibrator, but in the flowmeter the role of the springs is played by the thrust of the two liquid streams. A magnet attached to the vibrator induces emf in its coil of the same frequency as that of the vibrations; this signal is amplified and transmitted to secondary devices. The theory and operation of the flowmeter on gases and liquids are examined and typical dimensions and operating conditions listed.

#### Application of chemical preparations for the storage of sugar beet

N. Lambrev. *Khranit. Prom.*, 1988, 37, (1), 28 - 29; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (15), Abs. 15 R415.

An investigation of the effect of stored beet treatment with allyl isothiocyanate and 2% Malside-30 on losses showed that treatment with the former preparation reduced sugar and weight losses by 29.68% and 30.32%, while Malside-30 decreased them by 71.49% and 51.33%, respectively.

#### Carlow seeding system

M. E. Buckley. *Paper presented to Tate & Lyle Crystallization Seminar*, 1988, 36 pp.

The patented Selwig & Lange pan seeding system was installed at Carlow sugar factory in Ireland for the 1987/88 campaign at a cost of £350,000. Fondant sugar, as a slurry in iso-propanol and glycerin, is added to standard liquor of 74°Brix and 93 purity at 50°C, i.e. 1.10 supersaturation, in a crystallizer. The liquor is cooled further under computer control to 20°C, during which grain size rises from 9 µm to 80 µm, and then taken into a seed pan which holds standard liquor at 80.7°Brix, equivalent to 1.05

supersaturation. The pan is boiled during less than 3 hours to give a magma of 300 µm seed which is dropped into storage crystallizers for use in boiling the final white sugar. Control of seed boiling is by gamma-ray density meter following a computer program and the conditions maintained are such as to prevent conglomerate formation. White sugar colour improved by 17% while wash water was reduced by 20%, giving an increase in sugar yield of 2 1/2%. Crystal regularity index measurements showed almost total elimination of conglomerates but not of twins, whilst dust (sugar through a 200-mesh screen) in the final product was greatly reduced. The opportunity to use low-grade vapour for boiling (8 psi instead of 17 psi) permitted valuable fuel savings whilst pan station capacity rose by 18%.

#### Continuous crystallization

M. Guyot. *Paper presented to Tate & Lyle Crystallization Seminar*, 1988, 24 pp.

After a summary of the main points of the design of the Fives-Cail Babcock continuous vacuum pan, the author discusses the main factors in resistance to heat transfer from steam to massecuite. He then describes new methods which are being applied for monitoring and operation of the pan, and also operation with a magma proportion reduced from 15/30% to 8/10% while avoiding false grain. A further reduction (to 5/7%) is expected from application of an integral magma production line linked to the pan; such a line could therefore be installed to operate with an existing FCB pan.

#### Investigation of the adsorptive properties of activated filter cake

M. G. Parfenopulo, Yu. N. Dobromirov and N. E. Karaulov. *Izv. Vuzov, Pishch. Tekh.*, 1988, (3), 32 (Abstract only).

It has been found that dried and heat-treated filter cake may be used to decolorize and purify raw juice and thus reduce lime consumption.

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# Sugar refining

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## The use of critical path analysis in production management of the crystallization process

R. E. O'Neal. *Proc. 1985 Meeting West Indies Sugar Tech.*, 141 - 168.

The use of critical path analysis to show how to attain five strikes per shift in the boiling house at the U.S.M. refinery of Caroni (1975) Ltd. in Trinidad is described.

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## The development of software for use in the sugar industry

R. E. O'Neal and D. M. Ramdial. *Proc. 1985 Meeting West Indies Sugar Tech.*, 179 - 228.

The application of personal computers to calculate production data, compile balances, simulate processes, calculate steam generation, etc. in a refinery is described.

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## Study of the influence of different variables on the crystal yield in refinery massecuites

T. Cruz C. and A. Delgado R. *Centro Azúcar*, 1985, 12, (2), 43 - 48 (*Spanish*).

A list was prepared of operating variables which could affect the crystal yield in refined sugar boiling, and measurements were made at two refineries from which it was possible to develop mathematical equations and a computer program for calculation of the yield.

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## Effect of electrofiltration in the purification of liquor

H. Estacio C., J. Castellanos E. and R. Fajardo G. *Centro Azúcar*, 1985, 12, (2), 83 - 86 (*Spanish*).

In the electrofiltration technique, successfully applied in the USSR, electrically charged impurities are deposited on a polarized surface under the action of a magnetic field. It has been applied to raw sugar liquor from a Cuban refinery to determine the effect of different voltages and concentrations on colour removal, using finely divided bagasse as the support. From the results

it is concluded that higher voltages improve colour removal, while for increased concentrations a higher voltage is needed to achieve the same colour removal percentage.

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## Clarification and decolorization processes

R. R. Trott. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 265 - 291.

Refinery liquor clarification, phosphatation, carbonation and decolorization using bone char, active carbon (granular or powdered) or resin (including Ecodex-R powdered form) are discussed and recent developments examined, including the use of the Sure process involving an adsorbent based on a support polymer of polypropylene which has a very regular microporous structure and overcomes the problems of diffusion resistance found with conventional resin particles. Traditional cane juice clarification and more recent developments in it are also described.

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## Raising the quality of fructose run-off

N. I. Odorod'ko. *Sbornik Pishch. Prom.*, 1986, 32, 63 - 66 (*Russian*).

A procedure for obtaining fructose from sucrose involves loosening the 1st massecuite at the end of boiling with ethanol which, after centrifuging, is evaporated from the run-off in a vacuum pan and the run-off then evaporated to a required Brix and used to boil the 2nd massecuite. Since both boiling and evaporation take place in an acid medium, the major colorants formed are hydroxymethyl furfural (HMF) and its polymerization products; during evaporation, monosaccharide degradation took place at a faster rate than HMF formation and the pH fell by 1.3. In an investigation of their removal using active carbon, the run-off had to be diluted to 45 - 50°Bx before filtration to remove turbidity followed by treatment with 0.2 - 2.4% carbon on dry solids at 30°C. Best result was 90% decoloriza-

tion using 1.0 - 1.2% carbon, with the major colour removal occurring during the first 10 - 15 min.

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## The Crockett refinery - preparing for the future

R. L. Knecht. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, G-6 - G-10.

Future plans for Crockett refinery are outlined, including the processing of very low colour (VLC) raw sugar and automatic storage and retrieval of packaged sugar.

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## Refining of VLC raw sugars

D. M. Humm. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-1 - F-7. See *I.S.J.*, 1988, 90, 120A.

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## Obtaining condensate from pan vapour

O. I. Dapiro, V. V. Tantsyura, N. I. Yakimenko and V. S. Samoilenko. *Sakhar. Svekla*, 1988, (4), 50 - 52 (*Russian*).

In the refinery section of Slutsk beet sugar factory, condensate is prepared from pan vapour for use chiefly in the resin decolorizing station and to a lesser extent for other process purposes. Details are given of the condensation scheme and of the monetary savings from use of surface condensers. The system is of particular value during processing of cane raw sugar when the evaporator is not in operation.

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## White sugar quality

J. F. Dowling. *Paper presented at Conf. on Sugar Processing Research*, 1988, 7 pp.

Details of granulated sugar analysis and frequency of testing were obtained in the form of completed questionnaires from nine US and six other refineries. The results are summarized in tables which showed that the most frequent analyses were for sediment, grain size, colour, ash and moisture content.

# Starch based sweeteners

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## Molasses: a source for high-fructose syrup

Y. S. Dhamankar, H. M. Modak and D. G. Hapse. *Bharatiya Sugar*, 1987, 13, (1), 57, 59.

The advantages of using cane molasses as raw material for HFS production under Indian conditions are discussed. A 55% HFS can be obtained by inversion, chromatographic separation of the glucose and fructose and subsequent enzymatic isomerization of the glucose to fructose. The costs of producing 18,500 tonnes of HFS annually from molasses are briefly analysed.

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## The properties of glucoamylase, soluble and immobilized on DEAE-cellulose. I. Kinetics and thermodynamics of enzyme reaction

M. Przybyt and H. Sugier. *Starch/ Stärke*, 1988, 40, 108 - 111.

Soluble glucoamylase and glucoamylase adsorbed on DEAE-cellulose were used in a study of the kinetics of starch hydrolysis. Results showed that immobilization of the enzyme caused an increase in  $K_M$  and a decrease in  $V_{max}$  (two constants in the Michaelis-Menten kinetic equation). The activity of soluble glucoamylase was inhibited by the substrate, while immobilization caused changes in the thermodynamic properties of the enzyme which could be due to the adsorption on DEAE-cellulose as well as to diffusion inhibition by the starch substrate.

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## The properties of glucoamylase, soluble and immobilized on DEAE-cellulose. II. Thermostability of glucoamylase

M. Przybyt and H. Sugier. *Starch/ Stärke*, 1988, 40, 171 - 174.

Immobilization of glucoamylase by adsorption on DEAE-cellulose caused a greater fall in thermostability (and hence a substantial increase in its denaturation activation energy) as a function of temperature than for the soluble form of

the enzyme; however, the presence of starch reduced this thermal inactivation at  $<55^\circ\text{C}$ , thus favouring catalysis of starch hydrolysis, while thermostability rose with increase in the amount of enzyme adsorbed.

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## Dual hollow-fibre membrane bioreactor for whole-cell enzyme immobilization of *Streptomyces griseus* with glucose isomerase activity

B. H. Chung, H. N. Chang and Y. H. Kho. *J. Ferment. Technol.*, 1987, 65, (5), 575 - 581; through *S.J.A.*, 1988, 50, Abs. 88-993.

A new process was developed by which *S. griseus* with glucose isomerase activity was enabled to proliferate in a dual hollow-fibre bioreactor to a desired density. The resulting material converted glucose in 0.5M solution to fructose with high productivity. With culture for 10 days and operation at  $56^\circ\text{C}$ , initial conversion was 34%, initial productivity was 22.5 g/litre/hr and decay constant was 0.041/hr.

