

























VOLUME LXXXXI/ISSUE No. 1087

**JULY 1989** 

# G centrifugals – a successful series –



BMA's high-capacity centrifugals of the G series are available for 1000, 1250, 1500 and 1750 kg massecuite charges. Outstanding design features contribute to the great success of these machines:

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- ✤ X-raying
- \* ultrasonic examination
- examination of mechanotechnological properties (tensile, notched bar, bending, macro/ microsection, hardness profile)
- \* dynamic strength
- \* depth of roughness
- \* test run
- and, moreover,
- \* minimum maintenance and operating costs
- \* excellent price/performance ratio. At home At home inc supar



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Issue No. 1087

July 1989

### CONTENTS

Page	
121	News and views
123	Product news
	Technical articles
124	DESIGN ASPECTS OF CONTINUOUS SUGAR CENTRIFUGALS – A CRITICAL STUDY By V. Ramamurti, C. Sujatha and S. Swarnamani (India)
130	A WEDGEWIRE SUPPORT FOR SCREENS IN CONTINUOUS CENTRIFUGALS By P. B. Quinan, P. G. Atherton and A. G. Noble ( <i>Australia</i> )
134	Conference on the sugar market
134	ICUMSA 20th Session, 1990
135	CITS Scientific Committee Meeting, 1989
140	Facts and figures
	Abstracts section
67A	Cane sugar manufacture
70 <b>A</b>	Beet sugar manufacture
72A	Sugar refining
73A	Starch based sweeteners
74A	Laboratory studies
76A	By-products
xix	Index to Advertisers
David C	Contenido Contenu Inhalt
121	Noticias y opiniones / Nouvelles et opinions / Nachrichten und Ansichten
123	Noticias comerciales / Nouvelles commerciales / Produkt-Berichte
	Artículos Técnicos / Articles Techniques / Technische Artikeln
124	Aspectos del diseño oe centrífugas continuas para azúcar – un estudio crítico / Aspects quant à la conception des centrifugeuses continues de sucre – étude critique / Konstruktionsaspekte von kontinuierlichen Zuckerzentrifugen – eine kritische Studie
130	Un soporte de alambre en cuña para tamices de centrífugas continuas / Un support en treillis pour les toiles dans les centrifuges continues / Eine Keildrahtunterlage für Siebe in kontinuierlichen Zentrifugen
134	Conferencia sobre el mercado del azúcar / Conférence sur le marché du sucre / Konferenz über der Zuckermarkt
134	20a Sesión de la ICUMSA, 1990 / 20e Session de l'ICUMSA / 20. Sitzung der ICUMSA
135	Reunión del Comité Científico de la CITS / Réunion de Comité Scientifique de la CITS / 1989 Versammlung der wissentschaftliche Komitee der CITS
140	Hechos y números / Faits et nombres / Tatsäche und Ziffern

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# A WATERTIGHT SOLUTION TO REFRACTOMETRY PROBLEMS



INDEX

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## News and views

### Europe 1989 beet area estimates

The total area sown to sugar beet in Europe is now estimated by F. O. Licht GmbH1 to reach 7,173,000 hectares, down 0.4% from their previous projection of 7,203,000 ha2 but more than 2.6% above the 1988 area. The forecast for the EEC is raised by 6000 ha, to 1,845,000 ha, only 7000 ha more than in 1988. The figure for the remaining West European countries is reduced by 25,000 ha, mostly owing to a reduction of 23,000 ha in the forecast for Yugoslavia. The estimate for Eastern Europe has been left roughly unchanged, at 4,693,000 ha but may be amended later in the year as official information becomes available.

### World sugar prices

A bullish trend in raw sugar prices at the beginning of April lifted the London Daily Price from \$295.20 on March 31 to \$315 on April 4 but rapid and erratic reaction to rumours and news resulted in a fall by April 17 to \$294.60. Reports that the USSR had bought large quantities of sugar from the French trading house Sucden Kerry and from Thailand, and that Indonesia would require considerable imports, strengthened the market and the LDP rose again to \$313 on April 20 but subsequently sagged, to end the month at \$299. During May there was little end-user demand for raw sugar and price movements depended on technical factors. However, speculative funds moved into the market at the beginning of the month and the LDP rose, reaching \$315.60 on May 12. The funds withdrew later and the price slipped steadily, to a level of \$279 on May 31.

White sugar demand remained high during the period and the LDP(W) was much more steady. From \$333 on April 3 it fluctuated a little but on April 20 rose to \$342.50 and then remained near this level until May 5 when it started to climb again, reaching \$359 on May 12. It then fell gently during the remainder of the month, with occasional rises but ended the month at \$347.50.

Observers are concerned because recent estimates by the USDA, Czarnikow, Man and Licht, etc. indicate that production in the current crop year ending in August will not be sufficient to meet consumption requirements and that a further stocks draw-down will be required. Consumption in 1989/90 is likely to rise to 110 million tonnes and this will require an increase of some 4 million tonnes to maintain current stock levels. Licht points out that this would be the fourth increase in a row and that there has not been such a sequence of gains for 20 years.

Dry weather does seem to have affected some countries in Europe and, should this reduce the availability of sugar, prices could rise sharply because of the effect on the present delicate balance between supply and demand.

### Fall in Chinese sugar crop areas

The State Statistical Bureau says that China's 1989 sugar beet and cane areas will fall 4.4% from the 1988 level, because farmers have switched to more lucrative crops3. Earlier reports had indicated that the sugar crop areas would rise by an estimated 60,000 hectares but the new information suggests that there will be no increase in sugar production in 1989/90, although domestic requirements are steadily rising. Hence, China will again have to import substantial quantities in 1989/90 to cover domestic demand.

Moreover, China is facing an unprecedented energy crisis, with power cuts hitting key factories, hospitals and households nationwide. This could well affect also sugar production in the current (1988/89) season which is still under way.

### EEC farm price agreement<sup>4</sup>

The Council of EEC Agriculture Ministers has finally fixed the institutional support levels for farm products covering the marketing year 1989/90. As it happens, this year's negotiations have been concluded in good time but the discussions were not quite as smooth as

some had initially expected. The latest meetings ran through a week and, although there were again last minute demands by Greece for additional concessions, agreement was finally reached on April 22.

As expected, the minimum support prices in most areas have been held unchanged in e.c.u. terms. For sugar the 5% cut originally proposed by the Commission has been scaled back to a 2% reduction in the agreement for the coming year. There had been strong opposition to any reduction, with ministers putting forward a number of arguments. Since stabilizers were agreed last year, some held that sufficient corrective measures were now in place while the fortuitous improvement in the overall farm budget following reduced spending on export refunds for cereals after last year's Mid-West drought now gave more room for manoeuvre. The opportunity was also taken to point out that the successful conclusion to the GATT mid-term meetings did not require any reductions by the EEC in farm supports until 1991. Despite all these urgings, the Farm Commissioner, Mr. Ray MacSharry, held firmly to the view that a cut for sugar was necessary although the new intervention level for whites will not take effect until the beginning of October. A similar 2% cut in the minimum beet price, however, is scheduled to take effect, as before, on July1.

The margin available to raw sugar refiners will not be reduced by a greater percentage than the margin available to the processors of sugar beet. There was no reference in the new price package to the likely return to ACP producers for their cane raws and the usual separate negotiations will take place to determine the guaranteed price for that sector.

### Domestic competition for Australian sugar<sup>5</sup>

#### The New South Wales Sugar

4 Czarnikow Sugar Review, 1989, (1784), 51 - 52. 5 F. O. Licht, Int. Sugar Rpt., 1989, 121, 200.

<sup>1</sup> Int. Sugar Rpt., 1989, 121, 187 - 190. 2 I.S.J., 1989, 91, 83.

<sup>3</sup> F. O. Licht, Int. Sugar Rpt., 1989, 121, 179 - 180.

#### News and views

Milling Cooperative has decided to end the 33-year old agreement under which its sugar is sold through the Oueensland government's Sugar Board. Instead, the Cooperative and the Manildra Group of Companies is to build a refinery at Harwood, on the Clarence River, which will be the second biggest in Australia. It will process 200,000 tonnes of sugar produced annually - 25% of domestic demand - and the NSW sugar will then be sold in competition with CSR-refined Queensland sugar. Australian press reports suggest that prices could be slashed by up to 20% following the decision and a 2kg package of sugar could be expected to drop from its present Sydney price of \$Aus 1.72 to \$Aus 1.45 and possible less. The Queensland Minister for Primary Industries said the move would destabilize the sugar industry.

#### South African sugar expansion<sup>6</sup>

There has been a period of intense dialogue and activity between the sugar industry and government in South Africa over the past several months, culminating in various measures which were announced in April towards deregulating the industry and embarking on a program of expansion. Bearing in mind the concern about low priced subsidised sugar entering deregulated domestic markets, recent tariff mechanisms in South Africa are now thought to give sufficient protection from the considerable distortions which are still a feature of the world sugar situation and the government has now decided to abolish quantitative import controls on sugar and molasses. It has also been decided to pass the responsibility for setting the level of industrial prices of sugar and molasses in the domestic market from government to the sugar industry.

Various factors, both domestic and international, have brought about the need for change and the reduction in government controls, together with a new expansion program by the sugar industry, should bring about a more ready access to production facilities, especially for small growers. Some 30,000 hectares have been taken out of cane production in recent years owing to the encroachment of the timber industry into the cane areas, rapid urbanization and the loss of outlying areas to cane production as a result of the introduction of the new cane transport payment system. At the same time the domestic sugar market, which has been static for some years, is beginning to expand once more.

It is to meet these changes that new measures are being introduced which the industry estimates will lead to some 30,000 hectares of land being regained to cane production. Small growers within a 30-km radius of a mill will now have unrestricted access to the facility. Small cane growers, defined as producing less than 150 tonnes in sucrose terms in any season, will now receive the "A"pool price for all deliveries of cane, while a restriction on the proportion of "B"-pool deliveries for the remaining growers will be gradually phased out over the next five years. The rigid provisions for the registration of all cane land are to be abolished and, under simplified quota arrangements, growers will be allowed greater flexibility in the short term to transfer quota among themselves to fill seasonal shortfalls. There will be limited expansion of new production areas at Pongola, depending on the availability of new irrigation, and further expansion is planned in the Onderberg and Kangwane areas.

Further outlets for cane may be developed if it is decided to go ahead with government assistance for a cane based fuel alcohol facility. The government's Central Economic Advisory Service has been conducting an in-depth investigation into all aspects of such a scheme and was expected to submit a report by the end of May. At that stage the government will consider whether, and if so on what terms, to go ahead with such a project.

World sugar production estimates, 1988/89

F. O. Licht's latest estimates of

1988/89 world sugar production<sup>7</sup> remain largely unchanged and total 106,665,000 tonnes or 2.2% higher than that for 1987/88 and 671,000 tonnes less than the 2nd estimates. This is in spite of a record Thai crop of 4 million tonnes owing to reductions in India, Bangladesh and elsewhere. Unfavourable weather has reduced the estimate for Mexico and less sugar is now expected from the Dominican Republic. Brazil's sugar crop has turned out better than expected earlier, however, as has that of Colombia.

Although beet sugar production in the EEC is more or less the same as expected earlier, the crop in Turkey fell below expectations as did that of Yugoslavia. However, in East Europe the crops in East Germany and Rumania were not as bad as had been feared. World beet sugar production is set at 38,048,000 tonnes, raw value, against 38,601,000 tonnes in 1987/88, while cane sugar is set at 68,617,000 tonnes against 65,731,000 tonnes.

#### Thailand sugar exports<sup>8</sup>

	1988	1987
	tonnes, r	aw value
Bangladesh	29,950	13,031
Brunei	1,801	1,991
China	857,389	837,858
Egypt	0	15,559
Hong Kong	18,534	14.467
India	0	13,685
Indonesia	30,654	0
Japan	488,640	440,699
Korea, South	363,446	343,882
Laos	2,655	3,157
Malaysia	38,383	95,427
Maldives	. 0	868
Nepal	4,050	0
New Zealand	1,469	16,901
Pakistan	0	15,730
Papua New Guinea	0	7,594
Phillippines	52,025	456
Singapore	16,773	18,825
Sri Lanka	38,832	72,327
Syria	0	24,958
US	12,828	11,642
USSR	0	108,053
Vietnam	3,794	14,564
	1,961,223	2,071,783
Czarnikow Sugar Review	1989, (1784).	54.

7 Int. Sugar Rpt., 1989, 121, 241 - 250.

8 I.S.O. Stat. Bull., 1989, 48, (2), 35 - 36.

## Product news

### Pieralisi's continuous centrifugals SCP-C5

The world sugar industry is striving to obtain a final product at the lowest possible production cost. In order to achieve this objective, a sugar factory needs high production potential, low running costs, and low maintenance costs. Nuova M.A.I.P. Pieralisi S.p.A. has kept these objectives in mind when designing its SCP-C5 continuous centrifugals for the sugar industry.

The SCP-C5 continuous centrifugals have the following main characteristics:

(a) Production capacity is high thanks to the construction specifications of the machine and of the basket in addition to the large basket dimensions.

(b) Running costs are low owing to: limited installed power per unit, limited number of units of high capacity, low power consumption, and automation of all the machine functions.

(c) Maintenance costs are low because stainless steel is used for all parts in contact with the product to be treated, and machine components are simply designed in order to reduce ordinary and extraordinary maintenance.

In order to satisfy the manufacturer's needs to cut costs, all components of the SCP-C5 continuous centrifugals have been standardized. This means a considerable reduction of the spare part inventory and consequently of running and maintenance costs. Moreover, every SCP-C5 unit is so conceived as to allow the use of the same machines in case of enlargements or updatings of existing production lines in order to obtain different final products. The SCP-C5 centrifugals are highly flexible and require minimum interventions of their basic components, such as a basket of 30° or 34° angle, the sugar dissolving device, and the sugar washing or covering device.

This exceptional characteristic of the SCP-C5 centrifugals comes from the design which provides:

(1) a magma production device,

(2) the possibility of installing a sugar INT. SUGAR JNL, 1989, VOL. 91, NO. 1087 dissolving device with automatic Brix control, a sugar washing or covering device, and a run-off separator, as well as

(3) standardization of the casing and product storage, the supporting structure, driving motor, electric and automatic equipment, utilities (water, juice, steam, run-offs, magma, compressed air), fluid control and cut-off systems, and massecuite filter and feed control valve.

When used for affination or the separation of high-grade massecuites, the specifications include a 30° basket of AISI 304 stainless steel with a maximum inner diameter of 1465 mm and a filter area of 2 m<sup>2</sup> with either 10 or 15% open area depending on the perforation dimensions. Speed is 1170 r.p.m. and acceleration at the maximum diameter is 1300 g. Capacity for different sugars lies in the range 34 to 40 tonnes/hr and provision is made for massecuite heating by low-pressure steam and adjustable water washing of the sugar.

The machine can also be used for treatment of low-grade massecuites, when a  $34^{\circ}$  basket is employed, of AISI 304 or AISI 329 stainless steel having a filter area of 2.12 m<sup>2</sup> and 7.5 or 15% open area. The machine speed is 1700 r.p.m., giving an acceleration of 2390 g at the maximum diameter. Throughput is 13 to 18 tonnes/hr.

Further details:

Nuova M.A.I.P. Pieralisi S.p.A., Viale Cavalotti 30, 60035 Jesi (Ancona), Italy.

### Orders for BMA centrifugals and sugar dryers

BMA has already received orders for a total of 87 centrifugals (among which are 40 batch machines) for delivery in 1989. Efforts made to sell the fluidized-bed dryer and cooler, built under licence from SKET (the Ernest Thälmann machinery combine of Magdeburg, East Germany) have also met with success and BMA will supply 17 of these to ultimate purchasers in the USSR. Recent installations of other plant are described in the latest edition of BMA Information, available from:

Braunschweigische Maschinenbauanstalt AG, P.O. Box 3225, D-3300 Braunschweig, Germany.

#### New Johnsons screens brochure

Johnson Filtration Systems has released a 16-page, full colour brochure featuring screen panels, sieves and baskets used for pulp and paper and food processing. Because of their unique strength, durability and flow characteristics, Johnson screens are built to withstand the rigours of various processing methods. They provide a cost-effective way to recover and dewater hard-tohandle fines. The new brochure contains screen construction information, application and design guidance.

Free copies of the new brochure are available from: Johnson Filtration Systems, P.O. Box 64118, St. Paul, MN 55164, U.S.A.

