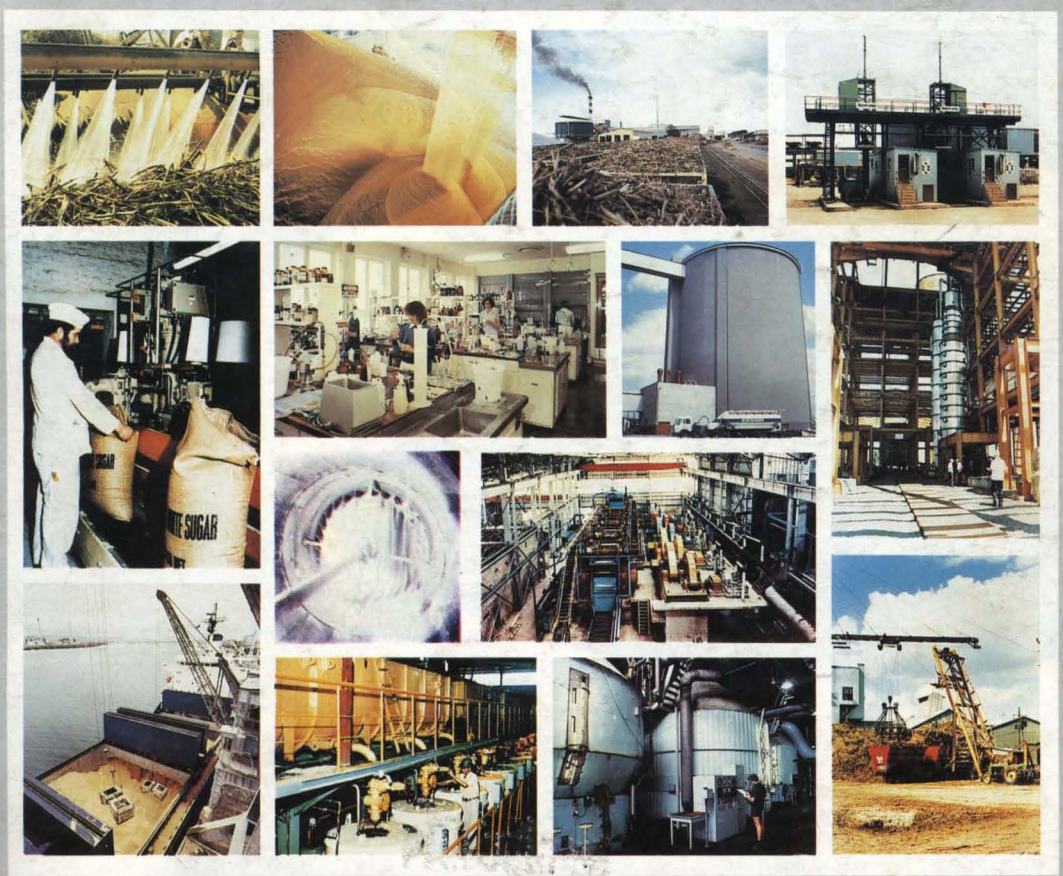
INTERNATIONAL SUGAR JOURNAL



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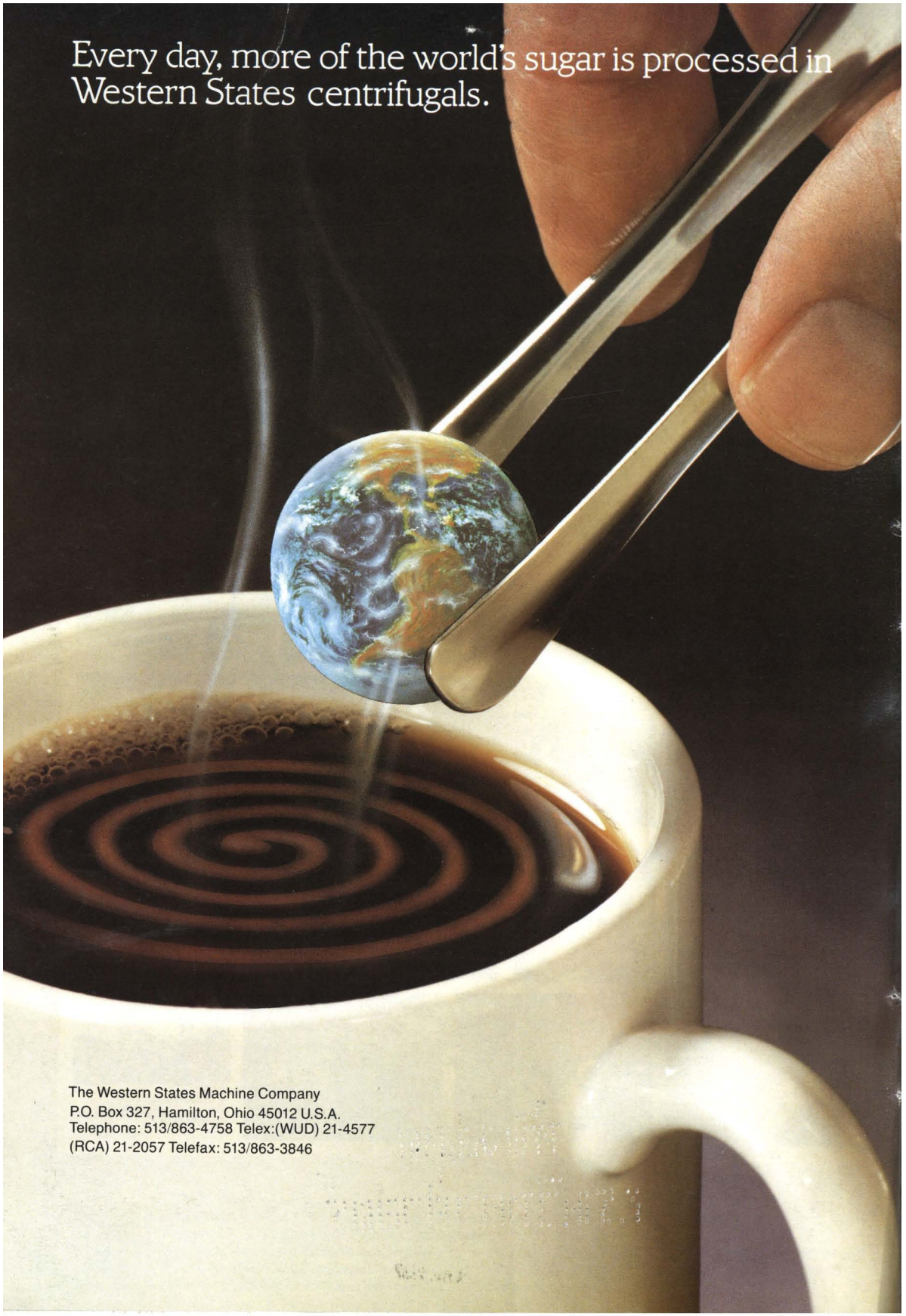
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News and views

International agreement on agricultural reform[1]

The world's leading farm producers on April 7 agreed an outline deal on agricultural reform which could unblock the stalled Uruguay Round on multilateral trade talks. The deal was agreed between representatives of the US, the European Community and the 13-nation Cairns group of farming countries.

Under the deal, governments' farm policies will be made more responsive to international market signals. Their stated intention is to do away with the curbs and distortions in farm trade which currently cost taxpayers in the US and EEC some $25,000 million a year in support for agriculture and to bring the trade under the discipline of the General Agreement on Tariffs and Trade. A freeze will be imposed on current levels of support until completion of the talks in December 1990. Governments even envisage a cut in support and protection levels in 1990, although no specific level of reduction is mentioned.

Under the agreement the long-term objective will be to achieve "substantial progressive reductions in agricultural support and protection" within a time limit to be agreed during the talks but not later than the end of 1990. Commitments will cover "all measures affecting directly and indirectly import access and export competition". Governments are asked to submit by next December detailed proposals of how they expect to achieve the long-term objective. A surveillance system has to be put in place to ensure that governments comply with their commitments.