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## Studies on the immobilization of *Streptomyces* cells containing glucose isomerase

P. Ellaiyah and K. V. R. N. S. Ramesh. *Indian Drugs*, 1987, 24, (7), 355 - 356; through *S.J.A.*, 1988, 50, Abs. 88-994.

*Streptomyces* cells containing glucose isomerase were immobilized by three methods: in calcium alginate gel, by cross-linking with glutaric aldehyde and by temperature (heating for 10 min at  $75^\circ\text{C}$  in phosphate buffer at pH 7.0). Retention of activity was 66, 87 and 92%, respectively; half-life was 108, 264 and 144 hr, respectively.

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## Immobilization of glucoamylase on cellulose

M. Przybyt and H. Sugier. *Starch/ Stärke*, 1988, 40, 275 - 279.

Glucoamylase (GA) immobilized on cellulose activated with chlorides of Ni, Fe and Ti had insufficient stability,

whereas the use of cyanogen bromide to activate the cellulose gave GA of high stability but of low hydrolysis efficiency with regard to starch. The highest stability was obtained by immobilization on amine derivatives of oxidized cotton linters; amination with ethylene diamine gave higher enzyme activity and stability than with hydrazine. Cotton linters had better mechanical properties than beech cellulose pulp. In starch hydrolysis experiments, the initial DE of the solution obtained using GA immobilized on ethylene diamine-activated linters was far higher than with GA immobilized on CNBr-activated linters and the kinetics were close to those for the soluble enzyme.

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## Methods of enzyme analysis applicable to industrial enzymatic preparations

J. C Collin and R. Delecourt. *Ind. Alim. Agric.*, 1988, 105, 448 - 460 (*French*).

Notes are given on the analysis, microbial source, inhibitors, substrates, reaction products, optimum reaction pH and temperature, bio- and physico-chemical definition and activators of specific enzymes used in industry, including amylases, isomerases, invertase and galactosidase.

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## Ultrafiltration used in a novel flexible process to produce high-fructose syrup from different raw materials

T. R. Hanssens and K. Koerts. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 127 - 138.

Details are given of a process developed by Suiker Unie for production of HFS, liquid invert or sugar from sugar beet, Jerusalem artichoke or chicory in which juice and pulp are separated in a number of solid-bowl decanting centrifuges and the juice purified by ultrafiltration and deionization. Tests showed that ceramic membranes have technological and cost advantages over polymeric types. A  $70^\circ\text{Bx}$  syrup containing 80% fructose and 20% glucose is obtainable.

# Laboratory studies

## Fluid resistance of sugar solutions

S. Jáuregui R., I. Pedrosa M., O. Cruz F., T. Reyes C. and D. Roque F. *Centro Azúcar*, 1985, 12, (2), 75 - 82 (Spanish).

A rheological study was made of molasses and the pseudoplastic irregularities of sucrose solutions were shown experimentally. Quantitatively, these abnormalities can be depicted by means of the Ostwald de Waele mathematical model. Using a Rheotest rotational viscometer, which measures the shearing stresses over a wide range of velocity gradients, the influence of several factors, including Brix, pol, purity, sucrose, reducing sugar and ash, on apparent viscosity and pseudoplasticity index for molasses samples from 15 Cuban sugar factories was determined. In addition, from a friction table and experimental results, the variation of the friction coefficient with temperature and concentration was studied for a constant flow of molasses within commercial piping.

## Effect of metallic impurities on the shape and size of sugar crystals. III.

R. A. Hernández L., A. Egido M. and S. Coello G. *Centro Azúcar*, 1985, 12, (2), 113 - 118 (Spanish).

Sucrose crystals were grown from 65°Bx solutions containing 1500 - 2500 ppm Na<sup>+</sup>, 30,000 - 50,000 ppm K<sup>+</sup> or 8000 - 16,000 ppm Ca<sup>++</sup> or 65 - 155 ppm Fe<sup>+++</sup> in the form of the metal chlorides. The solutions were concentrated in a vacuum pan, maintaining at a constant temperature during nucleation and then concentrating to 91 - 93°Bx. The length and width of 100 of the crystals produced were measured. Nucleation was not affected by the presence of the cations at the concentrations employed, but the growth rate and crystal dimension ratio were affected by all but the Na<sup>+</sup> cation; the latter had an effect but it was not statistically significant. Fe<sup>+++</sup> impeded deposition of sucrose molecules on the crystal surface.

## Transport properties of sucrose solutions. A bibliographic study

R. Alvarez B. and E. Martínez C. *Centro Azúcar*, 1985, 12, (2), 125 - 131 (Spanish).

41 references to the literature are quoted in a study of work on transport phenomena in sucrose solutions. Contradictions are pointed out and an analysis made of the topics which need to be investigated to identify the controlling mechanism, ion interaction, etc.

## Determination of the dissociation constants of aconitic acid in sugar solutions

J. Guerra, A. M. Rodríguez and J. L. Díaz. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 1 - 9 (Spanish).

Aconitic acid is among the more abundant non-nitrogenous organic acids in cane juice. Its three dissociation constants have been determined experimentally by a simple and fairly exact method based on a conventional instrumental analysis technique supported by a standard non-linear statistical least-squares fitting procedure.

## Influence of the ammonium ion on precipitation from simulated juices

L. Zumalacárregui C., R. Santana M., J. Guerra D. and M. Veitía. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 11 - 20 (Spanish).

Simulated cane juices were made alkaline with sodium hydroxide in the presence of ammonium ions and compared with similar previous experiments in which ammonium ions were absent. It was found that there was no effect on the nature of the precipitated calcium, calcium hydrogen and magnesium phosphates or on the physical characteristics of the precipitate.

## Determination of the degree of adsorption of egg albumin on the calcium phosphate precipitate

## formed during the process of liming model juices

R. Santana M., T. Victorera F. and J. Guerra D. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 33 - 42 (Spanish).

Measurements are reported of the degree of adsorption of egg albumin on the calcium phosphate precipitates formed at room temperature during balanced liming of model cane juices and of the effect of magnesium upon the degree of adsorption. The precipitates showed a high degree of adsorption, amounting to as much as 1700 mg of the protein per gram of precipitate. The presence of magnesium ions reduces the adsorption significantly.

## Influence of non-sugars on the refractometric determination of dry substance content. I. Experimental investigations and interpretation of the results

K. Wagnerowski. *Gaz. Cukr.*, 1988, 96, 49 - 54 (Polish).

See *I.S.J.*, 1989, 91, 21A.

## Elimination of heavy metals from limy laboratories

R. R. Tamaye. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 64 - 65.

Polarimetry of diluted final molasses clarified with varying amounts of a mixture of aluminium chloride and calcium hydroxide and in varying ratios between the two clarifying agents was investigated. In all but one case, the pol values were lower than obtained with lead subacetate as clarifying agent. Analysis by HPLC of three of the samples clarified with aluminium chloride and calcium hydroxide and comparison with an untreated control indicated changes in composition after clarification, especially in the reducing sugars content, and it is suggested that these and possibly other changes not detected could contribute to the differences in pol values obtained.

### Analysis of glucose and sucrose with a glucose analyser

D. Hsu. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 65 - 67.

Investigation of the performance of a Model 27 analyser manufactured by Yellow Springs Instrument Co. Inc. and provided with a glucose electrode membrane showed that determination of sucrose in the presence of glucose was affected by the buffer solution in which either sugar was prepared; phosphate buffers of moderate concentration (0.5M) gave a 3 - 5% higher glucose reading. There was also slight non-linearity in instrument response. Establishing a multipoint calibration curve daily (as against a two-point calibration for zero and a standard solution) was found to improve precision. With preparation of all standards and samples in the same buffer solution, the accuracy of the analyser technique applied to artificial solutions and final molasses was comparable to that of the Clerget method for sucrose, although the latter method consistently over-estimated the sucrose content, particularly in the presence of maltose and dextran and perhaps other substances that produce glucose as a result of acid hydrolysis. Both methods gave sufficiently consistent results for sucrose, with the Clerget method having slightly better reproducibility. The glucose analyser method was much more time-efficient and required only a fraction of the sample required for the Clerget method; the results suggest that both methods are subject to interference by kestoses.

### HPLC analysis of sugar and factory products

R. R. Tamaye. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 66.

In HPLC analysis of final molasses, a component was found which had the same retention time as mannitol but was not definitely identified as such; however, since mannitol is used by the

HSPA Experiment Station as internal standard in HPLC analysis of factory products, it was thought necessary to find a new internal standard for low-grade products. While sorbitol is a possible choice, a substance that is eluted just before it could cause interference. A small peak on the trailing edge of the sucrose peak, and having a shorter retention time than glucose when reagent-grade sucrose was being analysed using a Shodex SC-1011 column, was attributed to the need for column regeneration after several months of use; after this was carried out with 0.1M calcium nitrate solution, the peak no longer appeared.

### Comparison studies on HSPA versus modified ICUMSA colour

C. M. Kinoshita, T. Moritsugu and S. Goya. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 67 - 68.

The standard HSPA method of colour measurement at pH 7 (essentially equivalent to the official ICUMSA Method 4) was compared with the modified ICUMSA method of measurement at pH 8.5 (recommended in place of the former method by the HSPA Raw Sugar Technical Committee because an increasing amount of Hawaiian raw sugar is being sold under Raw Sugar Contract No.14 which uses the modified ICUMSA method as a basis for payment). While correlations between the two methods were reasonably good for 120 raw sugar samples, they were not considered good enough for payment purposes, while the modified ICUMSA method requires the use of a special centrifuge which could have a significant effect on the reproducibility of affined sugar colour values.

### Saturation temperature relationships in impure sugar solutions

G. E. Sloane and B. J. Somera. *Rpts. 45th Ann. Conf. Hawaiian Sugar Tech.*, 1986, O-7 - O-12.

See *I.S.J.*, 1988, 90, 56A.