#### Long life conveyor rollers

The Hosch roller is manufactured from high density abrasion and corrosion resistant polyethylene machined to a fine finish to give a concentricity of  $\pm 0.2$  mm about its axis, so reducing starting torques, bearing loads and belt agitation at high speeds. The bearing is protected by a revolutionary interchangeable seal housing, protecting against the ingress of dirt and moisture which are thrown outwards by the peripheral movement of the seal. The bearing end caps are made of a high impact resistant material which, with their built-in memory, will return to their original positions after undue conveyor loading. Seize resistant bearings giving a B10 life rating are used. The new conveyor roller is a third lighter than its steel counterpart but also more robust. It has a life ten times that of the same traditional steel roller.

#### Further details:

Hosch Fördertechnik GmbH, Königswall 16/18, D-4350 Recklinghausen, Germany.

# Design aspects of continuous sugar centrifugals – a critical study

### Introduction

The continuous centrifugal is used to separate sugar and molasses from massecuite. It runs at a constant speed and is fed by a continuous stream of material giving a steady output of sugar. It requires only intermittent supervision, thus making it more advantageous than the classical batchtype sugar centrifugal machines.

Most of the literature available on centrifugals relates to the batch-type machine. The construction, working, and range of speeds of operation for various standard baskets has been discussed in detail by Hugot<sup>1</sup>. Ramamurti & Prakasam<sup>2</sup> have carried out experimental and analytical investigations on batchtype centrifugals. The axial symmetry of the basket was exploited and the finite element method was employed with triangular ring elements and the linear polynomial as appropriate shape function<sup>3</sup> to find out the stresses analytically.

Literature relating to continuous sugar centrifugals has been reported by Hugot<sup>4</sup>. These centrifugals are conical in shape and rotate at speeds between 1200 and 2200 r.p.m. The semi-cone angle varies from 25° to 35°. Table I gives details of the commercial baskets used, viz. their diameter, semi-cone angle, speed of rotation and capacity<sup>4</sup>. However, information regarding working stress is not available.

A fairly high level of working stress is experienced in commercially available centrifugals, often close to yield stress. This paper presents the steady state stress distribution patterns in continuous sugar centrifugals using a fairly accurate model. Since the problem under consideration is a matter of cyclic symmetry the finite element method is employed using the familiar triangular By V. Ramamurti, C. Sujatha and S. Swarnamani

S. Swarnamani

(Department of Applied Mechanics, Indian Institute of Technology, Madras, India)



shell elements to determine the stresses and these results are compared with experimental results obtained from actual field tests with the help of strain gauges and slip rings. The variance of stress with change in the thickness of the basket has been studied. Various standard baskets have been considered and a relationship between the maximum speed of basket, the permissible stress and the diameter has been established.

#### Theoretical analysis

#### Theory

The centrifugal under consideration has bolts located at every 18° around its periphery both at its top and bottom as shown in Figure 1 to enable easy dismantling of the molasses separator and the sugar deflector from the main basket. Hence the problem under consideration is one of cyclic symmetry and not rotational symmetry. A triangular shell element which can be considered as a combination of a plate

	Table I. S	Standard contin	uous sugar ce	entrifugals	
Massecuite	Angle, degrees	Top diameter, mm	Screen area, sq.m.	Speed, rpm	Capacity, tonnes/hr
С	34	981	1.098	1930	4.5 - 8
С	34	1237	1.832	1880	9
	30 - 35	1100	1.420	1400 - 2000	10 - 11
	30	1500	2.320	1700	24 - 30

element and in-plane stress element<sup>3</sup> is used for the analysis. By assembling the stiffness and force matrices for both the plate and in-plane stress elements the final equation for each element is written in the form

 $[K]_{18\times18} \{\delta\}_{18\times1} = \{f\}_{18\times1}$  (1) where  $\{\delta\}$  is the displacement vector consisting of the displacements and slopes along three perpendicular directions of the three nodes that constitute the element. Establishing compatibility through the nodal displacements the governing equation is written for the entire structure.

#### Steady state loading

The centrifugal basket is continuously subjected to loading due to fluid pressure and to pressure due to the centrifugal forces.

#### Fluid pressure

The pressure due to the fluid (massecuite) on the surface of the basket is insignificant, as the thickness of the layer of fluid along the surface of the basket is very small (2 - 5 mm) and at the discharge it is hardly more than the dimension of the biggest crystal of sugar<sup>4</sup>. Thus the pressure exerted by the fluid is negligible by comparison with the radially outward pressure due to the centrifugal force on the basket.

### Centrifugal effect

The radially outward load per unit area of the basket due to centrifugal force,  $P_{\rm r}$ , is given by

 $P_r = \rho_m h \omega^2 r/g \quad (2)$ 

#### Analysis of standard centrifugals

An analytical study has included those carried out on standard industrial baskets of 1100 and 1350 mm diameter, and experiments have been subsequently conducted on these baskets. The study

1	"Handbook of cane sugar engineering" (Elsevier, Amsterdam) 1960
2	"Centrifugal baskets critical study: Advances in
	reliability in stress analysis" (ASME Special Publication), 1979, pp. 185 - 200.
3	Zienkiewicz: "The finite element method in engineering science" (McGraw-Hill, London), 1971.
4	"Handbook of cane sugar engineering", 3rd Edn. (Elsevier, Amsterdam), 1986.

# TWO NEW QUALITY INSTRUMENTS



### MASSECUITE EXAMINATION

Our new **Saturascope** is designed for easy visual determination of the saturation temperature of a massecuite. The sample cup and resistance bulb are in close proximity in the heated block which is of solid copper. This arrangement allows measurement of the temperature in the sample cup to within  $\pm 0.1^{\circ}$ C.

Using a polarised light source, the massecuite is examined through a X150 microscope which allows the crystal melting point to be indicated on the digital indicator. The heating element uses 110/220 volt single-phase A.C. and is provided with a coarse and fine control for the rate of heating.

The microscope is attached to the instrument by means of a pivotal mount, thereby allowing increased accessibility to the sample cup and minimum re-adjustment of the focusing system.





### SUGAR COLOUR

The **Talameter**<sup>®</sup> **S100** is a new, purpose designed, sugar colorimeter intended for use in quality control laboratories of both Sugar Factories and White End Refineries.

This new instrument, developed by Tate & Lyle Process Technology Limited, has been licenced to 'Suma Products' to manufacture and market. It is based on the same principle of the original "8000 Series Talameter®" but with a simplified method, aimed strictly for repetitive colour determinations in dissolved sugar. Measurements in ICUMSA units or RBUs can be made in factory process streams from raw juice to final product sugar. ADVERTISING FEATURE PAGE 2

# A RANGE OF QUALITY INSTRUMENTS



### BAGASSE ANALYSIS

The 500 gram sample size **Deerr Type Bagasse Digester** is fabricated entirely in stainless steel, and is designed for operation by a 220V, single-phase electric immersion heating system.

The outer vessel is lagged to prevent heat losses. The spiral conductor tube, surrounded by a water jacket with cooling water inlet and outlet, is permanently connected to the digester body top cover which in turn is fitted to the body by means of thumb screws and rubber gasket.

The inner perforated container is supplied with a lid to prevent the escape of bagasse particles during extraction. A handle for removing the inner basket is provided.

For the rapid and accurate determination of moisture in Bagasse (or suitably prepared Cane samples). Equal in accuracy to the oven drying method.

The quick action of the **Moisture Teller** is due to thermostatically controlled hot air being blown through a thin layer of Bagasse which is contained in the sample pan which has a woven wire base. The pan and sample are weighed before and after drying to give the moisture. A feature of this machine is that a large sample (1400 c.c.) is used, thus increasing

the accuracy of the method.

It has an automatic time switch from 0 - 60 minutes and a temperature range of 90 - 170°C.



Deerr Type Bagasse Digester

Moisture Teller

### JUICE ANALYSIS

The Automatic Digital Polarimeter is a versatile instrument which is highly suited to both research work and routine daily quality control. It is very easy to use; the polarimeter does all the hard work involved in taking readings, leaving you time to concentrate on your samples and results. Also, comparatively unskilled technicians can carry out the routine work and obtain accurate and reliable results.

Automatic Digital Polarimeter

The Automatic Digital RFM80 Refractometer is designed for fast response, high accuracy determinations of Sugar solution concentrations by measurement of the refractive index of samples.

The RFM80 provides the ideal solution to the problem of accurately measuring concentrations in the range 0 - 95% Sugar w/w. Integral sample temperature sensing and compensation capability permits both ambient and temperature compensated results to be shown on the digital readout display, together with sample temperature.



Automatic Digital RFM80 Refractometer



also includes the analysis of standard baskets of 1200. 1400 and 1500 mm diameter, at various speeds, in which both stresses and deformations have been studied. For the problem under consideration, since the centrifugal is cyclically symmetrical for every 18° interval, one section of 18° subtended angle at the centre is considered. The section is treated as 510 discrete triangular shell elements with 310 associated nodes.

A simple method of estimating the hoop stress in the rotating basket is to treat the basket as statically determinate. Then this stress will be given by

 $\begin{array}{l} \sigma_{\theta}=\rho_{m}\omega^{2}r^{2}/g \quad (3)\\ Assuming \ \rho_{m} \ of \ 7.85\times 10^{4}\\ N/mm^{3}, \ this \ value \ in \ MPa\\ can \ be \ expressed \ as \end{array}$ 

 $\sigma_{\theta} = 20N^2D^2$  (4) where N is the running speed in thousands of rpm and D the diameter in metres. This value is compared subsequently with the result obtained by the finite element method.

#### Experimental investigation

Experiments were conducted on two industrial continuous sugar centrifugals of 1100 and 1350 mm diameter. The baskets were run without massecuite. A view of the experimental set-up is shown in Figure 2.

The 1100 mm diameter and 1350 mm diameter centrifugal baskets, manufactured for commercial use, were driven by a flange-mounted induction motor of 75 h.p. Strain gauges (90° rossettes) were pasted on the inner surface of the basket to measure the strains in the circumferential and radial directions, the locations of which are

1100 ab 308 d All dimensions 12

Fig. 1. Strain gauge location on centrifugal basket

shown in Fig. 1. Two gauges measured the strains in the radial direction and ten in the circumferential direction. The connections from the strain gauges were taken, five at a time, to the rotor of the slip ring unit. The stator of this unit was connected to a six-channel strainmeasuring bridge. After balancing the bridge while the basket was at rest, the baskets were run and the strains recorded. The stresses corresponding to the strains recorded at various speeds were computed. Table II gives the locations of the strain gauges and the strains recorded5. Table III gives the computed stresses in the circumferential and the radial directions for 1100 mm and 1350 mm diameter centrifugal baskets5. It is seen from Table III that the stresses in the circumferential direction on a continuous sugar centrifugal are higher than those in the radial and meridional directions.

#### **Results and discussions**

### Comparison of experimental and theoretical results

The experimental results obtained are compared with the theoretical values calculated by the finite element method for baskets of 1100 and 1350 mm diameter in Figures 3 and 4, respectively.

From the figures it is seen that the theoretical values match well with those from the experiments. The maximum difference in the results is about 15%, which is fairly reasonable bearing in mind the fact that the experimental values are obtained through the medium of slip rings when the unit is running at speeds around 1600 rpm.

Figures 3 and 4 show identical trends for both the baskets. It is observed that

in the conical portion of the centrifugal the stress steadily increases with increase in radius of the cone. This is because of the increase in centrifugal forces with increase in radius. A similar trend is also seen in the conical portion

<sup>5 &</sup>quot;Experimental stress analysis of continuous sugar centrifugal basket" (Machine Dynamics Laboratory, Indian Inst. of Technology, Madras, India 600036), Reports Nos. 54/86 and 12/87.

Design aspects of continuous sugar centrifugals - a critical study



Fig. 2. Experimental set-up with a 1100 mm dia. basket

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of the molasses separator. However, in this portion of the separator and the sugar deflector the stresses decrease with increase in radius. Probably the fixing bolts connecting the three independent parts influence this behaviour.

Equation (3) is used to plot hoop stress vs. radius of the centrifugal in Figs. 3 and 4. In general this hoop stress value is lower than the result obtained by the finite element method. However, the agreement is poor in the zone of the sugar deflector and the molasses separator, probably owing to the presence of the bolts.

### Effect of thickness of the basket

Figure 5 shows the variation of stress with radius of the cone for different thicknesses of the basket used. It is seen that the thickness of the basket

Table 11. Experimentary recorded strains in incroits										
Basket diameter 1100 mm							neter 13	350 mm	Remarks	
Speed, rpm 1740 2050			1520 1920			20				
Position	С	R	С	R	С	R	С	R		
1	40	-2	168	30	80	-40			On the basket (close to the drive end)	
2	184	-52	248	-52	128	-12			Close to the topmost holes on the basket	
3	180	-18	260	-36	124	36			Away from the topmost holes on the basket	
4	304	-42	408	-72	320	-18			On the basket	
5	350	-32	480	-136	440	-42	790	-60	On the basket, topmost point	
6	390		530		660	-60			On the sugar deflector plate	
7	460	40	560	60	720	-30			Molasses separator, mid-section, close to weld	
8	490	16			670	-64	1170		Molasses separator, extreme edge, close to weld	
9					580	-40	1040	-48	Molasses separator mid-section, away from weld	
10	440	-90			780	-96			Molasses separator, extreme edge, away from weld	
C = circumferential; R = radial										

. . . . .

	В	asket di	ameter 11	00 mm	F	Basket di	asket diameter 1350 mm			
Speed,	rpm	1740	2	050	15	520	19	20		
Positio	n C	R	С	R	С	R	С	R		
1	9.1	2.4	40.8	18.6	15.7	-3.7				
2	38.8	7.4	53.6	5.2	31.5	24.9				
3	40.3	8.4	57.6	9.2	31.1	16.9				
4	67.2	11.4	89.2	11.6	72.6	10.8				
5	78.6	16.8	101.4	1.84	98.6	20.8	178.2	40.8		
6	90.0	27.0	122.4	33.6	143.1	31.8				
7	109.0	41.0	133.4	52.6	164.1	42.9				
8	114.2	37.6			150.2	31.6	270.0	81.0		
9					131.1	30.9	236.7	60.9		
10	107.8	9.6			173.4	31.8				

has no effect on the stress developed in the basket. With increase in thickness there is no appreciable change in the stress levels in the basket. It is obviously the manufacturing consideration which is the deciding factor on the choice of thickness.

## Effect of variation of cone angle of the basket

Table IV gives the maximum hoop stress developed in each part of the centrifugal for various cone angles. It is seen that when the cone angle is changed there is no appreciable change

#### Design aspects of continuous sugar centrifugals - a critical study



Fig. 3. Comparison of experimental and theoretical results

### in the stress developed in the basket. Maximum speed of the centrifugal

From Table IV it may be observed that the stress developed is directly proportional to the square of the speed. The maximum speed of the centrifugal is plotted against the diameter of the basket in logarithmic permissible stresses. It is now easy to obtain a relationship connecting the maximum speed of the centrifugal and the permissible stress in the basket for a given diameter. This is given<sup>6</sup> by

 $\sigma_{max} = 27 (N_{max})^2 D^{127} \quad (5) \\ From Table III it is observed that the stress in the molasses separator for a basket of 1350 mm diameter, running at a speed of 1920 rpm, is much higher than the permissible limit. A residual stress of 104 microns was recorded during the experiment which shows that the specimen has yielded. This can also$ 

be inferred from the above equation, thereby confirming the validity of the

#### Conclusions

equation.

The following are some of the important conclusions arrived at:

(i) maximum stress levels are observed in the region of the molasses separator and this limits the maximum speed of the centrifugal,

(ii) since the thickness appears to be of little importance an optimal thickness can be used in the conical portion of the centrifugal taking into consideration the manufacturing aspects,

(iii) the cone angle of the centrifugal has no influence on the stress distribution on the centrifugal, and

(iv) the hoop stress on the basket is under-estimated when it is treated as statically determinate.

Summary

The steady state stress distribution in continuous sugar centrifugals has been analytically computed using the finite element method and cyclic symmetry concept and has been verified experimentally. A design chart relating the permissible stress, maximum speed and diameter of the basket is presented along with an equation relating these parameters.

### Acknowledgement

The authors are grateful to K.C.P. Limited, Madras, for the facilities extended to them in providing data and for conducting the experiments. They are also grateful to Mr. K. S. Ramaprasad and Mr. Y. Ramakrishna, students in the Mechanical Engineering Dept., I.T.T., Madras for help extended

<sup>6</sup> Ramakrishna & Ramaprasad: "Steady state stress analysis of continuous sugar centrifugals," B. Tech. Thesis (Mechanical Engineering Dept, Indian Institute of Technology, Madras), 1987.