The EEC and US had argued that it was technically difficult to apply the immediate freeze on support for which the Cairns group was pressing. A compromise formula commits countries 'within the scope of their existing legislations and their existing GATT rights and obligations" to ensure that their current support and protection levels "are not exceeded" before the completion of the negotiations in December 1989. For sugar this means that the arrangement does not require changes in the US sugar import quota through 1990 or bar a cut in this quota. Diplomatic sources in Geneva said that the freeze "within the scope of existing legislation" would allow the US Administration to continue the import quota system in 1989 and 1990, and cut quotas if the law required such a cut. This is bad news for sugar exporters as with no change in the US sugar policy net imports must be expected to fall.

Under the deal it was also agreed not to strengthen present barriers against imports of farm produce nor to extend them to additional products over the next 20 months. This means the agreement stipulates that market access for individual products in 1989 and 1990 should not be lower than the average for 1987 and 1988 which, however, apparently does not apply to US sugar imports. The US refusal to submit its land set-aside program to the freeze has been overcome by simply leaving out supply control measures.

European farmers' concern about the effect of currency fluctuations, in particular a depreciation of the US dollar, on their ability to export has been partially met by stipulating that the support prices can be expressed in national currencies – in the case of the EEC, in e.c.u.. The fears of the countries concerned with national food security such as Japan and Switzerland, both with heavily subsidized farmers, were partly eased by accepting that the proposals to address "non-trade concerns" could be taken into account in the negotiations.

China sugar expansion[2]

Measures have already been taken to reverse the flow of labour and resources away from arable farming in China and although domestic production this season has been disappointing in the cane sector, national output is still a modest improvement over the previous crop and represents a step towards recovery.

It is planned to achieve a substantial expansion next year to 6.5 million tonnes of white sugar from an area of some 1.63 million hectares, whereas the current crop is unlikely to exceed 4.8 million tonnes from beet and cane. Consumption is officially acknowledged to have exceeded 7.0 million tonnes last year after rising by around 0.5 million tonnes per year since 1982. The authorities expect that demand will continue to rise so that, even if the projected large gains in production can be attained, sizeable imports will still be needed. One of the important growth areas for sugar in China is by industrial users and for the present there is every indication that this trend will continue.

Quite apart from issues of overall policy for the Chinese economy it must be remembered that the weather and local conditions have a major bearing on what can be achieved. Much of the regeneration of sugar production is taking place in new locations where farmland will take several years before it attains the yields reached in areas which have since switched to other cash crops demanded by local centres of population. Last year the weather was particularly damaging in the cane sector. As an example there were severe earthquakes in Yunnan Province last November when widespread damage to infrastructure included 18 sugar factories. These are now reported to have been repaired and are back in operation.

Brazil sugar export contracts cancellation[3]

The Brazilian Sugar and Alcohol Institute has suspended contracts for export of a total of 300,000 tonnes of sugar to Bulgaria, Czechoslovakia and Portugal. The Institute is reported to have said the action was because world prices had risen since signing the contracts late in February, and there had been much local criticism of the deal. The president of the Institute has been dismissed following controversy over alleged "irregularities" in the deal[4].

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 179 - 180.
2 *Czarnikow Sugar Review*, 1989, (1783), 35.
3 *Financial Times*, March 2, 1989.
4 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 153.

Product news

New non-contacting level system

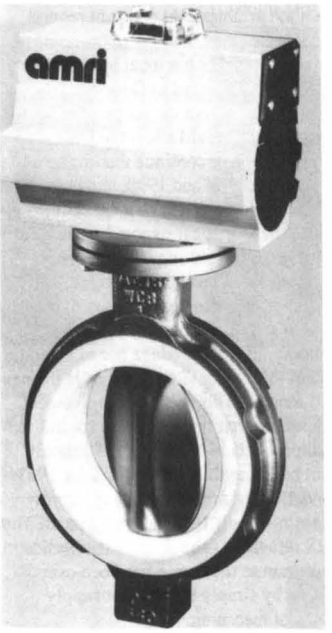
Kay Ray have introduced the Model 4160 non-contacting level measurement system. It features a sensor that emits neutron energy to measure process level or material interface (gas/foam or liquid/solid) through several inches of steel, without contacting the process. Also featured is the Model GLT indicating transmitter, the first truly field-mountable, two-compartment neutron level transmitter suitable for installation in a hazardous environment. Rugged explosion-proof construction of both sensor and transmitter has made the system ideal for process industries where high reliability is important and instrument downtime must be virtually eliminated. The electronics are never exposed to the environment during installation or calibration. Two push-buttons mounted on the transmitter allow data entry similar to setting a digital watch. No special training is required to calibrate the system, which provides a linear output related to level or interface changes.