### Analytical methods of sugar factories - new developments

H. Schiweck and G. Steine. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 146 - 161.

New methods and techniques described for the beet sugar factory and used by Süddeutsche Zucker-AG include isotope dilution, GLC, HPLC and enzymatic methods to determine beet sucrose, fluorimetry to determine amino-groups, ion chromatography and enzymatic analysis to determine lactic acid in raw juice for bacteriological control of diffusion, an infra-red radiation method to measure pulp dry solids, on-line purity determination and radiometric density measurement for boiling control, crystal size distribution analysis by means of a Coulter counter and grain size measurement using a Zeiss Mikrovideomat.

### Flavour and odour in sugar cane products

M. A. Godshall. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 236 - 252.

Volatile and non-volatile constituents responsible for the flavour and odour of cane sugar products such as table syrups, molasses and factory and refinery brown sugars are discussed and analytical methods for isolation of the compounds outlined. Processes that give rise to the compounds during sugar manufacture are also described, including sucrose degradation, Maillard reactions, microbial activity and other miscellaneous effects. Flavour interactions of sucrose, correction of flavour problems and future trends are also discussed.

### Chemistry of sugar in food processing

W. S. C. Tsang and M. A. Clarke. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 292 - 302.

The physical and functional properties of sugars, particularly sucrose, in foods and beverages are reviewed.



# By-products

## **Pulp effects obtained by the alkaline extraction process of beet sugar on minerals measured in growing lambs**

F. Meschy. *Paper presented at Tech. Conf., British Sugar plc*, 1988, 21 pp.

Two groups of lambs were fed rations containing 70% normal beet pulp and 70% pulp resulting from diffusion of limed cosettes. The increased calcium content in the latter pulp (4.75% by weight of mineral dry matter compared with 3.82% in the normal pulp) and a higher P content (3% as against 1%) increased Ca and P retention, although the values in the control group were very low, especially of Ca; the Mg retention was also higher. The lambs fed on this pulp showed much greater dry matter intake and daily growth rates.

## **Determination of sucrose in a commercial sucroglyceride used as a surface-active agent in the sugar industry**

L. R. de la Nuez F. and P. L. Gutiérrez M. *Centro Azúcar*, 1985, 12, (2), 133 - 139 (Spanish).

Sucrose is separated from a butanol solution of the ester with water and analysed by the anthrone-sulphuric acid method. The technique is accurate and suitable for chemical control in the manufacture of the esters.

## **Considerations on the partial hydrolysis of cellulose from the prehydrolysis-sulphate pulp of sugar cane bagasse**

B. García, S. Askenasi and R. Quintana P. *Centro Azúcar*, 1985, (By-products Supp.) 87 - 89 (Spanish).

The title pulp was reacted with ethanol and HCl at different concentrations and temperatures for different lengths of time and the properties of the product examined, chiefly the crystallinity of the cellulose by X-ray diffraction.

## **Influence of cane variety on the properties of leaves as fuel**

M. Rubio G., J. Suárez C., M. González F., P. Mora H. and P. R. Roque D. *Centro Azúcar*, 1985, 12, (Supp. on energy and purification), 113 - 119 (Spanish).

Both the ash content and the heat of combustion of dry leaves were found to vary with the cane in the case of three varieties studied; the ash content in the leaves was also higher than in the whole cane.

## **Effects of cane juice deteriorated by frost on alcohol manufacture.**

F. A. Fogliata, H. G. Ayala, E. Moreno, S. López and C. Tormé. *La Ind. Azuc.*, 1986, 92, (1034), 28 - 33 (Spanish).

See *I.S.J.*, 1987, 89, 147.

## **Studies on the fermentative production of L-lysine - an improvement of L-lysine producing strain by mutation of regulatory gene**

Y. T. Liu. *Taiwan Sugar*, 1988, 35, (2), 8 - 17.

See *I.S.J.*, 1988, 90, 95A.

## **Australian ethanol process is world first**

Anon. *Australian Canegrower*, 1988, 10, (5), 25 - 27.

The patented Sucrotech process developed over some 10 years by the Biotechnology Unit of the University of Queensland produces ethanol from cane juice, syrup or raw sugar with a limited amount of molasses added; special mutant strains of *Zymomonas* sp. are used in two possible variants of the process: (1) aimed at maximum ethanol production plus CO<sub>2</sub>, or (2) half the yields of alcohol and CO<sub>2</sub> obtained in (1) but with a yield of fructose representing the other half. The advantage of *Zymomonas* sp. over yeasts lies in its ability not only to split the sucrose into its glucose and fructose moieties but also to produce ethanol separately from the two monosaccharides via two different enzyme systems; by removing the

system that converts fructose to alcohol, the developers allow fructose to accumulate while glucose is converted to ethanol. The fructose can be separated from the mash, purified to 99.8% purity and supplied as crystals or syrup.

Because of the use of a very low bacterial cell density and the absence of by-products such as glycerol, the BOD of the process waste is significantly lower than with conventional yeast processes. A syrup containing 18% sugar has consistently yielded 11 - 11.5% ethanol (v/v) within 20 - 30 hr; by comparison with yeast fermentation, the Sucrotech process is characterized by reduced fermentation times, a higher feedstock conversion to ethanol, shorter downtimes and decrease in energy requirements.

## **Intensification of propionic acid fermentation of molasses vinasse by addition of whey**

E. Sobczak and Z. Komorowska. *Przem. Ferm. i Owoc.-Warzyw.*, 1987, 31, (6), 14 - 16; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (13), Abs. 13 R344.

Results are given of investigations on intensification of molasses vinasse fermentation by propionic acid bacteria with the addition of whey. Optimum results were obtained by treating a 7.7% dry solids 1:3 mixture of vinasse and whey with *Propionibacterium freudenreichii* subsp. *shermanii* T-107; under these conditions, 7.17 - 8.0 g/dm<sup>3</sup> of dry cell mass rich in vitamin B<sub>12</sub> was obtained.

## **Improving the commercial utilization of bagasse - ammonia treatment**

C. K. Sankat, P. O. Osuji and R. H. Singh. *Proc. 1985 Meeting West Indies Sugar Tech.*, 565 - 579.

Bagasse treatment with ammonia for use as animal fodder is described, and the effects of the level of ammonia, time-temperature relationship, moisture content and relative costs of ammoniation are discussed.

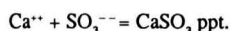
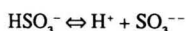
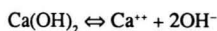
minima in the conductivity plots. The curve of Figure 3 is sharper than that of Figure 4 in which two consecutive minima are obtained. However, no such indications are obtained in pH curves. More important, the occurrence of minima almost coincides with the time observed in the laboratory. This suggests that conductivity measurement may be applied satisfactorily to ascertain two things:

- (i) the completion of the  $\text{CaSO}_3$  precipitation reaction in cane juice clarification, and
- (ii) the retention time of cane juice clarification.

The pH *versus* time data on the other hand do not indicate any sharp change with relation to precipitation in cane juice clarification as one can see in Figures 3 and 4.

The occurrence of minima in the conductivity has been explained elsewhere<sup>1</sup> and similar explanation holds good in the case of sulphitation both in the laboratory and in the factory.

Stoichiometric reactions may be represented as follows:



The initial rise in conductivity is due to increasing concentration of ionic species like  $\text{Ca}^{++}$ ,  $\text{H}^+$ ,  $\text{OH}^-$ ,  $\text{HSO}_3^-$  and  $\text{SO}_3^{--}$ , etc., in addition to other inorganic and organic ions which are usually present in sugar cane juice. During the passage of  $\text{SO}_2$  into limed cane juice, the most predominant chemical reaction other than decolorization is the precipitation of  $\text{CaSO}_3$ . As soon as the ionic concentration of  $\text{Ca}^{++}$  and  $\text{SO}_3^{--}$  ions becomes sufficiently high that their ionic product exceeds the solubility product,  $\text{CaSO}_3$  precipitation starts and conductivity shows a decline to reach a minimum value, indicating the completion of precipitation. On further saturation with

$\text{SO}_2$ ,  $\text{CaSO}_3$  is converted into soluble  $\text{Ca(HSO}_3)_2$  and the conductivity starts to increase, showing a clear minimum. The increase in conductivity continues until precipitation starts again. This process goes on and on in the continuous process of cane juice clarification in commercial factories.

#### Conclusion

(1) We attempt to show in this paper that the conductivity measurement can be employed to control the cane juice clarification.

(2) This technique appears to ensure minimum CaO content in the clarified cane juice.

(3) A minimum CaO content in clarified cane juice has several advantages, viz., (i) reduction in scale formation, (ii) increase in sugar recovery and (iii) decrease in consumption of sulphur and lime. These benefits are achievable by the conductivity control method.

(4) Control of the colour of clarified cane juice is expected to ensure better colour of the sugar crystal.

#### Acknowledgements

The authors express their thanks to Professor Ram Kumar, Director, National Sugar Institute, Kanpur, for his interest in the above investigation and to Kichha Sugar Company Ltd., Kichha, Nainital, and Kesar Enterprises Ltd., Tulsinagar, Baheri, Dist, Bareilly, for the assistance rendered to us during this work.

#### Summary

Electrical conductivity and pH measurements were made simultaneously during the sulphitation process of cane juice clarification, both in the laboratory and in commercial sugar factories. It is observed that in each experiment, electrical conductivity data show a sharp minimum with respect to time. This minimum corresponds to a pH 9.75 and 9.00 at 25°C and 55°C, respectively in the laboratory. Such results are indicative of the completion of precipitation of  $\text{CaSO}_3$  present in cane juice. Further

saturation of cane juice with  $\text{SO}_2$  to bring down the pH to neutral causes dissolution of about 25 - 35% CaO in clarified cane juice.

Comparison of pH and electrical conductivity curves suggests that the former as a control parameter does not seem to be as suitable as the latter for indicating the additional increase of lime in clarified cane juice.