		1	Table IV.	Maxin	num str	ess in th	ne centri	fugal				
							Ma	ximum str	ess, MPa			
				Baske	t	Mo	lasses se	parator	5	Sugar deflector		
	Cone angle		28°	30°	32°	28°	30°	32°	28°	30°	32°	
	Diameter, mm	Speed, rpr	n									
	1100 1200	1740 2000	148.6	96.3 148.6	149.1	164.1	104.2 164.0	165.4	143.2	92.7 143.5	144.2	
	1330 1400 1500	1800 1400	156.8 108.6	141.4 156.4 108.2	157.9 109.6	172.7 119.2	172.8 119.2	172.8 119.1	153.3 106.7	151.1 106.9	154.2 107.7	
to them in analytical work. Nomenclature			h r δ	, ] ]	Thickn Radius Displac	ess of b	asket vector	1/200	Aspo gas estu	ectos de continua dio crític	l diseño de ce s para azúcar o	ntrífu- — un
<ul> <li>D Diameter of the basket (metres)</li> <li>K Stiffness matrix</li> <li>N Speed of the centrifugal in thousands of rpm</li> <li>Nmax Maximum speed in thousands of rpm.</li> </ul>			3) μ σ σ <i>σ</i> <i>σ</i>	bscripi	Specifi Stress i Maxim the bas	c weigh in the ba in m per ket (MI	nt of the asket (M missible Pa)	basket IPa) stress in	estad conti dos a finito ha sio	La di lo estacion nuas para naliticamo o y el conc do verifica	stribución del str ario en las centr azúcar han sido ente usando el m epto de simetría ido experimenta	ress del ífugas calcula- iétodo cíclica y lmente.
1	Force vector		θ		circum	ferentia	directi	OR	Se pr	resenta una	a tabla del diseño	o re-

θ circumferential direction radial direction r

lacionando el stress tolerable, la

Acceleration due to gravity



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#### Design aspects of continuous sugar centrifugals - a critical study





Fig. 5. Variation of stress with thickness of basket

Fig. 6. Variation of max. speed with diameter (D) for different permissible stresses

velocidad máxima y el diámetro del cesto en conjunto con una ecuación relacionando estos parámetros.

des centrifugeuses continues de sucre – une étude critique

En faisant usage de la méthode de l'élément défini et du concept de la symétrie cyclique, on a analysé la distribution des efforts à l'état d'équilibre dans une centrifugeuse continue pour le sucre. On l'a vérifié expérimentalement. On présente un abaque reliant l'effort admissible, la vitesse maximale et le diamètre du panier. On donne en même temps une équation qui relie ces paramètres.

### Konstruktionsaspekte von kontinuierlichen Zuckerzentrifugen – eine kritische Studie

Die stationäre Verteilung von Belastung in kontinuierlichen Zuckerzentrifugen wurde analytisch errechnet mittels der Methode von begrenztem Element und des Konzepts von zyklischer Symmetrie; die Ergebnisse wurden versuchsweise überprüft. Ein Konstruktionsdiagramm wird gegeben, das die Beziehung zwischen zulässiger Beanspruchung, Höchtsgeschwindigkeit und Trommeldurchmesser darstellt, zusammen mit einer Gleichung, welche diese Beziehung bestimmt.

Aspects quant à la conception

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### A wedgewire support for screens in continuous centrifugals

By P. B. Quinan\*, P. G. Atherton\*\* and A. G. Noble\*\*

#### Introduction

BMA K 1000 centrifugal baskets were originally supplied with woven mesh backing screen of either 1.6 mm wire at 8 mm pitch or 2 mm wire at 10 mm pitch. The finer mesh initially gave longer working screen life than the coarser mesh but stretched to form depressions between the major support rods and rings. The chrome-plated nickel working screens tend to conform to the contours of the supporting woven mesh, causing uneven screen wear, uneven flow patterns in the massecuite stream and a widening of the working screen slots at every support point.

In 1978 Bingera sugar factory sent three baskets to the BMA factory in Germany to have the finer screens replaced with the coarse ones and the baskets balanced. During the past few seasons the stronger, coarse screens have also sagged and a cost effective replacement was needed.

Discussions between Bundaberg Sugar Co. Ltd., the Surescreen Group and the Bureau of Sugar Experiment Stations (BSES) resulted in BSES sponsoring the installation of a wedgewire backing screen in a K1000 basket at Bingera mill. This paper presents the results of trials carried out to test the performance of the machine fitted with the new backing screen.

#### Equipment and trial procedure

Consultation between Surescreen, Bundaberg Sugar and BSES resulted in the selection of a wedgewire backing screen with a 2.5 mm aperture and 70 per cent open area. This backing was installed and the basket rebalanced at the Surescreen factory in Brisbane. Machinery Department approval was readily granted as the basket structure was in no way altered.





The main objective in this work was to compare the performance of two identical machines situated side by side, one possessing a wedgewire backing screen, and the other a conventional woven mesh backing screen. Both centrifugals were fitted with new standard chrome-nickel working screen before the start of the trials. The machines selected for the purpose were Nos. 4 and 5 (both BMA K1000), which were located near one of the points of massecuite entry to the distributor. The general layout of these two trial machines, massecuite distribution system, etc. is illustrated in Figure 1. All working screens and backing screens in the two machines remained in place for the duration of the trials (approximately 700 hours operating time).

The performance of the two test machines was assessed on three separate occasions during the crushing season. Details regarding the timing of these trials are shown on Table I.

The general approach taken in comparing the performance of the two sets of backing screens was to set steam

	Table I. Hours of operation	ation of working s	creens	
Trial No.	Date	Wedgewire backing, hr	Woven mesh backing, hr	
1 - 3	October 8	87	18	
4 - 6	November 13	520	442	
7 - 9	November 19	582	507	

and water usage on the two test machines at the same level, and then adjust the massecuite feed rates to the two centrifugals to give roughly the same sugar purity. In each series of trials, three such comparisons were made at different levels of purity.

Operating data recorded for the two machines in each trial included:

- Massecuite, molasses and water temperature (°C);
- Steam pressure (kPa);
- Water usage (litres/min);
- Motor load (A);
- · Molasses flow (tonnes/hr)

Samples of C-sugar and molasses were obtained from each machine in all nine trials. A composite sample of massecuite being supplied to the centrifugals was taken in each series of three trials. Part of this material was subsequently used to obtain a sample of pressure filter molasses.

A total of 60 samples of massecuite, molasses or sugar was obtained. The pol and Brix of each of these samples were determined at Bingera mill, and sub-samples were forwarded to the Chemical Engineering Department at the University of Queensland for the determination of dry substance, and of sucrose by high performance liquid chromatography.

The definitions, and the formulae used to calculate the massecuite rate, purging efficiency, crystal content and molasses purity rise are given in Appendix I.

#### Results and discussion

The composition of the massecuite being handled obviously had some influence on screen performance. A summary of the range of conditions encountered is shown in Table II.

It may be seen that the average crystal content of the massecuite feeding the centrifugals at Bingera was quite low

1	Paper presented to the Australian Society of Sugar Cane Technologists, 1988.
•	Bundaberg Sugar Company Ltd., Bundaberg, Queensland, Australia.
••	Bureau of Sugar Experiment Stations, Bundaberg, Queensland, Australia.



# Cane sugar manufacture

### Some developments in roller cleaning

G. M. Jorgensen and D. C. Landy. Proc. 10th Conf. Australian Soc. Sugar Cane Tech., 1988, 333 - 335.

Problems with mill roller cleaning and excessive wear of scraper and apron plates at Mossman are outlined and the geometry of four different systems of mounting plates relative to the roller is described with the aid of diagrams. New techniques for making return, feeder nose and scraper plates and bar scrapers are described which have cut costs to one-third of previous expenditure.

### The development and testing of a computer-controlled machine for high-productivity automated roller arcing

P. M. Kuebler and K. C. Jones. Proc. 10th Conf. Australian Soc. Sugar Cane Tech., 1988, 337 - 341.

A prototype mill roller arcing machine has been developed which is capable of treating a 2.13 m long roller in <3 hr (excluding set-up time) at a cost which is 30% lower than that of manual arcing. Other benefits include its flexibility and wide field of application, e.g. hardfacing of scraper plates, trash bars, shredder hammers, etc. and ability to operate unattended, so that the operator is not subjected to the fumes, radiation and heat to which manual operators are exposed. The ranges of deposition efficiency when arcing dry and wet rollers are indicated in tables.

### A system of automatic monitoring and control of the dry solids content and pH of syrup in the sugar industry

X. S. Jiang. Process Autom. Instrum. (China), 1987, 8, (11), 1 - 4, 46; through Ref. Zhurn. AN SSSR (Khim.), 1988, (18), Abs. 18 R474.

An automatic monitoring and control system for syrup Brix in the final evaporator effect and for syrup pH is described; the fall in pressure head of the syrup at a given temperature is used as indirect parameter for the Brix, while pH is measured with an antimony and calomel electrode. A number of technical problems in pH measurement around the neutral point were solved experimentally.

### Pneumatic classification of products from sugar cane treatment

G. A. Roka, M. A. Boisan and V. F. Frolov. Zh. Priklad. Khim., 1988, 61, (3), 674 - 676; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs. 19 R447.

Experiments are reported on periodical removal of bagacillo from a fluidized bed in a vertical cylindrical unit. The particles were trapped in a rectangular separator with vertical baffles. The tests were conducted with six fractions of bagacillo. The relative moisture content of all fractions remained approximately constant and was equivalent to 10.6% of the wet weight of the original material. Fluidized-bed drying may be satisfactorily carried out in vessels having a conical bottom. Continuous classification of bagasse was also carried out under conditions such as encountered in a vertical pneumatic conveyor. On the basis of the results, an industrial unit was designed, manufactured and erected in a Cuban sugar factory. Drying and classification can be conducted simultaneously.

## Ethanol as an indicator of cane delays under industrial conditions

G. R. E. Lionnet and J. V. Pillay. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 6 - 8.

Investigations on extracts from burnt cane consignments showed that the ethanol content as determined by GLC allowed estimates of delay in cane processing to within  $\pm 20$  hr. The method is relatively simple and is recommended for use on a full-time basis. Multilinear regressions are given for delay as a function of average temperature during the period between harvest and processing, ethanol content and variety. (See also Lionnet & Pillay: I.S.J., 1988, 90, 60A.)

### An investigation into the causes of vapour pipe corrosion at FX mill

K. J. Schäffler, C. M. J. Day-Lewis and G. Montocchio. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 9-11.

Serious corrosion of vapour and condensate lines at Felixton was found to be due to high levels of acetic acid in the vapours, particularly in that from the 2nd evaporator effect; acetate contents in mixed juice were also found to be much higher than at other factories as a result of liming conditions in the diffuser which resulted in hydrolysis of hemiacetyl groups in the bagasse. When liming was stopped, the acetate concentrations fell to acceptable levels.

### Sixty-third annual review of the milling season in southern Africa

J. P. Lamusse. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 12 - 31.

Performance data for sugar factories in South Africa, Swaziland, Malawi and Zimbabwe are presented and discussed. Although the cane crop in South Africa was good as a result of adequate and well distributed rainfall and a mild winter, sugar production was adversely affected by the lowest cane sugar content ever recorded (an average of 12%), while sugar production in Zimbabwe was limited by reduced irrigation water availability as a consequence of a very severe drought. Severe floods in South Africa following very heavy rain in September 1987 disrupted the season and caused considerable damage in some cane areas; at some factories major problems were experienced in the processing of flood-damaged cane. Time lost because of the floods averaged 4.95% of available time; it reached 23.9% at one factory which failed to operate for 2 months because of damage to roads and bridges. Extraction

(97.63%) was at a near-record level and boiling house recovery (87.84%) was higher than in previous seasons.

### Modifications to and experiences with RapiDorr clarifiers including saccharate liming at Amatikulu

R. P. Scott. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 32 -35.

Brief descriptions are given of modifications to the four RapiDorr clarifiers to improve their juice handling capabilities following increased cane throughput; the alterations involved the clear juice internal off-takes, the juice inlet baffle, air/incondensable gas venting and mud withdrawal. The result has been a reduction in juice retention time from >2 hr to an average of 1.1 hr, the possibility of halving the number of clarifiers in service for prolonged periods at high cane crushing rates with an acceptable flocculant dosage rate of 2.5 - 4 ppm on mixed juice and an improvement in filter performance, giving a difference of <1.5 units between clear juice and filtrate purities. Although saccharate liming significantly reduced clear juice turbidity, this improvement was not extended in the main to syrup and final sugar and, in view of the marginal benefit and the difficulties involved (especially the large volume of slowly settling muds), the process was discontinued.

### Chemical cleaning of the evaporators at Felixton

R. W. Whitelaw. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 36 - 38.

In the procedure used, the Kestner 1st and 2nd evaporator effects are flushed with condenser water to remove all trace of syrup, NaOH at approx. 30% w/v is pumped in parallel from the bottom of the vessels and sprayed onto the top tube plates, the solution in the 1st effect heated to approx. 114°C and returned to storage after 3.5 - 4 hours. Both vessels are then reflushed with condenser water before boiling with water for 1 hour, flushed again and then treated with 1.5% w/v inhibited sulphamic acid for 1 hour at 70°C. While the cleaning procedure has permitted maintenance of a clean heating surface without reduction in factory throughput as previously, problems are being experienced with severe tube blockages around the periphery of the 2nd effect vessels, necessitating changes in the operating procedures.

# The effect of some operational factors on colour transfer during pan boiling

G. R. E. Lionnet. Proc. 62nd Ann. Congr. S African Sugar Tech. Assoc., 1988, 39 - 41.

A pilot batch pan developed at the Sugar Milling Research Institute was used to investigate the effects of a number of operational factors on colour transfer from mother liquor to crystal during Amassecuite boiling; results showed that the degree of colour transfer (as given by the ratio between affined sugar and syrup colour) increased with supersaturation, crystallization rate and crystal size but fell with use of stirring. The findings indicated that the effects of time of year and cane cleanliness on sugar colour were much greater than the boiling parameters studied; moreover, since there are limitations to the degree by which boiling procedures can be changed in existing stations for the production of VHP sugar, it is expected that operational factors will at best provide only limited control of sugar colour, so that investigations of the possible use of chemical means to reduce the colour level in syrup or remelt liquor could be worthwhile.

## Comparison of the FCB and SRI continuous pans at Sezela

S. S. Munsamy. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 42 - 44.

Comparison of the performances of the Australian SRI and Fives-Cail Babcock pans, particularly in terms of mother liquor purity, showed that under test conditions and normal factory operation the SRI pan gave better exhaustion and better natural circulation despite the higher evaporation rate of the FCB pan. The effects of changes in some operational conditions are discussed, including means of improving condensate drainage in the FCB pan; tilting the pan to provide a slight slope would give better drainage and facilitate passage of massecuite from cell 1 to cell 12.

## A financial evaluation applied to selection of *A*-centrifugals

B. St. C. Moor and M. S. Greenfield. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 45 - 50.

Methods used to assess the cost effectiveness of three different types of automatic batch centrifugal from UK and West German manufacturers are described. The machines were to be installed at Maidstone for the 1988 season. The major factors used for appraisal were curing capacity, ploughing efficiency and drive characteristics; the second most expensive of the three machines proved to be the one selected since, although it had the smallest basket of the three, it had a higher ploughing efficiency and superior drive by comparison with the cheapest machine which had the largest basket. While the investigation was specific to Maidstone and had a degree of subjectivity, the method used for assessment could be applied to other factories and to other equipment.

### Continuous sampling and analysis of clear juice, filtrate return and syrup at Darnall

A. Dunsmore and P. Mellet. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 65 - 66.

Darnall sugar factory sometimes experiences unusual purity profiles for products from mixed juice through to syrup, the main anomaly being a filtrate return having a purity often greater than that of clear juice. A system was set up for Cane sugar manufacture

continuous sampling of clear juice, filtrate return and syrup to enable the SMRI to investigate the profiles; the samples were analysed hourly and composited in a deep freeze at hourly intervals over 8-hr periods. Good purity profiles obtained at the SMRI contrasted with the irregular profiles obtained for the hourly catch samples analysed in the factory laboratory, despite good agreement between the analytical results at both locations; it was therefore concluded that poor sampling of filtrate return was probably the cause of the anomalous results. The scatter of purity values obtained for the hourly samples by comparison with the 8-hr composites was  $\pm$  0.60 units for clear juice and syrup, indicating that these products could be composited and analysed less frequently than at present.