#### Control de la conductividad eléctrica en la precipitación del sulfito de calcio en la clarificación del jugo de caña

Se realizaron mediciones de conductividad eléctrica y de pH simultáneamente durante el proceso de sulfitación de la clarificación del jugo de caña, tanto en el laboratorio como en las fábricas de azúcar comercial. Se observó en cada experimento, que la conductividad eléctrica muestra un punto mínimo agudo con respecto al tiempo. Este mínimo corresponde a un pH de 9.75 y 9.00 at 25°C y 55°C, respectivamente en el laboratorio. Tales resultados indican la precipitación completa de  $\text{CaSO}_3$  presente en el jugo de caña. Una mayor saturación del jugo de caña con  $\text{SO}_2$  para bajar el pH a neutro provoca la disolución de alrededor de 25 - 35% de CaO en jugo de caña clarificado. Al comparar las curvas de pH y de conductividad eléctrica se observa que las primeras como parámetro de control no parecen ser muy apropiadas como las últimas para indicar el aumento adicional de cal en jugo de caña clarificado.

#### Control par conductivité électrique de la précipitation du sulphite de calcium au cours de l'épuration de jus de canne

On a effectué des mesures simultanées de la conductivité électrique et du pH au cours du processus de sulfitation lors de l'épuration du jus de canne. Ces mesures ont été faites autant au laboratoire que dans des usines produisant du sucre commercial. On remarque que, dans chaque expérience, les résultats se

*continued on page 59*

# Further developments in automated white sugar pan boiling using radio frequency control

By D. J. Radford, D. J. Tayfield and M. G. S. Cox  
(Tongaat-Hulett Sugar Ltd. and Hulett Refineries Ltd., Durban, South Africa)

## Introduction

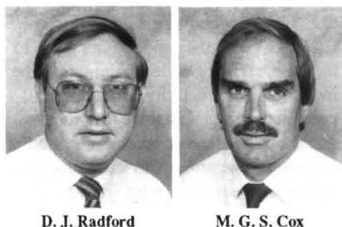
The use of radio frequency measurements for the control of sugar boiling is established and a probe developed in Australia which was successfully used for the control of low-grade raw sugar boilings was described by Reichard & Vidler<sup>1</sup> in 1975. Another probe, developed by D.D.S and used on high purity boilings, was described by Moller *et al.*<sup>2</sup> in 1977.

With the introduction of continuous high-grade pans into raw sugar factories in South Africa, the need for a better measurement than conductivity for the control of these pans became apparent, and development work in the use of radio frequency measurements was undertaken. This work led to the development of a probe which gives simultaneous measurements of electrical resistance and capacitance, unlike previous probes which provided only a single output signal.

The probes developed by Tongaat-Hulett Sugar Technology Department have for some time been successfully used for the control of continuous raw sugar pans and evaporator syrup Brix in some of the Tongaat-Hulett sugar factories. These applications and the relationships of radio frequency measurements to the physical properties of massecuites and syrups derived by pilot plant boilings have been previously described by Radford & Cox<sup>3</sup>.

Preliminary development work in the use of these probes for the control of white sugar boilings and jet Brix measurement at Hulett Refineries have also been described by Radford *et al.* at S.I.T.<sup>4</sup>.

Following the success of these probes it was decided that these should be developed further to produce an instrument more suited to trouble-free operation in factory environments which could also be marketed commercially. An electronics company was commissioned to continue with this work under the guidance of Tongaat-Hulett Sugar's Technology Department, and testing of a pre-production unit is now complete.



At the same time, further work in the control of white sugar pans has continued over the past year. This paper deals with four areas, namely: (1) further development of the probe, (2) the pan control system, (3) evaluation of benefits derived using automated pan boiling, and (4) possibilities for the use of radio frequency measurements for continuous white sugar pan boiling.

## Principle of operation

Although the theory of radio frequency measurements and the measurement of complex impedance of massecuites has been fully described in previous publications, the basic principle of operation of the probe will again be briefly summarized.

Referring to Figure 1, a measurement of massecuite impedance in a pan may be obtained by connecting a resistor  $R$  in a series with a probe, similar to a conductivity electrode, and connecting

an A.C. supply of constant voltage  $V$  across this combination. The massecuite may be considered equivalent to a resistance  $R_m$  representing the conductivity and a capacitor  $C_m$  which is proportional to the dielectric constant of the massecuite. These are termed the parallel resistance and capacitance.

At very low frequencies, the voltage  $V_0$  measured across the probe is related to conductivity since the capacitance has a negligible effect.

At radio frequencies however, the reactance of the capacitance  $C_m$  becomes very significant and the voltage measured is related to both massecuite resistance and capacitive reactance.

The combination of parallel resistance and capacitance  $R_m$  and  $C_m$  may, at a given frequency of measurement, be considered as being electrically equivalent to a resistance  $R_s$  and a capacitor  $C_s$  connected in series. These are termed the series resistance and capacitance.  $R_s$  and  $C_s$  are both a function of  $R_m$  and  $C_m$  and this relationship has been given in a previous paper<sup>3</sup>.

Referring to Figure 2, if a tuning circuit, consisting of an inductor  $L$  and

*Paper presented to Sugar Industry Technologists, 1988.*

- 1 Proc. Queensland Soc. Sugar Cane Tech., 1975, 42, 249 - 253.
- 2 Proc. 16th Congr. ISSCT, 1977, 2811 - 2818.
- 3 Proc. S. African Sugar Tech. Assoc., 1986, 94 - 102.
- 4 Proc. Sugar Ind. Technol., 1987, 46, 149 - 167.

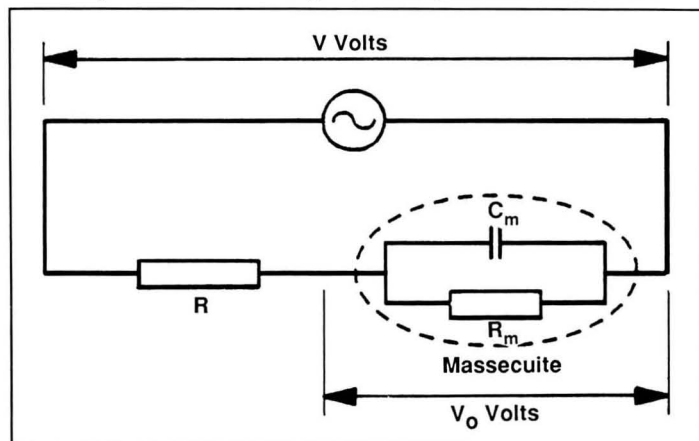


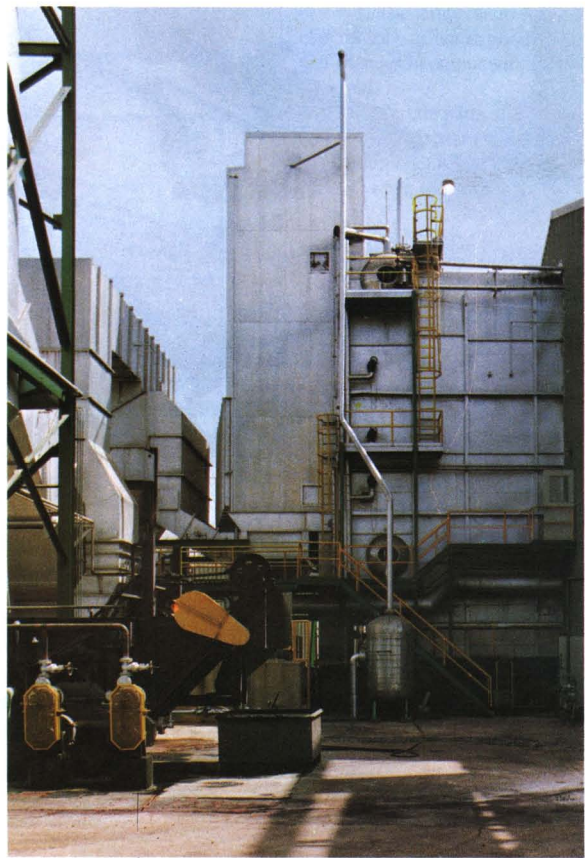
Fig. 1. Massecuite impedance measurement

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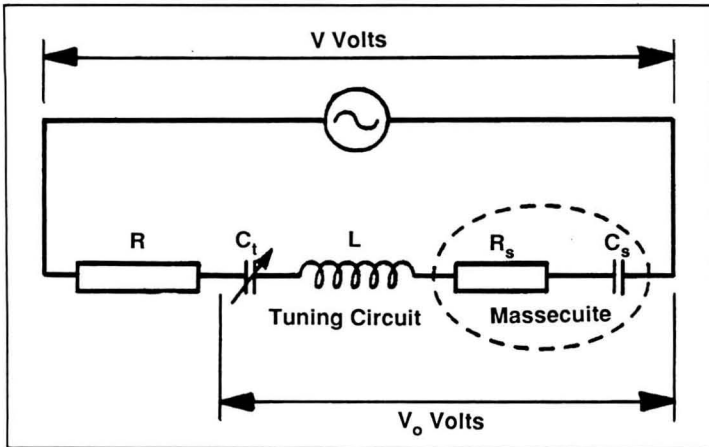


Fig. 2. R.F. probe series tuned circuit

variable capacitor  $C_1$  is connected in series with the above circuit, and the values of the capacitor  $C_1$  adjusted so that the circuit is in resonance, the inductive and capacitive reactance in this circuit would then be equivalent to the series resistance  $R_s$  and the voltage  $V_o$  would be proportional to  $R_s$ .

Furthermore, any change in massecuite series capacitance  $C_s$  could be compensated for by adjustment of the variable capacitor  $C_1$  to keep the circuit in resonance. These two will be inversely related. In the Tongaat-Hulett probe this variable capacitor is a varicap kept in resonance by adjustment of the diode and the circuit is automatically voltage on this diode.

There are two methods of detecting resonance. The first method, used in earlier probes, is to measure the voltage  $V_o$  across the probe and tuning circuit and continuously make adjustments to the probe tuning capacitor  $C_1$  to maintain minimum voltage. A microprocessor-based controller was used to accomplish this.

In the newer probes resonance is detected by measuring the phase angle across the series resistor  $R$  and using this to control automatically the voltage on the varicap diode to maintain zero phase angle and hence resonance. The advantage of this system is that simpler

analogue circuitry is used in place of the microprocessor.

In the R.F. probe, the R.F. voltage across the probe and tuning circuit is converted to a 4 - 20 mA output signal representative of massecuite series resistance and the varicap tuning voltage also converted to a similar signal representative of series capacitance.

#### Probe developments

The earlier probes which were designed and built by Tongaat-Hulett had some shortcomings:

1. The temperature stability of the electronics was not as good as desired and changes in output with temperature occurred.

2. Certain parts of the circuit were critical to component tolerances and some components had to be "hand picked" when units were assembled.

3. The electronics housing and plug assembly were not watertight.

4. The probe required a microprocessor to provide the tuning signal. These problems have been overcome and the new probe is an integrated unit incorporating the phase detector circuitry and requiring only a 24V D.C. supply. The probe provides two 4 - 20 mA output signals related to series resistance and series capacitance and can operate in hostile environments where the electronics may be subjected to temperatures of up to 70°C. These two output signals may be used individually or in combination for control.

#### Pan control system

During sugar boiling, both the series resistance and series capacitance of the massecuite change. A measurement of these values taken during a refinery white sugar strike using an R.F. probe is shown in Figure 3. The parallel resistance and capacitance of the

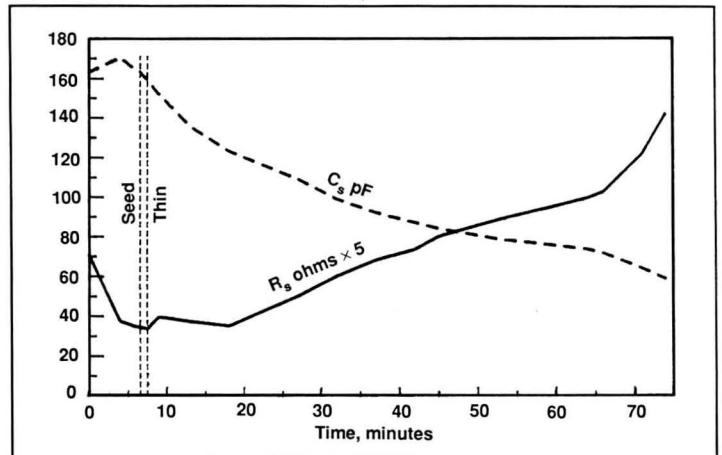


Fig. 3. Series resistance and capacitance of massecuite

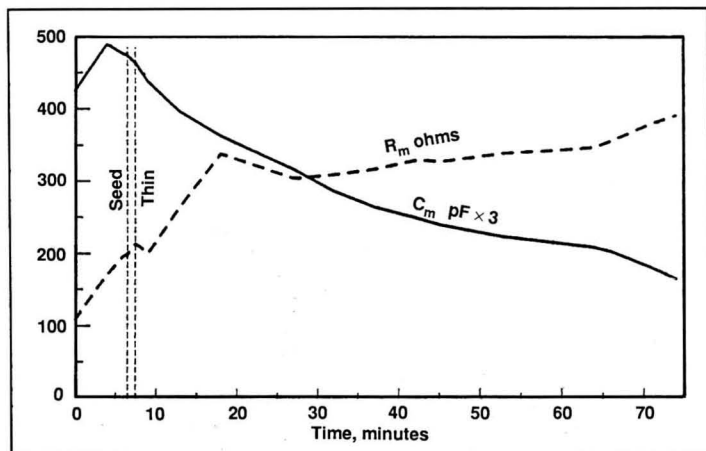


Fig. 4. Parallel resistance and capacitance of massecuite

massecuite calculated from these measurements are shown in Figure 4.

The series capacitance output is very suitable for use as measurement signal in massecuite having a low ash content. This signal is very closely related to parallel capacitance and also responds to changes in liquor Brix at the beginning of the strike to allow the seeding point to be established. It also correlates with crystal content once a massecuite has been established. In massecuites having a high ash content, however, the series resistance signal correlates better with crystal content than series capacitance.

Using a single measurement signal simplifies the control philosophy compared with other systems which may use more than one sensor (e.g. boiling point elevation and rheometer).

In order to automate a pan at Hulett Refineries and test the suitability of the R.F. probe for control, two Yokogawa single loop programmable controllers were used together with an earlier version of the probe. In this system, which has been described before<sup>4</sup>, one of the controllers was programmed to adjust the probe continuously to resonance and derive the required control signal. The probe was subsequently modified to incorporate a

prototype phase detector which made this part of the program redundant. Yokogawa also introduced a newer version of the S.L.P.C. onto the market having double the programming capacity of earlier units. This additional capacity enabled a more sophisticated program to be implemented.

#### Description of the controller and hardware

The Yokogawa S.L.P.C. is a stand-alone controller which has five analogue input ports (1 - 5V), three analogue outputs (one 4 - 20 mA and two 1 - 5V) and six digital ports which can be configured as inputs or outputs. The unit is programmed by means of a plug-in programmer and the program is stored on an EPROM which then plugs into the controller.

One of the major advantages of this unit which makes it suitable for use as a pan controller is that it has a built-in side panel with a display and a keypad which can be used to monitor and change various parameters within the program without having to use the programmer. In addition there are a number of ten-segment look-up functions which allows the pan boiling profile to be easily changed from the side panel.

One of these controllers was used as the feed controller and was programmed with all the logic to control the whole pan boiling cycle. The inputs and outputs on this controller were utilized as follows:

#### Analogue inputs

- (1) R.F. probe series capacitance signal.
- (2) Level signal from pan level transmitter.
- (3) Vacuum signal.
- (4) Signal from potentiometer used for setting steam flow rate during boiling on profile.
- (5) Signal from a selector switch to select pan strike level.

#### Analogue outputs

- (1) Output to feed control valve.
- (2) Output to remote set point of vacuum controller.
- (3) Output to steam control valve.

#### Digital I/O

- (1) Input from push button to start pan.
- (2) Output to operate seed control valve.
- (3) Input from stirrer motor starter relay auxiliary contacts.
- (4) Output to indicator lamp "on profile".
- (5) Output to indicator lamp "pan Brixing".
- (6) Output to indicator lamp "pan ready".

Another S.L.P.C. was used for vacuum control and this controller was also supplied with a tailpipe temperature input signal. A third input was used for the remote set-point derived from the other controller. Although a normal vacuum controller would have sufficed, having the computing power allowed an on-line calculation of condenser approach temperature to be made and this was used to limit injection water valve opening if this value was too high (useful to conserve injection water during start-up).

Steam flow was controlled by means of an output signal from the pan controller (1 - 5V), which was converted

to a 4 - 20 mA signal through a V/I converter and connected to the steam control valve. Here again, if a steam flow controller were available, this signal could have been fed to the remote set point input. The R.F. signal, pan vacuum and level, and steam flow rate were recorded.

Operation of the vacuum pump, pan discharge valve, and starting of the stirrer were manual. The stirrer switched automatically to slow speed and then tripped after Brixing-up. This was controlled according to motor current within the stirrer starter panel in the normal way.

*Pan control logic*

The pan control program was configured to be as flexible as possible to allow both shock seeding, slurry seeding, and changes to boiling profile to be implemented simply by changing parameters on the side panel of the controller. Referring to Figure 5, at the start of strike the operator closes the pan discharge door, starts the vacuum pump and then presses the start button. This sends a set-point signal (set-point 1) to the vacuum controller which causes the injection water valve to open.

Once there is sufficient vacuum in the pan, the feed valve opens. When the liquor level approaches a point near the top of the calandria, the steam valve ramps open at a predetermined rate to a set opening. When the liquor reaches charge level, the feed valve closes and the R.F. signal is then monitored by the controller. At a set R.F. value, before or at seeding point, the evaporation rate is slowed down and the steam valve closes on a ramp function to a predetermined opening.

As soon as the R.F. reading reaches seed point, the seed valve opens for a set time. When the R.F. reading reaches thinning set-point, supersaturation is reduced by decreasing the vacuum to set-point 2. At this stage the feed valve is switched to operate from the output of the P.I.D. function, and a thinning set-point signal is fed to the

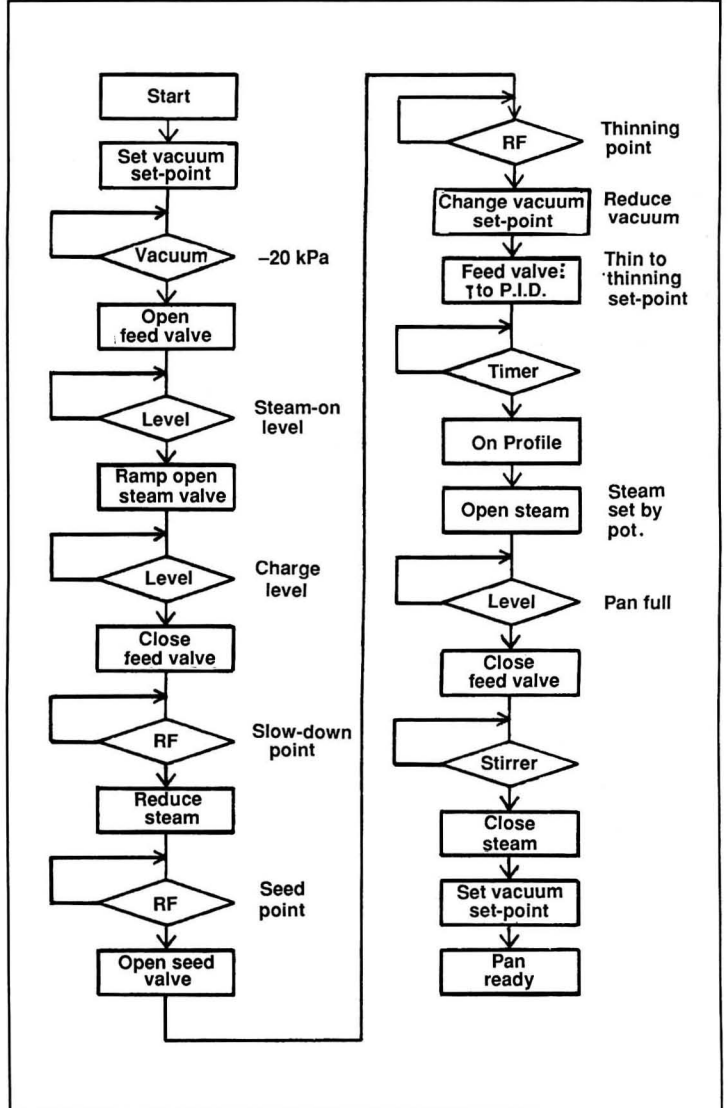


Fig. 5. Batch pan control logic diagram

remote set-point of the feed control loop. A second timer, which determines thinning time, then comes into operation. When thinning is complete, the controller set-point is then switched to vary according to an R.F. output profile where the set-point relates to pan level.