### A new sugar mill drive coupling

C. T. Tosio. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 70 -73.

A new design of cane mill drive coupling intended to avoid the problems associated with conventional tailbarand-collar drive couplings is described. The new coupling consists of driving and driven yokes, two pairs of steel ropes for torque transference and a compression plate that bends the ropes into a double-parallel-link arrangement to provide multi-misalignment. When installed on a final Walker mill in a 7mill tandem, the coupling enabled top roller hydraulics to be fitted to provide over-stress relief and reduce roller breakages. During a full season of operation with the coupling, there were no roller breakages and post-season ultrasonic tests on the shaft revealed no cracks. Advantages and disadvantages of the new coupling are listed.

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

M. J. Reid. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 74 -78. Details of 93 cane mill roller shaft breakages that have occurred in 8 selected sugar factories since 1979 were collated and analysed to determine the most likely causes of failure. Theoretical analyses of shaft stresses and fatigue stress concentration factors were carried out to see if current shaft design, machining practices, material specifications and shell assembly techniques are satisfactory and whether they can be improved. The feasibility of using adhesive to fix the shell to the shaft is discussed and some recommendations are made on roller shaft and shell specification, design, assembly and operation. It is pointed out that while there are many external causes of shaft failure that can be eliminated by changes in mill design and operation, the major causes of failure originate on the surface of the shaft, the life of which can be greatly prolonged by careful maintenance, including adequate planning of a roller repair and reshelling program during the off-season.

### Pneumatic spreading of fibrous fuels and coal in boiler combustion chambers

N. Magasiner and D. P. Naude. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 79 - 84.

The need to burn coal and bagasse in the same furnace and the almost simultaneous need to build larger boilers led to the introduction of spreader firing in the South African sugar industry in 1954. The development of spreading equipment is described, starting with purely mechanical spreaders, followed by combined mechanical and pneumatic equipment and ending with the single pneumatic spreader capable of handling fuels having a wide range of ballistic properties. The effectiveness of the latest design is illustrated by its use at Sezela on a 130 tonnes/hr boiler provided with a furnace burning a mixture of bagasse, coal and residue from furfural manufacture

Practical guidelines for reducing

#### stresses and loads imposed by thermal expansion of steam piping

B. H. Kitching. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 99 - 105.

The effects of thermal expansion of live and exhaust steam piping and the imposed load limits on turbine branches are discussed as well as stress in piping with reference to codes of practice. The procedures used for implementation and optimization of piping design and layout are examined and the definition and application of loops, restraints, supports, spring hangers and cold pulls to minimize these thermal effects without the use of expansion bellows are described. Recommendations are made on modelling, pipe installation and interpretation of stress analysis results.

### Practical experiences of vibration condition monitoring

A. R. Fairclough and A. Wienese. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 106 - 111.

The usefulness of measuring vibrations inherent in all machines is evaluated and how such measurements can be interpreted to indicate the overall internal condition of a machine is demonstrated. Results are presented for turbo-alternators at a number of sugar factories and measuring equipment and methods described. The savings in maintenance costs made possible by vibration condition monitoring are discussed.

### Industrial safety at TSB Malelane

D. J. Erasmus. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 112 - 115.

The results of an intensive safety program launched at the Malelane factory of Transvaalse Suikerkorporasie Bpk. in 1983 are discussed and an attempt made to quantify the financial effect of the overall improvement in safety since its start. Recommendations are also made for further improvement.

# Beet sugar manufacture

### Low-grade massecuite purging in a Konti 12 DCD/30° centrifugal at Hajduság sugar factory

K. Zemlényi. Cukoripar, 1988, 41, 115 -117 (Hungarian).

The superiority in performance of the title continuous centrifugal over a batch machine for low-grade massecuite treatment is indicated by performance data; the improvement included a substantial increase in raw sugar purity at a slight rise in molasses purity.

### Exchange of anions in molasses for hydroxides

J. Dobrzycki and A. H. Sadeghi. Gaz. Cukr., 1988, 96, 121 - 123 (Polish).

Investigations were conducted on conversion of the anions in molasses to hydroxides by ion exchange followed by addition of nitric acid to convert the hydroxides to nitrates which are known to reduce sucrose solubility and allow some 20% of the sugar in the original molasses to be recovered in crystalline form. From determination of the equilibrium constant it was found that the resin had a strongly alkaline character in the presence of sucrose; when molasses and NaCl solutions were in contact with the resin, the constant was a function of change in alkalinity of the solution surounding the resin particles. Temperature did not affect the reaction, but exchange efficiency fell with increase in molasses Brix from 20 to 60°, although this could be largely offset by reducing the reaction time and diluting the molasses.

### Aluminium salts as coagulants and clarifying agents in the sugar industry

J. Kubiak. Gaz. Cukr., 1988, 96, 124 - 127 (Polish).

Tests are reported on Al salts application as coagulants and clarifying agents. Colloid precipitation in raw juice reached a maximum of 65.9% of the total quantity at pH 3.5 (29.5% at pH 6) when 0.1% Al sulphate was used, and 67.5% at pH 3.5 (22.2% at pH 6) with 0.1% Al chloride. Use of 0.1% solutions of the two Al salts as clarifying agents in beet brei analysis by cold water digestion gave results that were in close agreement with values obtained using lead subacetate.

### Modern sugar storage at Petohaza

A. Palásti. Elelmez. Ipar, 1988, 42, (2), 70 - 75; through Ref. Zhurn. AN SSSR (Khim.), 1988, (18), Abs.18 R476.

Bulk sugar storage conditions are investigated and details given of a silo at Petohaza sugar factory in Hungary, including explosion prevention measures and the layout and interconnexion of the installations.

### Investigations of sugar pressure in silos. III. Proposal for determination of load values

M. Kaminski. Zuckerind., 1988, 113, 776 - 780 (German).

Investigation of the sugar pressure in bulk silos in a number of countries has shown that norms set failed to make satisfactory allowance for the influence of the type of sugar on increase in the pressure during discharge and its distribution over the surface area of the wall. A method is proposed for calculation of the pressure under conditions of symmetrical and off-centre discharge and for determining the loads in doublecylinder silos (in which different types of sugar can be stored in the outer and inner cylindrical sections). It is shown how pressure is a function of the height:diameter ratio in symmetrically discharged silos and increase in the pressure is small (not exceeding 20%). Comparison is made between the pressure curves for off-centre discharging based on the proposed method and on the appropriate German Standard DIN 1055 and between these two methods and that based on the US Standard ACI 313 77 in the case of symmetrical discharge.

The economic benefit of acidify-

### ing supplementary water for diffusion

E. Sarka and Z. Hotovy. Listy Cukr., 1988, 104, 197 - 200 (Czech).

The economic benefit of acidifying diffusion water with phosphoric acid (found to be preferable to HCl or sulphuric acid despite its greater cost) is discussed for a factory slicing 1500 tonnes of beet per day. The advantages come from the reduction in juice pectin content, sucrose degradation, filtration coefficient, losses in diffusion, carbonatation mud and molasses, viscosity and in the boiling time for A-massecuite by comparison with untreated water.

## Evolution of control at Eppeville sugar factory

G. Rousseau and S. Maquet. Ind. Alim. Agric., 1988, 105, 639 - 642 (French).

Details are given of the computerized semi-automatic system of linked analytical lines and processing of the data which will ultimately develop into a fully-automatic process control system using on-line sensors.

### Improving the performance of climbing-film evaporator effects and particularly of multi-sectioned vessels

B. de Warren, R. Smit and D. Leconte. Ind. Alim. Agric., 1988, 105, 651 - 653 (French).

Despite the installation of three new evaporator effects in the form of doublecirculation climbing-film units as the 4th, 5th and 6th effects at Bucy-Le-Long sugar factory, performance failed to come up to expectation, with poor heat transfer, particularly in the 5th and 6th effects, the need for greater head in the 5th effect, inadequate pressure in the calandria of the 6th effect, fluctuation in juice levels and increased colour formation. The problems were overcome and performance improved by adopting a scheme patented in the names of the authors whereby the recirculated juice is reheated with vapour withdrawn from

#### Beet sugar manufacture

later effects in the station and/or with vapour bled from the same effect. This led to a reduction in the pressure head in the 5th effect at the same temperature as before, a temperature rise in the calandria of the 6th effect, an increase from 6 to 17 tonnes/hr in the vapour bled for raw juice reheating and a reduction in the temperature difference between the 1st and 6th effect vapour from 48.5° to 38°C.

# Experiences in the operation of vibratory fluidized-bed dryer/ coolers for white sugar

Z. Pakowski, J. Iciek and J. Grochowski. Ind. Alim. Agric., 1988, 105, 655 - 658 (French).

The theory of sugar drying and cooling in vibratory fluidized-bed units is explained and 12 years' experience with them in the Polish sugar industry summarized. The type installed up to 1980 was designed for a daily capacity of 250 tonnes of sugar having an initial moisture content of 1% (although up to 360 tonnes/day could be handled if the initial moisture content was lower), and the entire unit vibrated at a frequency of 6 -10 Hz and an amplitude of about 10 mm; the later type has a daily sugar capacity of about 300 tonnes, and only the section carrying the bed of sugar is vibrated. On the basis of the results obtained, the authors advocate a small vibratory fluidized-bed dryer capable of reducing the moisture content to 0.1% or a large non-vibratory unit with a shallow bed of sugar and intermittent flow; air discharged from the cooling section could be recirculated so as to improve the heat efficiency.

### A new generation of batch centrifugals

F. Buyck and C. Oudart. Ind. Alim. Agric., 1988, 105, 689 - 92 (French).

Details are given of the latest generation of Fives-Cail Babcock batch centrifugals (Type D 412), with details of prototype tests which demonstrated their superiority over the C 410 and C 411 machines. The new machines have been installed in two French sugar factories where they have proved to be highly stable in operation.

### Mechnical compression in multiple-effect evaporation

G. Salani. Ind. Sacc. Ital., 1988, 81, 139 - 140, 142, 144 (Italian).

The benefit of mechanical vapour compression for evaporation where the aim is to provide a satisfactory final Brix while saving steam is discussed; two schemes, with and without pre-evaporator, are described.

## Intensifying the 1st massecuite boiling process

V. V. Spichak, A. S. Pakhomova, T. E. Luk'yanova and V. O. Shtangeev. *Pishch. Prom.*, 1988, (2), 42 - 43; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs.19 R438.

On the basis of industrial investigations, a means of intensifying the massecuite boiling process has been developed which involves the use of remelt liquors obtained by dissolving yellow sugar in thick juice. By increasing the Brix of the pan feed, the process reduces the 1st massecuite boiling time by 15 - 20% and steam consumption by 2.5 - 3.0% on beet.

### Application of an ultrasonic spectral method to control the sugar crystallization process

Yu. A. Dashkovskii, I. S. Gulyi and A. V. Gukalov. Rpt. Kiev. Tekh. Inst. Pishch. Prom., 1988, 7 pp.; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs.19 R441.

The possibility of creating an ultrasonic means of controlling the crystallization process is investigated. Changes in the characteristics of elastic waves in the frequency range 0.4 - 10 MHz after passage through massecuite were studied, and a relationship obtained between wavelengths at which dispersion of ultrasound commences and sizes of sugar crystals causing this dispersion; this relationship was obtained using an ultrasonic-spectral method in which elastic waves of reducing length were passed through test media and their parameters recorded.

# Thickening flume-wash and filtration mud in a centrifugal force field

Yu. V. Raskin and A. I. Sorokin. Tekhnol. Osobennosti Sakh. Pr-va i Puti Povysh. ego Effectiv., 1987, 94 - 101; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs. 19 R448.

A method described for treatment of diluted flume-wash mud from a settling tank consists of initial concentration in a vertical clarifier followed by dewatering in a sedimenting centrifuge. Hydraulic and semi-dry (pneumatic) conveying of filter mud has not found wide application: however, use of continuous horizontal scroll-type sedimenting centrifuges (for which operational parameters are given) for reagentless treatment of flume-wash and filter mud gives a dewatered mud of at least 50% dry solids content while a large part of the suspended matter is also removed to allow the water to be returned to the circuit.

### Recent trends in the use of ion exchange in the sugar industry

X. Lancrenon and D. Hervé. Sugar Tech. Rev., 1988, 14, 207 - 274.

The literature on ion exchange processes and their application in the sugar industry is reviewed, covering advances made in recent years with the type of resin and in the technology, automatic control of the process, and applications such as waste water treatment, beet juice deliming and demineralization and liquid sugar manufacture. Details are given of the Gryllus, N.R.S., Quentin and Applexion processes, and ion exclusion for e.g. molasses sugar recovery is also described. Aspects of refinery liquor decolorization and the use of ion exchange in sucrochemistry are also discussed.

# Sugar refining

Material balance of permanent and variable components from clarified juices to refined sugar. II. Balance of sucrose and nonsugars from analytical data

O. Janigova and D. Fernández. Cuba-Azúcar, 1986, (April/June), 47 - 55 (Spanish).

The relation between the sucrose:nonsugars ratio of components in sugar processing are discussed theoretically and values calculated for specific purities. Ash was used as the non-sugar in order to obtain balances, or colour where the process involved no colour loss or formation. The introduction of analytical error in high purity products brings about a greater deviation in ratio values.

### Carbonatation of Brazilian raw sugars: influencing factors and verification of efficiency by measurement of colour

I. V. Aoki and F. A. Tavares. STAB, 1986, 5, (1), 37 - 39 (Portuguese).

Using the colour of the carbonatated liquor at 420 nm by the ICUMSA Method 4 as a criterion, the optimum conditions for carbonatation of melt liquor from Brazilian raws was studied and found to be 0.9% CaO on solids, pH 8.0 - 8.5 and temperature of 80°C.

### Current status of statistical quality control (SQC) in sugar manufacturing. C & H perspective

R. L. Knecht. Paper presented at Conf. on Sugar Processing Research, 1988, 5 pp.

The question of statistical quality control in refining is discussed with particular reference to Crockett refinery.

### Flue gas for carbonatation

J. P. Lamusse. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 51 - 55.

Boiler flue gas is used for carbonatation INT. SUGAR JNL., 1989, VOL. 91, NO. 1087 at five refineries in southern Africa (in South Africa, Malawi, Swaziland and Zimbabwe). The gas, containing about 12% CO, by volume compared with about 30% in kiln gas), is scrubbed to remove sulphur compounds and to cool the gas to about 50°C; while one scrubbing with water is sufficient for gas from bagasse-fired boilers, a second scrubbing (with 5% sodium carbonate solution) is needed for gas from oil- or coal-fired boilers. About 140 m<sup>3</sup> of flue gas is required (at 50°C and 70 kPa) per tonne of melt solids. Descriptions and diagrams are given of the various types of scrubber used and compression of the scrubbed gas is discussed. Some advice is given on flue gas utilization.

## Mathematical model of an ion exchange column

J. P. Morley. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 56 -64.

A mathematical model of an ion exchange column was developed to predict the optimum conditions for colour removal from refinery liquor as a function of cycle time or number of cycles, resin bed height, feed liquor flow rate, initial liquor colour and operation in series or in parallel. The model was found to be an accurate description of the actual behaviour of a column, and results obtained with it and with a pilot plant showed that operation in series of a 2-stage unit with acrylic resin at a flow rate of 2.4 bed-volumes/hr in the 1st column and 1.9 bed-volumes/hr in the 2nd (the different rates being due to different bed heights) was optimum for decolorization. The results obtained with the pilot plant showed that acrylic/ styrene columns in series initially performed better than acrylic/acrylic columns, but the latter arrangement proved better with increase in the number of cycles: the styrene resin appeared to become irreversibly fouled more quickly than the acrylic resin and had to be regenerated with acid more frequently. The equilibrium batch test results agreed well with the Langmuir

adsorption isotherm, and the mechanism of colour removal with acrylic and styrene resin seems to be adsorption of a molecule on an adsorption site with negligible interaction between the adsorbed molecules.

### Modelling and optimization of enzymatic hydrolysis of dextran

O. V. Chopik. Sakhar. Svekla, 1988, (5), 63 - 64 (Russian).

The aim of tests on dextran removal from cane raw sugar solution using Novo DN50L dextranase was to find the minimum amount of enzyme that would be effective (in beet sugar manufacture hydrolysis to a molecular weight of  $7 \times 10^4$  is considered sufficient). The results are given in graph form showing dextranase consumption as a function of dextra M.W. and concentration, temperature and sucrose concentration, and are subjected to statistical analysis.

### Method of calculating the parameters of a plant for drying pressed refined sugar with convectionradiation energy supply

A. F. Zaborsin, A. R. Kazimirov and O. P. Sokolova. *Rpt. Vsesoyuz. Nauch.-Issled. Inst. Sakh. Prom.*, 1988, 29 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (20), Abs. 20 R378.