If required, the profile can be changed by entering new values into the ten-segment look-up functions through the controller side panel.

At the same time as boiling on the profile commences, the steam valve is switched to open to a value set on a



potentiometer (this is used to slow the pan down manually if there is a shortage of steam). The controller is now "on profile" and continues to boil until the level reaches the required strike level. This is set by a four-position selector switch which allows the strike level in the pan to be adjusted. When strike level is reached, the feed valve closes and the "Bringing-up" indicator lamp comes on. Bringing-up continues and the stirrer switches from fast to slow speed as the Brix increases.

When the stirrer trips, the controller closes the steam valve, changes the set point on the vacuum controller which causes the injection water valve to close, and activates the "pan ready" indicator lamp. The operator then takes over and strikes the pan. One of the advantages of the above system is that it can easily be implemented in factories that do not have a central process computer since the systems is "stand-alone". The cost of this system is also relatively low.

**Test runs**

All tests carried out on R.F. controlled boilings at Hulett Refineries were done on first boilings in a ribbon calandria pan of 55 m<sup>3</sup> capacity and heating surface of 200 m<sup>2</sup>, using steam at 330 kPa gauge. The results of initial tests on the unstirred pan using different boiling profiles have been reported<sup>4</sup>.

Over the past year, this pan was fitted with a stirrer and numerous tests carried out to assess the benefits of stirred *versus* unstirred boilings using manual control. These were followed by automatically controlled boilings to assess additional benefits. The automated boilings were carried out using the modified earlier version of the R.F. probe with a phase detector and the control systems as described above.

In all these tests shock seeding was used. On automatic strikes the seeding procedure was set up to duplicate the manual procedure. No effort was made to optimize seeding technique but a few strikes were carried out using slurry seeding to test the control system. Two boiling profiles were used on

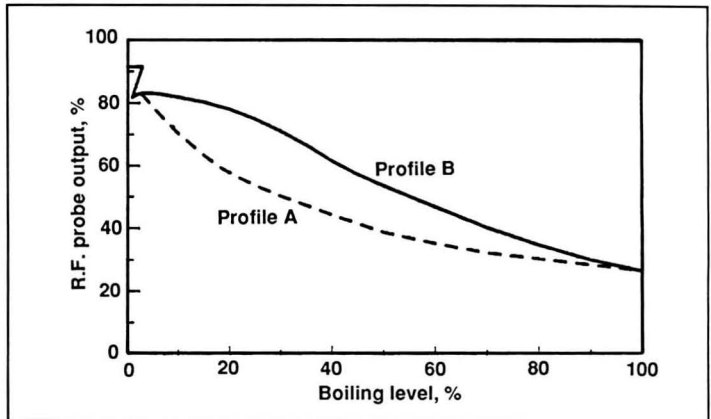


Fig. 6. Boiling profiles

automatic; these profiles – A and B – are shown in Figure 6.

**Results**

The average results obtained from these runs are summarized in Table I. The results show a significant improvement in both throughput and colour build-up in the pan when the stirrer was fitted. Automatic boilings gave variable results depending on the profile used.

It can be seen that when a stirrer was fitted, there was an improvement in a pan yield of 4.7% and a throughput improvement of 2.4%. Automating the pan gave a further improvement in pan

yield of 2.1% and in pan throughput of 5% when boiling on Profile B. Profile A gave larger improvement in throughput at the expense of sugar quality and exhaustion. Colour formation in the pan was reduced when a stirrer was fitted and improved even further when the boilings were automated and the pan boiled with a slacker profile (Profile B). The tighter profile (Profile A), gave a higher colour build-up and generally a lower sugar quality. Colour removal was better particularly on affined sugar despite the lower liquor colour.

In addition to the pan capacity increases measured, there are additional

Table I. Average results of manual vs. automatic boiling

	No. stirrer		Stirred	
	Manual	Manual	Profile A	Profile B
Control	Manual	Manual	Automatic	Automatic
No. of strikes	20	8	8	8
Feed colour	319	262	246	206
Massecurite colour	380	293	273	219
Crystal colour	24	21	12	11
Sugar colour	30	26	19	18
Colour formed in pan	61	31	27	13
% Colour removal affined sugar	92.5	92.0	95.1	94.7
% Colour removal product sugar	90.6	90.1	92.3	91.3
Sugar M.A.	565	567	530	563
Sugar C.V.	38	32	40	34
Conglomerate count	76	72	90	73
Massecurite Brix	89.4	90.5	90.2	90.6
Pan yield, %	55.3	60.0	59.6	62.1
Massecurite production, m <sup>3</sup> /hr	36.7	37.6	41.5	39.5

Note: All colour quoted in ICUMSA units.

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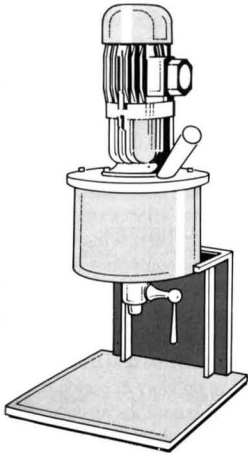
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*1. Report of Crystallographic Laboratory University of Utrecht, Holland.*

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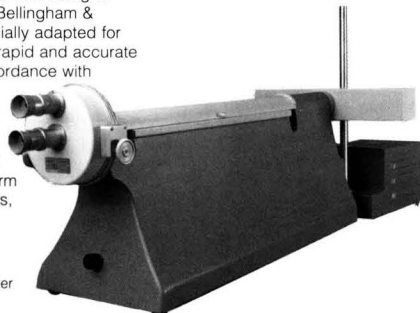


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Preparation of sugar cane for analysis.

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

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capacity increases attributed to the improved pan yields which result in a reduction in total quantity of massecuite boiled. This reduction in turn results in a reduction of process steam required to boil the pans for a given melt rate.

At Hulett Refineries, there are four white boilings followed by a first recovery crop boiling. All first crop molasses is mixed with some Jet 4 and converted to High Test Molasses.

In order to get a rough indication of what would be the potential increase in white pan capacity and saving in process steam at Hulett Refineries, if all white pans were fitted with stirrers and automated, a series of simulation runs were done using a computer mass balance model of the total refinery. It was assumed that stirrers would give a 4.7% increase in yield on all pans, and automation an additional 2.1%. The model then was used to calculate total massecuite quantities for first, second, third and fourth boilings, together with total water evaporated in all pans and evaporators. It was assumed that process steam requirements would be proportional to this water evaporated. The following results shown below were obtained:

*Stirrers on pans:*

Reduction in total massecuite boiled	8.7%
Increase in pan throughput	2.4%
Total potential increase in pan capacity	11.1%
Reduction in process steam demand	8.6%

*Automating pans with stirrers:*

Reduction in total massecuite boiled	3.1%
Increase in pan throughput	5.0%
Total potential increase in pan capacity	8.1%
Reduction in process steam demand	3.1%

The above results illustrate that, although the installation of pan stirrers can be expected to give large benefits in terms of throughput and steam consumption, additional benefits over and above

this can be expected by automating the pans.

At this stage the seeding procedure has not been optimized but it is expected that there is still scope for improving sugar quality. This could be at the expense of throughput since the boiling rate will probably have to be reduced during the seed formation stage.

During the past year some problems relating to the R.F. probe were encountered. Leaking of massecuite into the probe occurred owing to deformation of the probe insulator which was constructed from high-density polyethylene. This was then replaced with glass-filled polytetrafluoroethylene.

Other problems with unexplained drifts in seeding point occurred after the unit had run satisfactorily for some time. It was initially thought that this was due to temperature changes affecting the probe electronics since it was known that the prototype phases detector was not very satisfactory in this regard. Subsequently when the probe was replaced with a pre-production model which had greatly improved temperature stability, it was found that the problem was caused by variation of vacuum at seeding point and hence temperature caused by injection water shortages on the pan floor. The program in the S.L.P.C. has been modified to correct seeding and thinning set points as a function of pan vacuum.

*Continuous pan boiling*

Although Tongaat-Hulett has no experience in continuous pan boiling of refinery white sugar, we presently have eight Tongaat-Hulett and one Fives-Cail continuous pans installed in our raw sugar factories. Of these, three are on first boilings (80 - 85 purity), two on seconds and the rest on thirds. The Tongaat-Hulett pans have twelve compartments and the feed to each is individually controlled. Although conductivity measurements are used on second and third boilings, on first boilings this has not been very satisfactory. R.F. probes and boiling point

elevation have been used as alternatives but R.F. control has proved more successful, and has been used to control the continuous A-pan at Maidstone Mill for some years.

One of the major advantages of using R.F. measurements for the control of high-grade pans is response to crystal content changes. We believe that, in order to get optimum results, high-grade continuous pans should be controlled to maintain a constant crystal content in each compartment. This prevents the massecuite getting too tight or too slack when pan throughput changes, and maintains a good exhaustion under all conditions. It follows therefore, that crystallization rates and hence liquor supersaturation must vary according to pan throughput.

It has been shown that there is a good correlation between the series capacitance signal from a R.F. probe and crystal content of refinery white massecuites<sup>4</sup> and therefore these probes are ideally suited for the control of crystal content. If measurements highly biased towards mother liquor Brix are used for control, this may necessitate the changing of controller set-points as a function of pan throughput to maintain acceptable massecuite quality.