From experimental investigations of the kinetics of convection-radiation drying of pressed sugar and from a criterion established for optimization of energy parameters, the authors have found a way of determining the components of a materials and heat balance as well as the basic overall dimensions and technico-economic parameters of a unit having a daily throughput of 50 tonnes.

### A continuous vacuum pan - a report on its use at Colonial Sugars, Louisiana

E. O. Betancourt, J. L. de Chazal and J. D. McCulla. *Sugar y Azúcar*, 1988, **83**, (12), 18, 20, 20 - 23, 26.

See I.S.J., 1989, 91, 51A.

# Starch based sweeteners

### A new immobilized glucose isomerase with high productivity produced by a strain of *Streptomyces murinus*

O. B. Jørgensen, L. G. Karlsen, N. B. Nielsen, S. Pedersen and S. Rugh. Starch/Stärke, 1988, 40, 307 - 313.

The properties of a new immobilized glucose isomerase produced by a selected strain of *S. murinus* are described. Under optimum conditions of glucose isomerization to fructose, its productivity exceeds 10 tonnes of syrup dry solids per kg enzyme while by-product formation is minimal; a fall in pH of only 0.1 - 0.2 units demonstrates the small amount of organic acids formed by degradation.

### Investigation of glucose solubility in the presence of fructose

N. I. Odorod'ko, N. A. Arkhipovich and A. A. Ostrovskaya. Sbornik Pishch. Prom., 1987, 33, 54 - 55 (Russian).

Investigations of the effect on glucose solubility of fructose added to syrup at 5, 10, 15 and 17% by weight showed that it rose in the presence of 15% and 17% fructose with each temperature rise in the range 25 - 45°C, whereas in the presence of the two smaller amounts of fructose it fell initially with temperature rise to 30°C after which it rose. Viscosity rose in all cases, with a very gradual increase up to 40°C but an extremely sharp increase thereafter.

### Hydrolysis of concentrated starch solutions with immobilized glucoamylases

L. A. Ivanova, S. V. El'chits and S. P. Tsygankov. Sbornik Pishch. Prom., 1987, 33, 56 - 58 (Russian).

Glucoamylases immobilized on aminosilochrome using gossypol were used in continuous hydrolysis of a diluted 35% starch suspension at 55°C and pH 4.7 for up to 96 hours with enzyme doses of 4, 8 and 16 units/g starch; conversion rates up to 98.4% reducing matter were obtained as against a maximum of 99.3% using soluble forms of glucoamylase, this difference being possibly caused by diffusion effects in the direct vicinity of the support. After multi-cycle batch treatment for up to 48 hr at 55°C with 8 units/g, the glucoamylases were washed with water and the treatment repeated; after 50 days' operation, the hydrolysates of glucoamylases obtained from gluconigrine and glucoavamorine contained almost the same level of reducing matter as the initial hydrolysates, indicating high enzyme thermostability. The experimental data were in close agreement with theoretical values based on a relationship between the rate of passage of the starch and the reducing matter content in the hydrolysates. The economics are discussed.

### Prospects of industrial utilization of immobilized glucoamylase for starch hydrolysis

F. Toldrá. Rev. Agroquím. y Tecnol. Alim., 1988, 28, (1), 31 - 44; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs. 19 R452.

Questions are examined concerning the physico-chemical properties and characteristics of glucoamylase (GA) (a-1,4glucanglucanohydrolase EC 3.2.1.3). GA from various sources has optimum effect at pH 3.5 - 5.0 and 45 - 60°C and has a molecular weight in the range 50.000 - 110.000. Particular attention is paid to the use of GA in the industrial manufacture of glucose syrups from starch. The process schemes that are most widely used at present are described and aspects of GA immobilization on inert supports are examined, including electrostatic interaction between the enzyme and support, changes in the enzyme as a result of immobilization, the relative concentrations of the immobilized enzyme and its support, substrate flow rate, means of recycling unreacted substrate, etc. Various GA immobilization methods are discussed, including their advantages and disadvantages, and prospects of using immobilized GA on an industrial scale are examined.

## Hydrolytic depolymerization of starch raw materials

T. E. Abraham, C. Krishnaswamy and S. V. Ramakrishna. *Starch/Stärke*, 1988, 40, 387 - 392.

Enzyme-enzyme hydrolysis of a number of different starch raw materials gave a conversion rate to glucose of 97.5% in the case of rice flour which was almost as good as cassava flour used as standard. However, the liquefaction of rice flour needs to be more drastic than for the other materials (wheat flour, maize flour, maize starch and sorghum starch). Sorghum starch conversion was the poorest at only 84%. Acid-enzyme hydrolysis using HCl (mainly intended to reduce costs) gave at least 99% conversion of maize flour with the lowest concentration tested (0.05N HCl), followed by cassava flour and wheat flour; rice flour could not be liquefied with this concentration of acid, whereas it rose almost to the conversion rate of cassava flour when 0.2N HCl was used.

### Centrifugalling of glucose massecuites

V. S. Shterman, A. R. Sapronov, M. S. Zhigalov, N. N. Nesterova and I. R. Khanukhov. Pishch. Prom., 1988, (6), 24 - 26; through Ref. Zhurn. An SSSR (Khim.), 1988, (20), Abs. 20 R382.

An improved method of centrifugalling glucose massecuites has been developed based on concentration of a solution of low colour content, e.g. syrup from an evaporator that has been decolorized with activated carbon and cooled to 15 -20°C. The proposed method is based on a direct correlation between the amount of wash liquid and the quality of massecuite, i.e. its centrifugalling properties. A method for determining the centrifugalling coefficient is presented. It is shown how the quality parameters (glucose equivalent, colour and dry solids) of run-off varies during washing of glucose crystals by the new method. Modifying the washing conditions as a function of massecuite quality increases the crystal yield.

# Laboratory studies

## Conductivity ash vs. sulphated ash in plantation white sugar

Y. G. Yang, Y. J. Liang and W. X. Lin. Sugar J., 1988, 51, (2), 4 - 5.

Determination of conductivity ash by the ICUMSA method has gradually replaced gravimetric determination of sulphate ash in plantation white sugar in China, but differences have been found between the two values. Studies on a 28°Bx sugar solution yielded values of the equivalent conductivity (EC) and ash conversion factor (ACF) for a number of electrolytes; the inorganic constituents tended to have lower ACF values while the organic components tended to have higher values, so that any deviation between the calculated conductivity ash and true ash would depend on the balance between the organic and inorganic fractions as demonstrated by the differences between sequences of ACF and EC values given for electrolytes in descending order. However, linearity was established in the relationship between conductivity and sulphate ash contents of 38 random samples of cane and beet white sugar samples, and from this a regression equation derived which, when applied to conductivity ash calculations, gave values in close agreement with sulphated ash values. The need for individual factories to derive their own regression equations is underlined.

### A new method and apparatus for determination of fibre in cane

J. G. Loughran, P. C. Ivin, W. N. MacCarthy and T. L. Vidler. Proc. 10th Conf. Australian Soc. Sugar Cane Tech., 1988, 89 - 98.

In the method described, hot water is recirculated through a 500-g sample of prepared cane for 10 min at 10 litres/min to consolidate it into an active filter which traps insoluble matter. Hot water is then passed through the sample at 10 litres/min for 1 hr after which the water is effectively free of soluble solids, and the sample is then dried in an air stream at 105°C to constant weight (which takes about 75 min). The total analysis time of about 2.5 hr compares with the bag method time of about 18 hr while there is little difference between the values given by the two methods, although added soil recovery was better at 98% with the new method than with the bag method (96%). While the precision of both methods was about the same for clean cane, the new method was more precise on soiled cane, with a repeatability of 0.29% fibre compared with 0.37% for the bag technique and respective standard deviations of  $\pm 0.10$ and  $\pm 0.13$ .

## Microbiological investigations in the Polish sugar industry

M. Sebestyén-Murasiewicz. Cukoripar, 1988, 41, 98 - 103 (Hungarian).

The work of the microbiological laboratory at the Sugar Research Institute in Warsaw is outlined on the basis of a study tour conducted by members of the Hungarian sugar industry, and descriptions are given of some of the test procedures used to determine bacterial counts, including the reductase test with triphenyl tetrazolium chloride as indicator for diffusion and press water control and the Griess-Romija nitrate reduction test for raw juice and intermediate products1. Bacteriological work at Polish sugar factories is also mentioned, with positive results indicated of spraying beets with disinfectant and measurements of the nitrite content in sugar.

### Microbiological and physicochemical studies of cane raw sugar and affined sugar produced from it

G. Müller, E. Gutknecht and S. Stubel. Lebensmittelind., 1988, **35**, 169 - 171 (German).

Examination of the affined sugar obtained by laboratory centrifuging of a magma of cane raw sugar and saturated refined sugar solution showed that not only did the treatment raise the purity and lower the reducing matter and total acids contents so as to provide a quality approximating that of Class 2 white sugar, but it also reduced the numbers of aerobic, anaerobic and slime-forming bacteria, yeasts and moulds. The possibility is mentioned of establishing physico-chemical and microbiological standards for affined sugar, depending on the uses to which it is put.

# Polysaccharides in beet sugar juices: isolation and characterization

M. Vogel and H. Schiweck. Zuckerind., 12988, 113, 773 - 775 (German).

Details are given of a method for isolating polysaccharides from beet juices and molasses and values are presented of their concentration, composition, optical rotation and molecular weight distribution. Results demonstrated almost complete degradation of the pectin fraction in raw juice during purification; the other polysaccharides belong to the hemicellulose fraction in beet and possess high thermal stability and resistance to alkali.

### Modelling sucrose crystal growth

S. K. Heffels and E. J. de Jong. Zuckerind., 1988, 113, 781 - 786.

Experimental studies of the growth of individual sucrose crystals at 64° and 70°C showed scatter in the growth rates of crystals of the same size  $(>100 \,\mu\text{m})$ at 70°C under the effect of transfer rate, whereas under normal factory crystallization conditions both surface reaction and diffusion influence the growth of crystals >500 µm. Stirring increased the growth rate of larger crystals but also caused its dispersion. The surface reaction was not significantly affected by high supersaturation, while the growth rate remained constant at constant relative velocities between crystal and mother liquor. The Burton, Cabrera & Frank (BCF) model of crystal growth allows for rate dispersion and demonstrates the effect on the relationship between size or supersaturation and growth rate of crystal type, supersaturation and size.

1 Sebestyén-Murasiewicz: I.S.J., 1987, 89, 140A.

### Kinetics and technology of lowgrade massecuite exhaustion

V. Maurandi, G. Mantovani, G. Vaccari and A. Rossi. Zuckerind., 1988, 113, 791 - 794.

See I.S.J., 1987, 89, 106.

### The crystallization rate of sucrose

Z. Bubnik and P. Kadlec. Listy Cukr., 1988, 104, 174 - 182, 201 - 210 (Czech).

A laboratory crystallizer simulating a factory vacuum pan was used in a study of the kinetics of crystallization; the growth rate was determined as the ratio between the mean weight of a crystal and its linear dimensions. Boiling was conducted at reduced pressure under the following conditions: 70 - 85°C, supersaturation of 1.0-2 - 1.25 and 60 - 100 purity. Results showed that growth rate was a linear function of supersaturation and depended exponentially on temperature and non-sugars concentration. The thickness of the diffusion layer and the relative rate between crystal and mother liquor were determined; the results showed that the process was diffusioncontrolled.

### Analysis of herbicide residues in sugar beet and sugar

J. Tekel, P. Farkas, J. Kovacicova and A. Szokolay. *Nahrung*, 1988, **32**, (4), 357 - 363; through *Anal. Abs.*, 1988, **50**, Abs.10G33.

Finely chopped sugar beet (50 g) was extracted in a homogenizer with 200 ml of acetone for 5 min. The extract was filtered through cotton, and acetone was evaporated from 100 ml of the filtrate at 40°C; the remaining aqueous phase was extracted with chloroform  $(2 \times 60 \text{ ml})$ . Sugar (100 g) was dissolved in 400 ml of aqueous 10% KCl and the solution extracted with chloroform  $(2 \times 100 \text{ ml})$ . In each instance the organic layers were filtered through sodium sulphate and evaporated to 1 - 2 ml; they were then cleaned up on a column (1 cm i.d.) of 10:2 g aluminium oxide:sodium sulphate with 40 ml 9:1 chloroform:methanol as

eluent. The eluates were evaporated to dryness and each residue dissolved in 1 ml of acetone. A 10-ulitre aliquot was spotted on a Silufol plate for TLC with 3:1:1 benzene:ethyl acetate:acetone or 17:2:1 chloroform:ethyl acetate:acetone as mobile phase. Plates were dried, sprayed with 1:2 chloroplast homogenate:0.04% 2,6-dichlorophenolindophenol sodium solution in sodium tetraborate buffer (pH 8.6) and examined under 40W neon tubes; the lifetime of the dark blue inhibition zones was proportional to the amount of herbicide in the spot. The detection limits were: 1 µg/kg for lenacil, desmedipham and phenmedipham, 2 µg/kg for atrazine and 10 µg/kg for chloridazon. Recoveries of added herbicide were  $72.8 \pm 9.8\%$  of atrazine, 94.0 ± 15.3% of lenacil (each at 5  $\mu$ g/kg) and 88.0  $\pm$  9.9% of chloridazon (10 µg/kg).

### Innovations in sugar factory control

P. L. Devillers. Ind. Alim. Agric., 1988, 105, 619 - 623 (French).

The latest approaches to analytical control in the beet sugar factory are reviewed, including determination of the quality parameters of beet, intermediate products, raw and white sugar, molasses, pulp and waste water.

# Characterization of sugar factory products by near-infrared reflectance

E. Burzawa and M. Melle. Ind. Alim. Agric., 1988, 105, 629 - 634 (French).

The possible application of near-infrared spectroscopy to Brix and sugar determination is discussed. Tests using a Technicon Infranalyzer 450 initially calibrated with thick juice and molasses samples from 14 sugar factories gave standard deviations of  $\pm$  0.2 units for Brix and  $\pm$  0.3 units for sugar. However, less satisfactory agreement was obtained between the NIR values and those given by refractometry and polarimetry, indicating the need for greater precision in NIR instrument calibration. The

advantages of a routine NIR method of adequate precision include the possibility of using the one instrument for the two measurements, lack of need of sample preparation, greater rapidity and the possibility of automation and on-line measurement.

### The effect of alkalinity and reaction time on the Teles reagent

F. Teles, F. Francisco, A. Moreira A., E. L. Borges V. and A. Lopes M. *Experientiae*, 1987, **30**, (1), 1 - 11; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs.19 R428.

The effect of alkalinity and reaction time on the Teles reagent in the determination of sugars was investigated; the reagent, consisting of 1 g phenol, 2 g picric acid and 1 g Na bisulphite was used to determine 10, 20 and 30 g NaOH in the presence and absence of 10 g Na tetraborate. A new method of analysis has been developed on the basis of the results which indicated the negative effect of alkalizing the test medium.

### A new apparatus for measuring the Preparation Index

L. Bachan, G. R. E. Lionnet and V. Stone. Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc., 1988, 67-69.

A new unit designed by the SMRI to replace the tumbler-type apparatus for determination of the cane Preparation Index in terms of Brix recovery % Brix in cane is described. The cane-water mixture is stirred using electrically operated agitators in a stationary container instead of being tumbled, and the process is fully automatic (apart from weighing of the cane sample) through a microcomputer-based controller. Details are given of the procedure used. Evaluation tests at the SMRI and at two factories showed very good agreement between the results for both the two units, but the new apparatus tended to be more precise. Advantages and disadvantages of the new unit are listed.

# **By-products**

### The effect of adding an autolysate of feed yeasts on molasses wort fermentation by *Saccharomyces cerevisiae*

V. N. Shvets, S. R. Todosiichuk and E. G. Chasnyk. Sbornik Pishch. Prom., 1988, 34, 79 - 82 (Russian).

Addition of an autolysate of S. carlsbergensis Strain 11 to molasses wort at a concentration of 0.05 - 0.10% shortened the time of fermentation with S. cerevisiae V-30 and raised alcohol yield as a result of complete hydrolysis and fermentation of raffinose.

### Use of wastes from the Cuban fats industry as anti-foam agents in yeast and alcohol manufacture

O. Sanchez, R. Delgado, A. M. Kuts, V. F. Sukhodol and M. E. Rojas. Sbornik Pishch. Prom., 1988, 34, 85 - 87 (Russian).

Glanapon 806, an Austrian product, is used in Cuban yeast and alcohol plants to combat foam formed as a consequence of CO, generation during molasses fermentation processes but involves considerable hard currency expenditure. Earlier tests with ACJ oilbased anti-foam agent of Cuban origin had shown that it was much less effective than Glanapon 806; however, more recent experiments showed that the amount used could be raised to 1.6% by weight of molasses before it had any adverse effect on alcohol and biomass vield, while any increase in the dosage rate from a minimum of 0.12% caused a reduction in foam (although complete elimination required at least 4% ACJ).