One problem with R.F. probes is that they become encrusted with sugar after a time and this causes a displacement of the measurement. This problem also affects conductivity measurements to a larger extent, and B.P.E. measurements where the measurement time lag from encrustation causes problems with control. The R.F. probes however are designed to be easily removable, and slide into push fittings mounted on the pan. They can, therefore, be easily removed on the run and washed when necessary.

A control system based on R.F. measurements which we believe would be successful for refinery boilings is shown in Figure 7. In this system, seed is continuously pumped into the pan through a variable-speed positive-displacement pump. Liquor is fed from a common manifold into each compart-



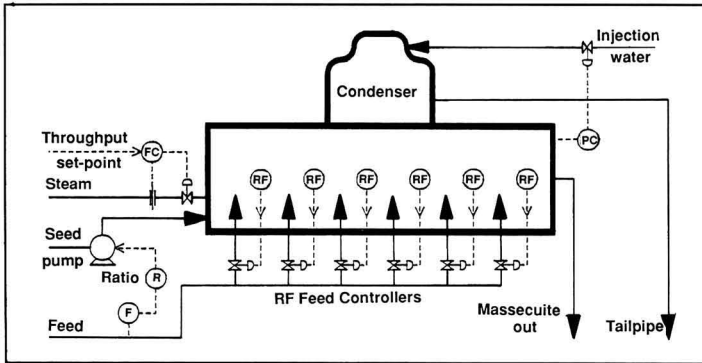


Fig. 7. Continuous pan control system

ment of the pan through individual control valves. Each compartment is fitted with an R.F. probe and controller.

The pan is fitted with an absolute pressure controller controlling injection water flow to the condenser. Steam flow rate to the pan is controlled and this rate may be adjusted to vary throughput. For example, if control of throughput were automated, the remote set-point could be derived from the liquor tank level, or it could be controlled from another supervisory system optimizing steam usage. Seed-to-massecuite ratio is controlled by a ratio controller using liquor flow to the pan to vary the seed pump speed.

A refinement that could be added is Brix correction to this ratio controller to cater for variations in liquor Brix, although normally it is preferred that this Brix be controlled at a reasonably constant value.

The costs of implementing feed control to each compartment can be reduced considerably by making use of controllers which have a time-proportional on/off output signal. These controllers are designed for temperature control application where a heater is cycled on and off. Although the output is digital, the output cycles on and off with a period of around 20 - 30 seconds and the "on time" varies in direct proportion to controller output.

This signal then is used to operate an on/off feed control valve (usually of

the rubber-lined butterfly type) and the feed cycles on and off every 20 seconds or so. Because the pan compartment acts as a stirred tank, this cycling does not appear in the sensor output.

The feed system is designed so that most of the pressure drop will occur across the feed orifices in the pan. The advantages of this system are as follows:

- (1) controllers are cheaper, current to air transducers and valve positioners are replaced with solenoid valves,
- (2) the feed into the pan is linearly proportional to controller output which is desirable for good control, and
- (3) an even distribution of feed in the compartments is assured at all feed rates and the possibility of the feed manifold holes blocking is reduced.

This system of feed control is being used on three of our continuous pans, and experience is that control is at least as good as that obtained using more expensive controllers and modulating control valves. Provided high-quality butterfly control valves are used, reliability is high and maintenance low.

A different approach used elsewhere for the control of some continuous pans is to proportion feed to each compartment according to an on-line mass balance done over the pan. In this instance Brix of massecuite leaving the pan is used as a feedback signal to trim the control system. This system has the advantage that it eliminates problems

associated with encrustation on measuring instruments.

One disadvantage of this system, we believe, is that there is no measurement of the massecuite condition in each compartment. Evaporation rates in each compartment change as the calandria becomes encrusted, and also vary according to mother liquor Brix. Crystallization rates also vary according to pan circulation which in turn varies with evaporation rate. These interactions, we believe, will make it more difficult to achieve optimum exhaustions.

### Conclusions

- (1) A radio frequency probe and single-loop programmable controller can form the basis of a very cost-effective stand-alone control system for the automation of a refinery white sugar pan.
- (2) Indications are that the automation of stirred white sugar pans will result in higher pan yields, a reduction of colour formation in the pan, increased pan capacity, and a reduction in process steam requirements.
- (3) Seeding procedure still needs to be optimized to improve sugar quality.
- (4) The seeding point, as determined by an R.F. probe, is dependent on pan vacuum and needs to be automatically corrected in the controller unless steady vacuum conditions can be assured.
- (5) R.F. probes can form the basis of a simple, cost-effective control system for the control of continuous pans to achieve optimum exhaustions.

### Acknowledgements

Thanks are due to the Management of Tongaat-Hulett Sugar Ltd. and Hulett Refineries Ltd. for allowing presentation of this paper as well as to Prem Sahadeo of Tongaat-Hulett Sugar Technology Department and the laboratory staff at Hulett Refineries for their contribution in collecting data for this project.

The Process and Instrument Department of Hulett Refineries Ltd. are thanked for their assistance and co-operation and S.I.T. for the opportunity to present this paper.

#### Summary

This paper describes further developments of a radio frequency probe for measurement of liquor Brix and massecuite crystal content and its use for the control of white sugar pan boiling. Simple control philosophy using single-loop programmable controllers to control the complete pan boiling cycle is described. The improvements due to implementation of this system on both stirred and unstirred pans are discussed with respect to throughput, yield and sugar quality. An assessment of potential energy savings and plant capacity increase is made using a mass balance model. The use of radio frequency probes for the control of continuous white sugar pans is explored.

#### Los últimos desarrollos en la cocción del azúcar blanco en tachos usando radio frecuencia

Este trabajo describe los desarrollos últimos de la sonda de radio frecuencia para medir el grado Brix de las soluciones de azúcar y el contenido cristalino de las masas cocidas y su uso en el control de la cocción del azúcar

blanco en tachos. Se describe la filosofía que hay detrás del control simple usando un controlador programable de un sólo bucle para el control del ciclo completo de la cocción del azúcar en tacho. Se discute el adelanto, debido a la implementación de este sistema en tachos con y sin agitación, con respecto a la cantidad, rendimiento y calidad del azúcar. Se hace una valoración del ahorro potencial de energía y del aumento en la capacidad de la planta usando un modelo de balance de masas. Se explora también el uso de las sondas de radio frecuencia en el control de tachos continuos de azúcar blanco.

#### Poursuite des développements de l'automatisation de la cuisson de sucre blanc en utilisant le contrôle par radio-fréquence

Cet article décrit la poursuite des développements d'une sonde à radio-fréquence pour la mesure du Brix du sirop et de la teneur en cristaux de la masse-cuite. On décrit aussi son utilisation pour le contrôle de la cuisson en 1r jet. On décrit la simple philosophie du contrôle mettant en oeuvre des contrôleurs programmables à circuit unique et permettant de réguler le cycle complet de la cuisson. On discute des améliorations amenées par l'application de ce système autant à l'appareil à cuire sans mouvement qu'à celui muni d'agitateur. Les avantages portent sur la capacité, le

rendement et la qualité du sucre. En établissant un modèle de bilan de masse, on évalue les économies potentielles d'énergie et l'augmentation possible de la capacité de l'usine. On explore l'usage des sondes à radio-fréquence pour le contrôle des appareils de cuisson continue.

#### Weiterentwicklungen der automatisierten Weisszuckerkristallisation in Vakuumapparaten mittels Radiofrequenzsteuerung

Beschrieben werden Weiterentwicklungen einer Radiofrequenzsonde zur Bestimmung des Trockenstoffgehaltes von Klären und des Kristallgehaltes der Kochmasse wie auch ihre Anwendung zur Regulierung der Weisszuckerkristallisation im Vakuumapparat. Die Philosophie einfacher Steuerung durch programmierbare Einkreisregler zur Regulierung des ganzen Kochzyklus wird dargestellt. Die aus der Anwendung dieses Systems an gerührten und nicht-gerührten Apparaten resultierenden Verbesserungen werden in Beziehung zu Durchsatz, Ausbeute und Zuckerqualität diskutiert. Die mögliche Energieeinsparungen und Leistungserhöhung von Anlagen werden anhand eines Massenbilanzmodells beurteilt. Die Anwendung von Radiofrequenzsonden zur Steuerung von kontinuierlichen Weisszuckervakuumapparaten wird untersucht.

#### Electrical conductivity control of calcium sulphite precipitation in cane juice clarification - continued from page 51

rapportant à la conductivité électrique présentent un minimum très net par rapport au temps. Ce minimum correspond à une valeur du pH (mesurée au laboratoire) de 9.75 à 25°C et de 9.00 à 55°C. Ces résultats marquent la fin de la précipitation du CaSO<sub>3</sub> présent dans le jus de canne. Lorsqu'on sature davantage le jus de canne avec du SO<sub>2</sub> afin de réduire le pH jusqu'au point de neutralité, 25 à 35% du CaO dans le jus épuré se remettra en solution. Une comparaison entre les courbes de pH convient moins que la conductivité comme

paramètre de contrôle pour indiquer l'accroissement de la teneur en chaux dans le jus de canne épuré.

#### Kontrolle der Ausfällung von Calciumsulfid mittels elektrischer Leitfähigkeit bei Rohrsaftklärung

Die elektrische Leitfähigkeit und der pH-Wert während Rohrsaftulfitation wurden im Labor und Zuckerfabriken gleichzeitig gemessen. In allen Versuchen zeigten die Leitfähigkeitswerte ein deutliches Minimum hinsichtlich der Zeit. Im Labor entspricht dieses

Minimum einem pH-Wert von 9.75 und 9.00 bei 25°C bzw. 55°C. Solche Ergebnisse deuten auf die Beendigung der Ausfällung von in Rohrsaft vorhandenem CaSO<sub>3</sub> hin. Weitere Saturation des Rohrsaftes mit SO<sub>2</sub>, um den pH-Wert bis zum Neutralpunkt herabzusetzen, verursacht die Auflösung von ca. 25 - 35% CaO in Klarsaft. Ein Vergleich von pH- und Leitfähigkeitskurven lässt denken, dass die erstere weniger geeignet als die letztere in der Rolle von Kontrollparameter zur Indikation der zusätzlichen Zunahme von Kalk in Klarsaft wäre.