## Commercial potential of bagasse as a cattle roughage

P. A. Inkerman, G. D. Tudor, N. J. Ashbolt, C. F. Brown, S. R. Lucas and M. Webster. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 69 - 79.

Evaluation of the keeping qualities of bales of treated alkali bagasse (TAB) and TAB containing molasses and urea

INT. SUGAR JNL., 1989, VOL. 91, NO. 1087

for use as roughage rations showed that they could be stored for up to 6 months without any significant effect on quality or acceptability by cattle, and storage of unsealed bales beyond this period should be possible because of their low moisture content. Although the bales were prepared at an initial moisture content of about 40%, the high residual pH ensured effective inhibition of microbial growth and production of deleterious metabolites. The long shelf life of the products greatly increases their potential as fodder during drought conditions. A diet containing 10% TAB plus 80% grain, molasses, urea and minerals was fed successfully to cattle in a commercial feedlot. The economics are discussed.

### The effect of molasses fractions on lysine growth and production by *Brevibacterium flavum* mutants

J. Plachy, J. Pelzbauer, V. Bulant and F. Paleckova. *Kvas. Prum.*, 1988, **34**, (3), 70 - 71; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1988, (18), Abs.18 R397.

Replacement of sugars with molasses as carbohydrate source has been found to inhibit the growth and reduce production of lysine using mutants of *B. flavum* CB. A molasses fraction containing an essential quantity of amino-acids has a maximum inhibiting effect on growth of the mutants as well as on lysine production; when a molasses fraction is used that contains practically all sugar, lysine production by the strains studied was 75 - 90% of the amount obtained using a sucrose substrate.

## Characterization and enzymic degradation of sugar beet fibres

X. Rouau, C. Bertin and J. F. Thibault. Food Hydrocolloids, 1987, 1, (5/6), 439 - 443; through Ref. Zhurn. AN SSSR (Khim.), 1988, (18), Abs.18 R504.

For a study of the properties of beet marc, dried pulp was used that had been crushed and sieved to yield fractions having particle sizes in the range  $250 - 500 \mu m$ . Results of treatment with an enzyme mixture (pectinase and hemi-

cellulase or cellulase) allowed determination of the effect of the pectin-rich structure on a number of its physicochemical properties.

### Characterization and oxidative cross-linking of sugar beet pectins after mild acid hydrolysis and arabanase and galactanase degradation

F. Guillon and J. F. Thibault. Food Hydrocolloids, 1987, 1, (5/6), 547 - 549; through Ref. Zhurn. AN SSSR (Khim.), 1988, (18), Abs.18 R505.

A study is reported of the properties and of oxidative cross-linkages in pectin from sugar beet after mild acid hydrolysis and treatment with arabanase and galactanase. The effect of pectin structure on its gelling properties was determined.

### Possible utilization of muds accumulated in effluent tanks at Lapy sugar factory

Z. Matyjasik and H. Pawlat. Gaz. Cukr., 1988, 96, 128 - 129 (Polish).

The chemical properties of mud that settles out of waste water in tanks at Lapy are indicated and possible land disposal of the material, including as a mixture with boiler ash, is discussed.

### Combined production of ethanol and white sugar

K. E. Austmeyer and H. Röver. Zuckerind., 1988, 113, 765 - 772 (German).

Three process models are described in which alcohol and white sugar are produced: (1) for Plattling sugar factory, based on a daily beet slice of 15,000 tonnes, a campaign length of 85 days and a maximum annual alcohol production from some of the thin and thick juice of 123,500 m<sup>3</sup>; (2) for Gross Munzel, in which a normal beet campaign is envisaged plus ethanol production from stored sugar solution supplied by other factories and/or from clarified predefecation juice (during the cam-

#### By-products

paign); and (3) for St. Michaelisdonn in which alcohol is produced from beet during the campaign and from wheat after the campaign. From examination of the energy balance involved in alcohol inanufacture and of the economics it is shown that combined sugar and alcohol roduction has cost advantages over alcohol production at a newly constructed distillery. Alcohol could be economically produced from beet throughout the year using stored thick juice as substrate. The costs of alcohol production are greater with wheat rather than beet as raw material, although with either material the total fossil fuel energy consumption is lower than the primary energy replaced by the products.

### The Swenson process for concentrating distillery and yeast plant vinasse

A. Pavlik. Ind. Alim. Agric., 1988, 105, 135 - 638 (French).

wo schemes for concentration of molasses vinasse are described: muluple-effect evaporation at 50 - 125°C (depending on concentration) with crystallization in the 1st and 2nd effects. and triple-effect evaporation at 100 -125°C with mechanical vapour compression, crystallization in the 1st and 2nd effects and the 3rd effect used as concentrator. In both processes, the final vinasse dry solids content exceeds 70% vhile almost all of the potassium in the i ntreated vinasse is recovered as sulphate crystals of sufficiently high purity to be sold to fertilizer manufacturers. The scheme with vapour compression uses less low-pressure steam ind cooling water but much more

lectricity than the other system, so that he choice of process will depend on electricity costs. Two installations based on the former scheme have been set up in France.

# Operation of plants for alcoholic fermentation of sugar products (molasses and syrups)

M. de Miniac. Ind. Alim. Agric., 1988, 105, 675 - 688 (French).

The fermentation processes used in France are outlined and their performances, advantages and disadvantages indicated. The key parameters and their optimization are then examined, followed by investigation of the origin and prevention of contamination by bacteria and yeast and various sources of chemical toxicity.

## Biodegradation of wastes in the alcohol and yeast industries

S. Gwardys, Z. Kokuszko, E. Kosiek and Z. Wlodarczyk. Przem. Ferm. i Owoc.-Warzyw., 1988, 32, (3), 7, 9; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs.19 R352.

Examination of molasses vinasse fermentation has shown that it can be carried out without pH stabilization, thus providing a substantial saving in sulphuric acid. The possibility of using vinasse as veed medium in thermophilic methanization is indicated; this process leads to a fall in COD and formation of a biogas (20 m<sup>3</sup>/m<sup>3</sup> vinasse) of high calorific value as well as 300 - 800 mg vitamin B<sub>1</sub>.

## Conditions for swelling dried beet pulp in pectin production

V. V. Nelina, V. M. Lysyanskii and L. V. Donchenko. Pishch. Prom., 1988, (5), 10 - 11; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs. 19 R461.

The kinetics of beet pulp swelling in the recovery of pectin were investigated and the quantity of pectin determined as well as its gelling properties in hydrolvsis-extraction of swollen pulp under laboratory conditions. It was found that the swelling process, which should be conducted at 50 - 90°C for 25 - 30 min, increases pectin production, raises its quality and reduces reagent consumption.

## A balance of products in pectin manufacture

N. S. Karpovich, O. S. Gaag, V. A. Khododova, L. V. Plaksa, I. A. Kra-

pivnitskaya and L. V. Donchenko. Pishch. Prom., 1988, (5), 21 - 22; through Ref. Zhurn. AN SSSR (Khim.), 1988, (19), Abs. 19 R458.

Balances are presented of products in pectin recovery from beet pulp containing 87 - 88% dry solids and 20 - 22% pectic substances: at the initial preparation stage, at the stage of alcoholic treatment of the pectin coagulate and at the hydrolysis, extraction and filtration stages. The data may be used for technological calculations of parameters for planned factories and plants manufacturing pectin. The quantity of products and consumption of chemical reagents are governed by the amount of initial material and the means used for hydrolysis and extraction.

### Application of nitrogen-fixing bacteria on the waste water treatment in a bagasse pulp factory

C. C. Liaw and Y. T. Chuang. Taiwan Sugar, 1988, 35, (4), 13 - 16.

A newly isolated Azotobacter sp., AP8a, was tested on BOD and COD reduction in effluent from Pingtung bagasse pulp plant; the aim was to save the cost of adding N compounds during aerobic treatment. The bacterium was added with activated sludge to one of four tanks (A), while the other three tanks received activated sludge plus urea. After 40 days' treatment the BOD in tank A was significantly lower than that in the other tanks at an average of 33 ppm compared with 47, 72 and 45 ppm, but there was no significant difference in the COD level between the tanks.

## Utilization of molasses for TSC beef cattle

M. D. Huang. Taiwan Sugar, 1988, 35, (4), 24 - 26.

The advantages and disadvantages of cane molasses as animal fodder are discussed on the basis of results obtained in experiments initiated in 1974 and on data in the literature.



(30.3%). This resulted from the practice of recycling more final molasses than is usual in order to reduce massecuite viscosity to compensate for inadequate reheating capacity.

Fig. 1. Schematic arrangement of test equipment Purging efficiency and screen capacity

Purging efficiency is an important indicator of centrifugal performance. (Refer to definition and formula in Appendix I). The influence of masse-



Table II. Massecuite composition					
		Range	Average		
	Sucrose, %	56.6 - 60.7	58.6		
	Dry substance, %	90.3 - 93.4	92.0		
	True purity	60.6 - 65.8	63.7		
	Temperature, °C	49.0 - 59.0	55.6		
	Crystal content, %	26.4 - 34.6	30.3		

cuite feed rate on purging efficiency is illustrated in Figure 2. In each case, there was a decrease in purging efficiency as throughput was raised, the regression equations being as follows: *Wedgewire backing* P.E. = 65.386 + 20.733 M - 3.695 M<sup>2</sup> (n = 9, r<sup>2</sup> = 0.923) *Woven mesh backing* P.E. = 89.949 + 3.482 M - 0.609 M<sup>2</sup> (n = 9, r<sup>2</sup> = 0.703) where: P.E. = Purging efficiency, and M = Massecuite feed rate (tonnes/hr) It may be seen that the correlations between purging efficiency and throughput obtained for both backing screen systems were quite good ( $r^2 =$ 0.923 and 0.703). At a massecuite feed rate of 3 tonnes/hr, the purging efficiencies achieved by the two test machines were very similar (approximately 94%). However, as the throughput was increased beyond this level, a more rapid decline in purging efficiency was experienced with No. 4 machine (wedgewire backing) than with No. 5 machine (woven mesh backing).

The capacity of the working and backing screens used in continuous centrifugals (i.e. the maximum massecuite throughput they can handle while still maintaining an acceptable purging efficiency) is obviously an aspect of considerable significance with regard to both overall performance and the economic viability of the screen system. The normally accepted capacity rating of a BMA K1000 fitted with chrome-nickel working screens, and a woven mesh backing screen, is 4 to 5 tonnes/hr of Cmassecuite.

It may be seen from Figure 2 that No. 5 centrifugal (woven mesh backing) was capable of achieving a purging efficiency of 90% at a massecuite throughput of almost 6 tonnes/hr. Under similar operating conditions and at the same purging efficiency, No. 4 centrifugal (wedgewire backing) was capable of handling a feed rate of only 4 tonnes/hr.

The limit on the capacity of this machine and its reduced purging efficiency at higher feed rates were presumably due to the greater resistance to molasses discharge presented by the wedgewire backing.

While the above observations do favour the woven mesh backing presently in use, the feed rate of 4 tonnes/hr at 90% purging efficiency achieved by No. 4 machine still represents quite an acceptable standard of performance. Furthermore, centrifugal capacity and purging efficiency should be considered in conjunction with screen life, and the minimization of molasses purity rise during purging. This is particularly

relevant where the overall centrifugal station capacity is not the limiting factor to factory crushing rate.

#### Molasses purity rise

During the centrifugalling process, the loss of sucrose in final molasses may become inflated owing to a number of factors. If the massecuite has a high fine grain content, or if the screens have become badly worn, a direct loss of crystal through the slots in the screen may occur. The excessive usage of steam or spray water also causes increased crystal dissolution, leading to higher sucrose losses across the screen. This obviously has a major influence on performance, and it has been estimated that, for a typical factory crushing say 400 tonnes/hr of cane, an increase of one unit in final molasses purity leads to a loss of approximately \$Aus 50,000 per season.

The method normally used to monitor sucrose losses due to the centrifugalling process is to measure the molasses true purity rise across the screen (Refer to the formula in Appendix I).

The influence of massecuite throughput on molasses purity rise is illustrated in Figure 3. For each machine the purity rise decreased as the feed rate was raised. This behaviour is well known from previous work<sup>1</sup>, and is due to the increased filtration effect which occurs as the thickness of the crystal layer on the screen builds up with increasing feed rate.

The regression equations for the two lines of best fit shown in Figure 3 are as follows:

Wedgewire backing screen  $P = 7.626 + 4.333 M - 17.017 \log_{2} M$  $(n = 9, r^2 = 0.728)$ Woven mesh backing screen  $P = 4.386 - 0.019 M - 1.298 \log_{2} M$  $(n = 9, r^2 = 0.738)$ where: P = Purity rise M = Massecuite feed rate (tonnes/hr)

Both correlations were reasonably good ( $r^2 = 0.728$  and 0.738), and it is clear that a lower purity rise (i.e. less sucrose lost in molasses) was obtained with the wedgewire backing screen. The benefit achieved ranged from about 0.5 unit of purity at a feed rate of 2.5 tonnes/ hr to 1.0 unit at a feed rate of 4.0 to 4.5



Fig. 3. Effect of throughput on molasses purity rise

INT. SUGAR JNL., 1989, VOL. 91, NO. 1087

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Fig. 4. Wedgewire backing in No. 4 centrifugal



Fig. 5. Comparison of working gauzes: (above) working screen in No. 4 centrifugal after 1300 hours with wedgewire backing; (below) working screen in No. 5 centrifugal after 400 hours with woven mesh backing

tonnes/hr. The only explanation which can be offered for this superior performance of the wedgewire backing screen is that the smoother, more complete support of the working screen avoids the point loadings and consequent slot widening experienced on woven mesh backing screens.

#### Screen life

The wedgewire backing screen installed in the BMA K1000 trial machine at Bingera (Figure 4) has shown no sign of corrosion or mechanical damage after more than 2000 hours of operation. It is expected that the working life of this screen would exceed that of woven mesh backing, because of its inherent strength.

Perhaps of even greater interest is the effect of the wedgewire backing on the damage which normally occurs to the chrome-nickel working screens used in low-grade centrifugals. The general condition of the two sets of screens installed in Nos. 4 and 5 machines (wedgewire and woven mesh backing, respectively) is illustrated in Figure 5. It may be seen that the screens fitted over the woven mesh backing suffered far greater deformation than did those installed over the wedgewire. This deformation would be expected to lead to cracking and increased corrosion of the working screens, with consequent loss of chromium, and slot widening, as described previously<sup>2</sup>. It is therefore expected that the improved support provided by the wedgewire will extend the useful working life of the screens and lead to lower screen replacement costs.

Furthermore, examination of the backing screens after the end of the season indicates that the wedgewire is less subject to blinding from deposits, such as syngenite, than is the woven backing.

The outer edge of each wedgewire seems to act as a slinger, thus avoiding any 'teapot' effect, except on the support bars. This phenomenon has

2 Greig et al.: Proc. Australian Soc. Sugar Cane Tech. Conf., 1984, 243 - 249. been described by Kirby & Greig3.

#### Conclusions

The results of this trial have been most encouraging. The machine fitted with the wedgewire backing screen was able to achieve a purging efficiency of 90% at a massecuite feed rate of 4 tonnes per hour. While this was only about 75% of the feed rate achieved in the machine with the woven mesh backing at the same purging efficiency, it is regarded as an acceptable standard of performance for a BMA K1000. Furthermore, changes to the wedgewire configuration, done in collaboration with the manufacturer, could reduce or eliminate this difference in capacity.

The molasses true purity rise achieved by the machine fitted with the wedgewire backing was 0.5 to 1.0 unit less than that obtained from the machine with the woven mesh backing. For an average Queensland sugar factory this represents an improvement in recovery worth some \$25, 000 to \$50, 000 per season, at current prices.

Working screen life was found to

### Conference on the sugar market

Landell Mills Commodities Studies Ltd. are organizing a conference on the sugar market during the next few years, to be held at the Barbican Centre in London during October 24-25, 1989, which is at a time when many concerned with the international trade in sugar will be present in London.

It will provide an opportunity for airing a number of topics, including the precarious balance between supply and demand in the world sugar market, the overwhelming influence of a relatively few key countries on world prices, the current GATT negotiations, recent changes in domestic sugar and sweetener policies, the influence of alternative sweeteners, and the increasing presence of funds in futures markets.

A two-day program has been put together, with presentations from decision makers in sugar and sweetener markets from the main regions of the be significantly longer for the machine with the wedgewire backing, and the authors would expect an approximate doubling of screen life. Screen blinding appeared to be reduced, and the "teapot" effect was minimal.

The experiments described in this paper refer to the use of wedgewire backing screens in the basket of a K1000 centrifugal. However, this type of backing screen could be applied in other types of basket.

### Acknowledgements

The authors acknowledge the valuable contribution of Mr. L. Kirby of BSES in arriving at the final design of the wedgewire screen; of Mr. G. Jensen of Bundaberg Sugar Co. for his assistance with the trials and the cooperation of the personnel of the Surescreen and Bundaberg Sugar Companies.

### **APPENDIX I**

Relationships used in evaluating centrifugal performance

The various formulae used in calculating massecuite rate, purging

world taking up one and a half days, and a visit to either a British Sugar factory or Tate & Lyle's London refinery.

The cost will be £195 and further

### ICUMSA 20th Session, 1990

The International Conference Center of the Broadmoor Hotel in Colorado Springs, Colorado, will be the venue for the 20th Session of ICUMSA, the International Commission for Uniform Methods of Sugar Analysis, to be held during June 3 - 8, 1990, under the auspices of the United States National Committee on Sugar Analysis. Alternate hotels will include the Antlers Hotel in downtown Colorado Springs and the Holiday Inn on the outskirts of town, from which bus services will be provided for delegates. Colorado Springs is about 60 miles south of Denver and is served by several major airlines.

efficiency, crystal content and molasses purity rise were as follows:

Purging efficiency is defined as the percentage ratio of the impurities leaving in molasses to impurities entering in massecuite.

Purging efficiency (%) =  $100(TP_{mag} - TP_{mc}) (100 - TP_{m})/(TP_{mag} - TP_{fm}) (100 - TP_{mc})$ Massecuite rate =  $DS_{fm}(TP_{mag} - TP_{fm})/DS_{mc} (TP_{mag} - TP_{mc}) \times Molasses rate$ 

Crystal content (% on massecuite) =  

$$DS_{mc} [(TP_m - TP_{nfm})/(100 - TP_{nfm})]$$

Molasses purity rise = TP<sub>fm</sub> - TP<sub>pfm</sub> where: TP = true purity DS = dry substance mc = massecuite mag = magma pfm = pressure filter molasses (mother liquor from the massecuite) fm = final molasses

3 Kirby & Greig: ibid., 1986, 179 - 183.

information, including the program details, are available from Landell Mills Commodities Studies Ltd., 14-16 George Street, Oxford OX1 2AF, England.

It is of interest to note that the 1990 Conference on Sugar Processing Research will be held in San Francisco on May 28-31 instead of its usual time in October so that people attending both conferences may coordinate their travel, while the annual meeting of Sugar Industry Technologists will be held in Vancouver on May 12 -15.

Registration and other information on the ICUMSA meeting may be obtained from Mrs. Mary An Godshall, US National Committee on Sugar Analysis, P.O. Box 19687, New Orleans, LA 70179, U.S.A. (Telephone +1-504-286-4329).

### **CITS Scientific Committee Meeting, 1989**

A meeting of the Scientific Committee of the Commission Internationale Technique de Sucrerie was held in Vienna during May 22 - 24 during which 33 members from 11 countries joined 11 of their Austrian colleagues for a useful exchange of information in the form of a series of oral presentations.

Participants gathered at the Hotel Modul on May 22 and were able to visit in the afternoon the laboratories of the Institut für Lebensmitttelindustrie of the Vienna Agricultural University. Professor H. Klaushofer, Director of the Institute, welcomed them and described the activities of the various sections concerned with alcohol and yeast fermentations, fodder manufacture, citric acid, fructose and fructose syrup production, etc. The visitors were able to inspect the laboratories of the Institute and also the pilot plants available for development of industrial processes. In the evening, guests were welcomed to Vienna at a reception given by Dr. G. Pollach of the Fuchsenbigl Research Institute.

On the following morning the meeting was opened by the President of the Commission, Prof. Giorgio Mantovani of Italy, and the series of 19 presentations began. By holding to a tight schedule, all were completed by the end of the day; English summaries of the presentations appear below. In the evening, Committee members were entertained to dinner at the Rudolfshof Restaurant in Baden by the Board of Directors of Sugana Zucker-Ges.m.b.H., the Austrian sugar company.

On the following morning they were taken by bus to Tulln where they were able to see both the factory, a 8000 tonnes/day facility which is being enlarged to 9000 tonnes by installation of a new quintuple-effect falling film evaporator (which will allow eventual expansion to 12,000 tonnes/day), a new beet reception station and enlarged sugar silo capacity. They also saw a new Bio-Research Institute which carries out work on analysis (leaning heavily on HPLC), fermentation processes for utilization of beet sugar by-products, development of new products, and pilot plant development.

Formal papers were not presented at the meeting; however, the following are summaries of the oral accounts of the work reported; the speaker's name is given in bold type:

Extraction of nitrogen compounds from beet cossettes (B. Wnuk, K. Lisik, K. Szwajcowska and H. Zaorska, of Lodz University)

During the process of extraction other substances besides sucrose pass into the raw juice. Among these are nitrogen compounds which exert a harmful effect on subsequent processing, and various chemicals added in order to improve extraction conditions. These substances can improve pulp pressing and thereby directly influence the heat economy in pulp drying. The aim of the work reported was to investigate the degree of extraction into raw juice of nitrogen compounds from cossettes. The study was made under model conditions and used a series of selected chemical substances. The process was carried out on a laboratory scale, with 1-kg quantities of cossettes extracted with model solutions containing various amounts of reagents: aluminium sulphate (between 21 and 86 ppm Al), calcium chloride (between 140 and 880 ppm Ca), and calcium hydroxide (between 357 and 1428 ppm Ca). Using the method of Kubadinow & Wieninger, a-amino nitrogen was determined in the cossettes and later in the raw juice and in the pulp. Total nitrogen was measured by the Kjeldahl method and the degree of extraction of nitrogen compounds from beet cossettes into the raw juice, as well as the residual compounds in the pulp, were calculated. It was found that the lowest amount of a-amino nitrogen and of total nitrogen passed into the raw juice when CaCl, was used; extraction amounted to about 55% under these conditions. Under similar conditions but in the presence of Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, nitrogen compound extraction rose to more than 60% and it reached nearly 80% when Ca(OH), was added. No visible effect

was observed of the dose of the chemicals on the degree of N extraction into the raw juice.

### Sucrose destruction during extraction (J. P. Lescure, of IRIS, France)

It is well known that sucrose destruction by hydrolysis or microbial infection during the extraction may be important; unfortunately, methods used to estimate the losses do not seem to be appropriate. The Lille Sugar Industry Research Institute has carried out experiments to try to correlate sugar destruction with glucose or organic acid formation. On the basis of biological pathways, a method of calculation has been developed and good agreement found between calculated losses and those measured by enzymatic determination; the correlation coefficient r<sup>2</sup> is 0.95. The most difficult task is to determine the contents of reducing sugars, malic acid and citric acid in cossettes which may provide the same metabolic products as with sucrose destruction. The method is rather laborious but it is in good accordance with losses by sucrose destruction during extraction. Calculated by the method, the loss in some French sugar factories is between 0.03% and 0.2%.

Beet productivity and industrial yield (G. Vaccari, G. Mantovani and G. Sgualdino, University of Ferrara, Italy)

Owing to the progressive decline in the technological value of beet observed in Italy during recent years, the authors, having considered the parameters currently utilized, consider it possible to achieve better results using more suitable methods. Under the peculiar climatic conditions existing in Italy, the pol content of beet does not provide a sufficiently reliable parameter if not related to the evaluation of beet dry matter. Moreover, evaluation of the cold extraction juice normally obtained using the Venema equipment cannot be directly related to that of sugar factory raw juice, its composition being different, particularly as far as α-amino

nitrogen is concerned. Consequently, yield formulae and evaluation of the juice theoretical purity does not always give a sufficiently correct picture of what will really occur. Preparation of a hot extraction juice for analysis, particularly as far as purity is concerned, would give more reliable data on which to evaluate the beet. The authors propose a scheme of operation which, by use of a near infra-red technique, can provide a rapid measure of beet pol and dry substance, and hot extraction juice from beet samples as normally analysed in tare laboratories.

### Some observations on shape and construction systems for sugar silos (F. Zama, of Sadam, Bologna, Italy)

Bearing in mind the fact that the ideal container which has a maximum volume for minimum outside surface is the sphere, a brief overview is made of the various likely shapes for sugar silos. Several nomograms have been devised for comparing height and diameter of cylindrical silos in relation to construction costs. It is of fundamental importance to study the ground on which the silo is to be based in order to make the correct choice of its type, shape and height. This technical aspect may be illustrated and translated into a nomogram in order to select the most economical solution, apart from constraints stemming from lack of space. As far as filling and emptying systems are concerned, those which do not require the installation of electrical components within the cell containing the sugar should be chosen for reasons of safety.

### Enzymatic synthesis of

oligosaccharides (J. Grosz and G. Pollach, Sugar Research Institute, Fuchsenbigl, Austria)

Work is reported on the synthesis of interesting new compounds from sucrose or other easily available carbohydrates with the aid of enzymes. Examples of such enzymatically derived products are palatinose, its hydrogenation product palatinit, leucrose and neosugar. It is known that enzymes which hydrolyse glycosidic bonds will synthesize oligosaccharides under certain reaction conditions, preferably at high solution concentrations. Reaction mechanisms have been studied and new oligosaccharides made by variation of the donor, acceptor and enzyme. The experimental approaches are monitored by analysis using thin-layer chromatography, HPLC and preparative column chromatography.

Modification of a thin juice demineralization process with a view to saving chemicals and a possible solution of the waste water problem (F. Perschak, Sugana, Hohenau, Austria)

A report is given of considerations and experiments which led to a modification of the demineralization of thin juice at the Hohenau sugar factory. Instead of demineralizing a delimed thin juice by means of two strongly acid cation exchangers in the H+ form, in series, followed by a weakly basic anion exchanger in the OH- form, the first of the cation exchangers is replaced by a weakly acid cation exchanger. It is thereby not necessary to delime the juice and the weakly acid cation exchanger can be regenerated using the total volume of waste sulphuric acid from the strongly acid cation exchanger after dilution to a concentration of 0.7%. In this way the total amount of sulphate from the demineralization unit is removed in the waste from the weakly acid cation exchanger. This allows on the one hand a saving of sulphuric acid and of sodium chloride, and on the other hand offers a possible solution to the waste water problem.

### Substances in British beet molasses which may be harmful to fermentation (J. V. Dutton, of British Sugar plc, Norwich, England)

Of some 100,000 tonnes of British Sugar's molasses which is sold, approximately two-thirds is bought by bakers' yeast manufacturers and approximately one-third goes to citric acid manufacturers. Occasionally these yeast or citric acid producers questions the quality of the beet molasses supplied because of problems which they experience either of low yield or, with yeast particularly, poor product quality. Research into such problems is frequently confused by issues such as the concomitant use of cane molasses or whether the fermentation process itself may be at fault. A literature search revealed a vast number of publications in this area. The substances which have been identified as causing problems ranged from volatile fatty acids, nitrite and sulphite, about which a good deal is known, to those of greater uncertainty, including crop pesticides, sugar process biocides and surfactants, with which the situation is less clear. British Sugar is approaching this question by more detailed analyses of molasses for suspect substances [volatile fatty acids, nitrite, sulphite, formaldehyde, thiocarbamates, crop pesticides, pan boiling aids, anti-foam oils, flocculants, antiscalants, coloured substances, heavy metals, a combination of high Mg and low sugar (as in Quentin molasses), and acid floc]. In the case of one yeast quality problem, British Sugar is also planning to seek help from at least one centre of excellence. Whilst this will help with one problem, there is evidently a need for collaboration. possibly through a new CITS sub-group, to cover not only yeast and citric acid fermentations, but other areas of fermentation in which beet molasses is now being used.

### Theoretical and practical limits of energy consumption reductionduring sugar production (P. Christodoulou, Hellenic Sugar Industry, Greece).

According to the late Prof. Anton Baloh, the lowest theoretical reversible work required for the separation of a 15% sugar solution into crystal sugar and water can be calculated from the exergy diagram for technical solutions<sup>1</sup> as follows:  $\Delta e = 23.24 - 16.12 = 7.12$  kJ/ kg. For 100 kg of beets with a sucrose content of 15% and a juice content of approximately 90 kg, we have:

1 Baloh: "Wärmeatlas", 1975, p. 45.

ADVERTISING FEATURE PAGE 3

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

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

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 $\Delta E = 90 \times 7.12 = 640 \text{ kJ}/100 \text{ kg beets.}$ The above is based on the assumption that the separation of sugar from water occurs at an ambient temperature of 20°C; this could be theoretically possible with reverse osmosis or membrane techniques but these are not so far introduced in beet sugar technology, and in practice we apply high-temperature evaporation for the separation of sugar from water. Using the exergy diagram and isotherm curve of 128°C (the maximum permissible temperature for a 15% sugar solution entering the first body of an evaporator station) we find an exergy of  $\Delta e' = 82.14 - 16.12 = 66.02 \text{ kJ/kg is}$ needed. This gives  $\Delta E' = 90 \times 66.02 =$ 5942 kJ/100 kg beets, or 9.3 times the value found for 20°C. The practical limit of energy consumption in a modern sugar factory, according to a model scheme, not including pulp drying, is 1.4 kg standard coal (29.33 MJ/kg lower calorific value) or 41,062 kJ per 100 kg beets. This gives an exergy coefficient of  $5942 \times 100 / 41.062 = 14.5\%$ . To this reasoning the following comments are added: The exergy diagram of Baloh is based on 94.3 purity; in fact, we begin with diffusion juice of 85 - 90 purity and juice purification - the elimination of non-sugars to achieve a purity as high as 94.3 - also needs exergy consumption. The extraction process itself also costs exergy. Maybe the 66.02 kJ/kg calculated previously should be doubled, when the exergy efficiency becomes approximately 30% or one of the best existing in a chemical process industry. Examining an ideal model scheme of low fuel consumption in sugar production with a steam consumption of 13.8% on beets, we see that 7.9 kg standard steam per 100 kg beets is given up to the preheating of thin juice from 85° to 125°C. The preheating of thin juice is part of the evaporation and not of the juice purification; the evaporation is not gratis. Half and more of steam entering the evaporator (13.8% on beets) is used for the thermal evaporation itself. If we could imagine a pure juice with no need for purification the whole of the energy necessary to bring the juice from

an ambient temperature of 20°C up to 125°C would be devoted to the thermal evaporation. The temperature difference of 105°C could be used in a turbine to produce more electricity as in a power plant where vacuum turbines are used. The validity of the generally expressed view that the evaporation station is only a converter and not a consumer of steam (energy) is questioned.

Calcination in a circulating fluidized bed (R. Kalwij and L. H. de Nie, Suiker Unie, Breda, Holland)

On the basis of existing literature a theoretical study has been made into the possible development of a circulating fluidized bed (CFB) as an alternative to the existing lime kiln. In addition, attention has been paid to the possibility of recalcination of lime sludge. The investigation has been concentrated on the calcination of particles with a radius of 10<sup>-5</sup> to 10<sup>-2</sup> m at a temperature between 700 and 1200 °C. During the design of the CFB a new model describing the reaction time of the lime particles has been developed. The residence time distribution within the CFB forms the guideline for the design. On a basis of the research the following conclusions can be drawn: (1) The calcination of limestone is possible at 950°C in a CFB; (2) The recalcination of lime sludge in the above-mentioned bed is also possible; (3) A mixture of limestone or lime sludge and coke with a diameter of 50 µm to 200 µm can be used as feed; (4) Energy consumption will be approximately 10% lower than in the present kiln; (5) The possibility has become apparent of describing a CFB as a parallel process of a plug flow reactor and a continuous stirred tank reactor followed by a plug flow reactor; (6) The calculated residence time distribution determines the size of the reactor; (7) A daily lime production of 300 tonnes of CaO requires a bed with a diameter of 2.7 m and a height of approximately 8 m.