# Facts and figures

## Mexico sugar industry privatization<sup>1</sup>

The Mexican government has concluded the first stage of its gradual, large-scale withdrawal from sugar activities with the sale of 13 sugar factories. It will continue the restructuring of the industry with an invitation to the social and private sectors to purchase another major group of the state-owned companies. In addition to the sales already announced<sup>2</sup>, other sales have been of Ingenios Puga, Rosales, La Concepción, El Higo, Mahuixtlan, El Potrero, El Modelo, San Miguelito, Adolfo Lopez Mateos, Tres Valles and La Gloria. Ingenios Nueva Zelandia, Estipac, Libertad and El Refugio have been closed.

## A simple direct colorimetric method for assay of starch in plantation white sugar

*continued from page 48*

ure de la densité optique du complexe bleue formé entre l'amidon et l'iode. On y a cependant apporté certaines modifications, telle que l'élimination de l'ajoute de sucre lors de l'établissement de la courbe standard. La méthode actuelle permet de retrouver 99.1% de l'amidon et il faut remarquer qu'elle évite la précipitation de l'amidon par l'alcool.

## Ein einfache, direkte kolorimetrische Methode zur Bestimmung von Stärke in Plantationsweisszucker

Beschrieben wird eine einfache, direkte kolorimetrische Methode zur Bestimmung von Stärke in Plantationsweisszucker. Im wesentlichen beruht diese Methode auf jener von Sang u.a., bei welcher die optische Dichte des blauen Stärke-Iodkomplexes gemessen wird, aber mit einigen Veränderungen, z.B. dem Weglassen des Saccharosezusatzes bei der Bereitung einer Standardkurve. Mittels der gegenwärtigen Methode wird 99.1% der Stärke wiedergewonnen, und es ist zu bemerken, dass es nicht nötig ist, Stärke mit Alkohol auszufällen.

## International Sugar Agreement quota proposals<sup>3</sup>

The Chairman said recently that a scheduled meeting of the International Sugar Council in May would discuss a new Agreement with economic clauses to provide guidelines for producers. He said it would be much easier to negotiate export quotas now because production and consumption have levelled off. In his opinion world sugar prices will rise to 12-16 cents/lb from 10 cents now and 7 cents a year ago. However, he emphasized that producers should prevent a boom as it would only be short-lived and harmful to the industry. Producers agree that export quotas are necessary but that allocations had to be worked out; he would appoint a committee of experts to study formulae for an allocation system for producers and would recommend the most viable program to the Council. He hoped that the program could be in place by late 1989.

## Australian cane alcohol economics<sup>4</sup>

The Queensland Premier announced in September that the State government would encourage a cane-based alcohol industry in Queensland, based on normal commercial arrangements in which the government would not be directly involved. Preliminary findings of a study were that such an industry could bring the State permanent economic and social benefits, including increased cane production and employment and reduced industry dependence on world sugar

export markets. The study examined in detail the large-scale manufacture of alcohol based on cane as the feedstock in a fermentation process and concluded that an alcohol industry has the potential to be commercial provided that the alcohol continues to remain exempt from Commonwealth government excise, sales tax and other duties. A scheme envisaged by Queensland Science & Technology Ltd. would require 3 million tonnes of cane per year, to be processed in five plants. An initial capital of \$Aus 120 million would be needed, but the scheme would inject \$Aus 360 million a year into the State's economy when fully operational.

## Abortive Berisford talks on buying into US beet sugar

S. & W. Berisford, owners of British Sugar plc, held talks in December on buying through its American company Bristar Inc. a near half-interest in Amalgamated Sugar Company, which is wholly owned by Valhi Inc. and accounts for 9% of sugar production in the US<sup>5</sup>. The talks were called off after two weeks, however<sup>6</sup>.

## Egypt sugar production, 1988

According to the Egyptian Minister of Industry, sugar production in his country during 1988 reached 900,000 tonnes, against 841,000 tonnes in 1987.

- 1 *GEPLACEA Bull.*, 1988, 5, (11), Sugar Inf. 1 - 2.
- 2 *I.S.J.*, 1988, 90, 243.
- 3 F. O. Licht, *Int. Sugar Rpt.*, 1989, 121, 27.
- 4 *Australian Cane Grower*, 1988, 10, (12), 4 - 5.
- 5 *The Times*, December 8, 1988.
- 6 *ibid.*, December 21, 1988.

## Sugar Industry Technologists Inc. 1989 Meeting

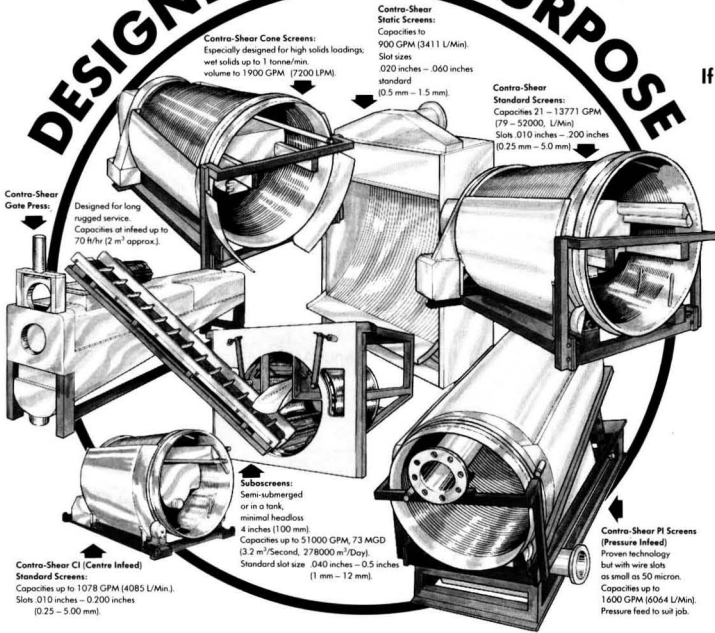
The 1989 meeting of SIT is to be held during May 7 - 10 in New Orleans, Louisiana. The convention hotel, the Canal Westin, is adjacent to the Mississippi River and the French Quarter of that city, and the meeting will include two days during which technical papers will be presented.

The program also includes tours of the Amstar Chalmette refinery and the Colonial Sugars refinery of Savannah

Foods, while a Ladies Program is being organized with emphasis on the Cajun traditions of New Orleans and Louisiana.

Members wishing to participate should get in touch with the Executive Director of Sugar Industry Technologists Inc., Bruce Foster, P.O. Box 632, Sainte-Thérèse de Blainville, Quebec, Canada J7E 4K3 (Telephone 514-621-3524) as early as possible.

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### Sugar Centrifugals:

- 6 - 40" x 30" Western States Auto Centrifugals
- 2 - BMA K850 Continuous Centrifugals
- 1 - W.S. 48" x 30" Auto Batch Centrifugal
- 5 - Broadbent 48" x 30", 3-Speed Centrifugals, SS
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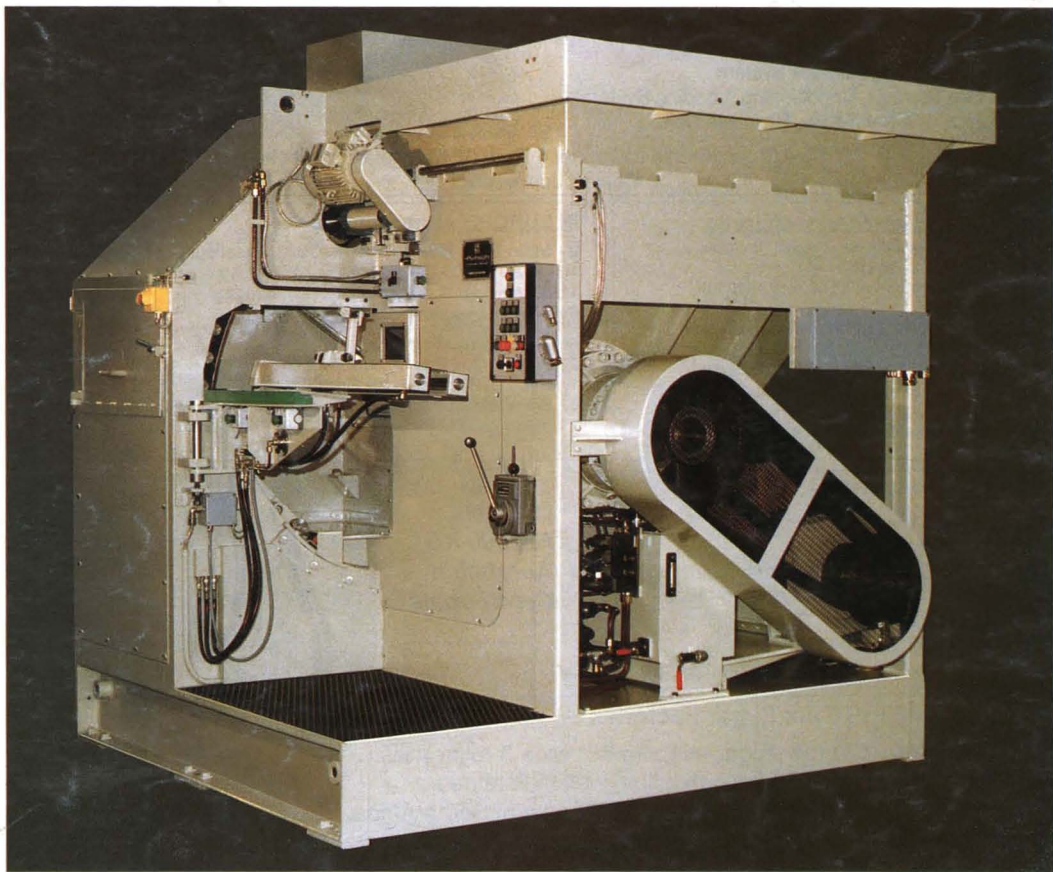
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