Practical improvement in optimal control and data processing (G. Windal, of IRIS, France)

Presentations have already been given at the CITS on IRIS structured models for automation and optimization of the process (CHEOPS) and for its technical "surveillance" through laboratory and on-line measurements (CLEO-PATRA). Both families of systems are now implemented on personal computers and recent development has been made in different practical directions. On the control side, the last campaign gave new practical results in the management of crystallization plant, for instance, in the case of factories with thick juice storage, evaporator optimization through the RAMSES system received significant improvement. especially for the control of ejectors and for its balance with the condenser control. On the "surveillance" side, the CLEOPATRA system made a lot of slight steps forward, often coming from the advice of users. Very significant improvement took place with the connection of CLEOPATRA and the CHEOPS structure for optimization; the link is made between the micro-computers through the local area network (LAN) and needs a "data validity controller" implemented in a new module called "HORUS".

### Some comments on mass transfer in pure sucrose solutions (V. Maurandi, Eridania, Italy)

It is well known that the Sherwood, Reynolds and Schmidt numbers are linked by a relationship, often indicated as the Frössling equation. Diffusivity, viscosity, crystal linear size, slip velocity between crystals and solution, stagnant film thickness, solution density and transport coefficients are the parameters coming into play. But the Frössling equation contains also a factor (Ø) which may vary in laminar motion conditions from 0.3 to 0.9 and therefore gives the equation a character of indeterminacy. This factor was determined for potash alum dissolution by Mullin, who found a value of 0.37. According to the diffusivities of Kaganov & Tuzhilkin, Wagnerowski's viscosities and transport kinetic constants, we determined experimentally, for pure sucrose solutions between 15 and 25°C, at stirring rates of 10 and 100 rpm, a Ø value for crystallization between 0.33 and 0.47, averaging 0.39. These values, relevant to crystallization mass transfer, are comparable with 0.37, commonly related to dissolution mass transfer. From the Frössling equation, the order of magnitude for the stagnant film thickness may also be obtained. With macro-crystals rotating at 10 rpm in pure solutions having a supersaturation of 10 - 20% at 15 - 25°C, we calculated a thickness of about 440 um. This value is in a certain accordance with the values between 400 and 800 µm, face to face, obtained from the research carried out using holographic interferometry (by Bedarida, Mantovani, Vaccari, Aquilano et al.) in stationary conditions at 23°C and a supersaturation of about 12%. Finally, from an analysis of the frame formed by the above cited dimensionless numbers and their mutual correlations, it follows that generally the minimum motion to have a uniform crystal distribution, the related slip velocity and mass transfer coefficient increase when the crystal size increases.

### Unusual sucrose morphology (G. Vaccari, G. Mantovani and G. Sgualdino, University of Ferrara, Italy)

It is well known that sucrose crystals originating from sugar cane processing show an elongation along the c-axis. By carefully observing crystals from A-, B- and C- massecuites, we can realise that the high value of the c/b ratio is not the only morphological variation. In fact, we can observe that faces shown by the theoretical morphology and only rarely present in crystals grown from pure solutions can be found in crystals originating from sugar cane processing. In particular, the q' faces on the crystal right pole are very prominent, especially for crystals of C-massecuites, so promoting a rounded shape of the pole itself. On the other hand, faces always present in crystals grown from pure solutions, as for instance the o and p faces of the left pole, are not observed in crystals

originating from low-grade massecuites in sugar cane processing; therefore the crystal morphology presents a characteristic D shape. With the purpose of identifying which impurities can be responsible for such remarkable habit modifications, we have taken into consideration glucose and fructose which are present in relatively large quantities in the products originating from sugar cane processing. Bearing in mind that in low boiling massecuites the concentrations of both monosaccharides can reach 100 - 150 g per 100 g of water, sucrose mono crystals were grown in artificially prepared solutions containing these amounts of glucose and/or fructose. We observed that glucose blocks the growth of the p faces. causing the disappearance of the o and q faces on the left pole, whereas fructose slows down, in particular, growth of the o' and q' faces, so promoting their appearance on the right pole. In conclusion, glucose and fructose, if present in large quantities in the solutions where sucrose crystals are growing, promote their elongation along the c-axis, and most of all cause the appearance of the characteristic D shape which can be observed in cane sugar crystals.

### The influence of coloured substances on quality and crystallization kinetics of sugar (D. Schliephake, Braunschweig Technical University, Germany)

The aim of crystallization experiments in a stirred fluidized bed was to determine inclusion of coloured substances in the crystals which were grown under constant conditions. The impure solutions were obtained by adding sucrose to molasses and, in a second sequence of experiments, by adding isolated synthetic coloured substances to pure sucrose solutions. The experiments were carried out at constant supersaturation and at temperatures of 50° and 70°C. For the evaluations a method was selected which allows a quantitative description of the relationship between colour in the crystal and colour in the solution. The crystal growth rate measured in the stirred fluidized bed is to be compared with a mathematical formula obtained in earlier experiments for the fluidized bed without stirrer, and the ash content is to be taken into consideration.

### Effect of invert sugar on the colour of sugar beet juices (A. Dandar, P. Kusy and D. Janicek, Bratislava Technical University, Czechoslovakia)

The causes of a high degree of colour formation in juices from the 1st saturation through decantation of juices up to thick juice were studied in one sugar factory during the beet sugar campaign. The increase of colour was followed by the decrease of juice alkalinity. The influence on the colour of long residence of juice together with mud in decanters was investigated. From study of the colour development under laboratory conditions, the main cause was attributed to high invert sugar content and its insufficient degradation during liming and clarification. On investigating the main colour formation curve, confirmation was found of the correlation between the invert sugar content in the juice, its degradation by lime and the colour of the juice. It was unequivocally confirmed that there is a positive effect of air oxygen in oxidizing clarification and saturation upon reduction of juice colour formation and its effect on the colour developed by invert sugar. By clarifying and saturating the juice under oxygen, a thick juice was obtained with about 30% lower colour.

### Inclusion of colouring matter inside sucrose crystals in relation to spontaneous nucleation or seeding (G., Vaccari, G. Mantovani and G. Sgualdino, University of Ferrara, Italy)

In previous experiments the authors have pointed out the strict correlation existing between growth rate and inclusion of coloured mother liquor droplets which promotes crystal colour. They have now focused their attention on the initial stage of crystal formation by comparing seeding and spontaneous nuclei formation. As is well known, traditional seeding is carried out by injecting into supersaturated syrups sugar dust in general obtained by milling sugar in the presence of alcohol mixtures. Consequently the initial seeds are completely shapeless and more or less spherical, i.e. not showing the characteristic faces normally shown by sucrose crystals. During the change from these shapeless seeds to the morphologically complete crystals, the possibility of including mother liquor droplets is very high. Crystals obtained by seeding supersaturated thick juice show clearly that crystal seeds continue to include coloured mother liquor until they achieve the final habit; during the following growth crystals do not show phenomena of further inclusion of solution. Crystals nucleated in the same thick juice do not shown any inclusion in the initial growth stage. For the purpose of obtaining crystals which do not show, in their initial stage, coloured mother liquor inclusions, it would be advisable to adopt spontaneous nucleation or to use as seeds crystals previously grown in solutions of high purity.

### Studies for the calculation of the browning intensity during the evaporation of technical sucrose solutions (W. Mauch, Berlin Technical University, Germany)

During the planning or optimization of evaporating plants, chemical processes must also be considered in addition to the aspects of energy economy and chemical engineering. Whilst quantitative relations have been evolved both for sucrose hydrolysis and invert sugar decomposition, there are none that take into account the simultaneous influence of retention time, temperature, pH value, and contents of dry substance, invert sugar and amino-acids, on the intensity of the browning reactions. For this reason an attempt was made to develop a polynomial for the calculation of the extinction coefficients, in which, alongside the decomposition of invert sugar, the other factors are also borne in mind. The polynomial was calculated by means of an approximation computer

program which is based on the method of least squares. The form of the polynomial was specified with the values examined; a total of 504 samples, consisting of diverse combinations of influence factors, was investigated and a correlation coefficient of 0.992 determined.

### Colour formation in the evaporator station (G. Witte, of Südzucker, Germany)

Colour formation during evaporation is not only a problem of sugar losses; it also creates a higher steam consumption in the boiling house to achieve an acceptable quality of white sugar. Especially when SO, is not used for juice purification the increase of colour from thin juice to thick juice can be remarkably high. Therefore all changes in the evaporator station have to be done very carefully and always keeping the problem of colour formation in mind. In recent campaigns the formation of invert sugar and colour during evaporation has been studied in different Südzucker factories and the changes in the content of ammonia N in juices as well as in condensates were also investigated. Regarding colour formation, the trials give no reason against the installation of falling-film evaporators with 5000 m<sup>2</sup> heating surface working as preevaporators, fed with thin juice but working on the steam side as 5th effect.

### Decolorization and degradation products of technical sugar juices following a hydrogen peroxide treatment (C. A. Accorsi, University of Ferrara, Italy)

The effect of hydrogen peroxide addition to technical sugar juices of different purities and with varying dry substance content was studied by altering the amounts of hydrogen peroxide added as well as the reaction time and temperature. The following variables were determined for both treated and untreated juices: pH, colour (ICUMSA), glucose and fructose contents, and the presence of volatile and non-volatile organic acids. Determinations were performed either enzymatically or by HPLC. Decolorization seems to depend on the amount of H<sub>2</sub>O<sub>2</sub> added, increasing with the latter. At the same time, the pH decreases for all solutions, no matter at what temperature. Within the 50 - 80°C temperature range an increase in temperature led to a poorer decolorization effect along with a decrease in the purity of the solutions. Heating time plays an important role; H<sub>2</sub>O<sub>2</sub>- treated solutions when heated at 70°C and 80°C showed a rapid decolorization followed by an almost quantitative reversal of the decolorization effect. Chemically untreated solutions, on the other hand, but which received an identical thermal treatment, darkened in a relative equivalent way. These browning effects, however, were not detected when solutions of higher purity were heated at 70°C for 90 minutes, probably because of their lower content of nitrogenous substances. These are in fact known to react with sugar degradation products to form brown (Maillard) byproducts. An increase in the amount of formic and acetic acids, formed respectively by the breakdown of carbohydrates and the decay of melanoidins, are partially responsible for the decrease in pH which is more marked in the case of low purity solutions. Glucose and fructose concentrations increase in all cases.

### Immobilized tyrosinase from beets and application for model reactions on melanin formation (K. Buchholz, Braunschweig Technical University, Germany)

Recovery and concentration of enzymes for application can be performed, with very few unit operations, utilizing bentonite as an adsorbent, even from very low concentrations, e.g. when plant tissue is used as raw material. The enzymes can be easily utilized in immobilized form as a complex with bentonite. By further simple operations, spherical biocatalysts or test strips can be obtained for application in reactors or in test systems. Model experiments concerning tyrosine and dopa oxidation were performed using the tyrosinasebentonite complex with different

continued on next page

# Facts and figures

### **British Society of Sugar Cane** Technologists

The Annual General Meeting of the B.S.S.C.T. was held in London on April 12, 1989, and was followed by a Technical Meeting in the afternoon during which four papers were presented. These included "A personal view of product stewardship" by S. S. Lim of Rhône-Poulenc Agriculture<sup>1</sup>, "Developments in continuous pan boiling" by J. M. Goddard of Fletcher Smith Ltd., "Disease risks in rain-fed cane" by Dr. G. L. James of Booker-Tate Ltd., and "A view of the sugar market" by C. J. Pack of C. Czarnikow Ltd.

The Mike Bennett Award for the best paper of 1988 was made to Charles Batchelor of the Institute of Hydrology for his presentation on the MSIRI-IH drip irrigation research project in Mauritius.

### WSRF symposium on the role of sugar in nourishment

An international symposium, "Recent advances in the role of sugar in modern diet", promoted by the World Sugar Research Organization, will take place at the Maksoud Plaza Hotel in São Paulo during October 11-12 (immediately before the ISSCT Congress). Experts from Canada, France, Germany, Greece and the US, as well as from Brazil, will discuss recent research on the consequences of lack and excess of calories in nutrition, as well as the part that carbohydrates may play in the diet of diabetics. Further information may be obtained from AAB Ogilvy & Mather Relações Públicas Ltda., Rua Hungria 888 - 2º andar, São Paulo, SP, Brazil 01455 (Telephone: +55-11-815-8200).

### continued from previous page

reaction parameters. Limited oxygen availability and shift to alkaline conditions following the enzymatic reaction resulted in soluble browning products (melanins). Such reactions are discussed with respect to unusual browning of sugar juices under specific conditions.

Malawi	sugar	exports,	1988 <sup>2</sup>
--------	-------	----------	-------------------

1988	1987
tonnes, ra	w value
14,146	845
0	12,215
20,674	42,456
2,502	17,006
2,153	310
0	8,485
17,776	26,083
30,513	8,731
87,764	116,131
	1988 tonnes, ra 14,146 0 20,674 2,502 2,153 0 17,776 <u>30,513</u> 87,764

#### Irish sugar factory closure possibility<sup>3</sup>

The Irish Sugar Company, a semi-state monopoly, announced plans to close the second of the country's sugar factories at Thurles, with the loss of some 200 jobs. (The Tuam plant was closed some years ago.) Closure will not affect total sugar output as the Carlow and Mallow factories have been recently modernized and can easily accommodate the extra beet. However, strong opposition has come from many sources, including the labour unions, farmers organizations, the local clergy and politicians and even the Minister of Agriculture in whose constituency the factory is located; he had pledged at the last general election that the factory would stay open.

Australia sugar exports, 19884				
	1988	1987		
	tonnes, raw value			
Canada	495,405	442,499		
China	485,685	484,005		
Japan	723,964	692,699		
Korea, South	461,795	322,433		
Malaysia	554,715	419,247		
New Zealand	63,861	81,762		
Singapore	109,276	108,710		
USA	74,673	69,636		
USSR	0	193,141		
Other countries	10,659	12,720		
Total	2,9809,033	2,826,852		

### Cyclone damage in Australia<sup>5</sup>

A cyclone which hit North Queensland has damaged sugar cane which was flattened by the strong winds. However the flattened cane can still be harvested

although at higher cost, with less sugar and greater risk of attack by pests. Early estimates said that about 10% of the Burdekin region's sugar cane crop, or some 450,000 tonnes, was destroyed; however, the full extent of the damage will not be known until the cane is harvested and experience shows that damage is usually less than expected immediately after the event.

#### Flood damage to cane in Pakistan<sup>6</sup>

The prospects of the cane crop at the start of the 1988/89 season were considered good, favourable climatic conditions having prevailed during cane planting and the early growing period. However, floods in the Punjab appear to have affected the crop very adversely and the early sugar production estimate for that province has been reduced by 200,000 tonnes, bringing the total estimate for the country to 1.9 million tonnes.

### Swedish sugar industry con-traction

Sockerbolaget AB, the only beet sugar producer in Sweden, has opened negotiations with the unions to close some of its seven sugar factories because of excess production capacity7. According to the Managing Director, negotiations have only just begun and it will take some time before the company can decide which factories will be shut. Sweden's sugar production usually ranges between 350,000 and 400,000 tonnes, raw value; however, production in 1987/88 was substantially down, owing to unfavourable weather conditions, which necessitated net imports of some 95,000 tonnes. Production in 1988/ 89 was 365,295 tonnes8 and in the current crop year is estimated at 395,000 tonnes, which will slightly exceed the country's requirements.

- 4 I.S.O. Stat. Bull., 1989, 48, (4), 2.
- 5 F. O. Licht, Int. Sugar Rpt., 1989, 121, 185.
- 6 Pakistan Sugar J., 1989, 3, (1), 3
- 7 F. O. Licht, Int. Sugar Rpt., 1989, 121, 169 170. 8 I.S.J., 1989, 91, 99.

See Sugar Cane, 1989, (3), 2-3.
 I.S.O. Stat. Bull., 1989, 48, (2), 24 - 25.
 F. O. Licht, Int. Sugar Rpt., 1989, 121, 182.

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### Index to Advertisers

Alpha Boilers Inc	x					
Automation Products Inc	viii					
Bosco Industrie Meccaniche S.p.A xviii						
Braunschweigische Maschinen-						
bauanstalt AG	Cover II					
Thomas Broadbent & Sons Ltd	vii					
CSR Limited	xix					
Ferguson Perforating & Wire Co	xiii					
Fontaine & Co. GmbH	Cover IV					
Hein, Lehmann AG	iv					
Manville (GB) Ltd	Cover III					
Optical Activity Ltd	iv					
John H. Payne Inc	viii					
Perry Equipment Co. Inc	xiii					
Pieralisi Nuova MAIP S.p.A	xiv					
Silver Engineering Works Inc	ix					
Sugar Manufacturers Supply Co. Ltd	d. v, vi, xv, xvi					
Universal Process Equipment Inc.	xvii					
Wabash Power Equipment Co	xix					
Nils Weibull AB	xx					
Western States Machine Co	ill					
Wiedemann KG	xi					

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