Further details:

Acal Auriema Ltd.,
442 Bath Road,
Slough,
Berks. SL1 6BB,
England.

Amri valves

The Amri range includes lined butterfly, high performance butterfly, multi-port butterfly and wafer style check valves, together with a comprehensive selection of actuators. Elastomer lined shut-off and regulating valves in the size range 32 to 3200 mm (like that illustrated) utilize unique disc and seat geometry to ensure complete and permanent tightness at pressures up to 20 bar and temperatures from –32° to +220°C. For applications where corrosion and/or temperature parameters bar the use of elastomers, Teflon PFA lines valves in sizes from 32 to 600 mm are available. They are produced in a wide choice of materials in wafer, flanged, double



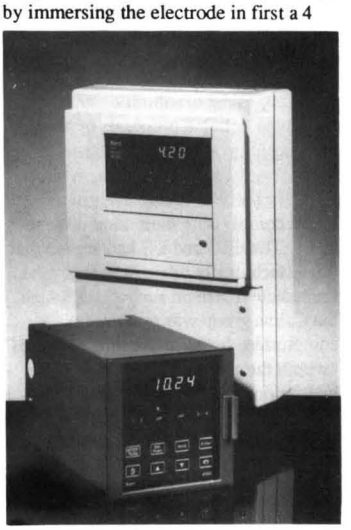
flanged and lugged configurations. For severe service conditions such as high pressure or high temperature requirements, high performance valves with either metal-to-metal or metal-to-plastomer seats and a double offset disc design provide tight shut-off both upstream and downstream. Wafer and lugged styles in sizes from 80 to 1200 mm and flanged models in sizes 80 to 2000 mm cover pressures from full vacuum to 5 bar and temperatures from –250° to +600°C. Wafer style twin plate check valves in accordance with API 6D, API 598 and API 594 are available in sizes from 50 to 1650 mm, rated 125 to 2500 ANSI and 2000 to 10,000 API. The wide choice of body, plate and seal/seat materials suit virtually all applications in the temperature range –250° to +650°C. Other Amri specialities include 3 or 4-way valves as well as double block and bleed systems ensuring complete segregation irrespective of differential pressures. A comprehensive range of actuators including manual, electric, pneumatic and hydraulic types, in addition to complete remote control automation systems, complement the extensive valve program.

Further details:

Amri,
40 rue Jean-Jaurès,
93176 Bagnolet Cedex,
France.

New microprocessor pH transmitters

Kent Industrial Measurements Ltd. have launched two pH transmitters in similar wall (Model 4535) and panel (Model 4545) mounting cases. A single $4^1/_2$ digit blue filtered vacuum fluorescent display is used for indicating the measured value, programming parameters, and user information during setting up and on demand. The latter information includes the alarm settings, measured temperature, electrode check value, etc. Ranges are programmable anywhere from –2.00 to +16.00 pH, 0 to ±1000 mV and –10 to +110°C, enabling the instrument to be set to meet the precise application needs. A four-digit user-selectable security code must be entered first to avoid inadvertent or unauthorized adjustment. Calibration can be accomplished in two ways. Simple automatic calibration is achieved by immersing the electrode in first a 4



pH and then a 9 pH buffer. The alternative manual method for other buffer solutions involves entering the buffer values, using the up/down buttons, and pressing the ENTER button. The electrode condition can subsequently be monitored by observing the check value and slope on the display. The instruments can be used as straightforward monitors; the output can be connected to a Kent recorder to provide a permanent record; output signals can be retransmitted to a central control room; information can be communicated bi-directionally via serial data interface; simple on/off control can be used; or a full control can be used; or a full control look can be configured by use of a microprocessor based PID controller such as Kent's P96M. The instruments have been designed to work with any of Kent's wide range of electrode systems to provide continuous process monitoring and control.

Further details:

Kent Industrial Measurements Ltd.,
Howard Road,
Eaton Socon, Huntingdon,
Cambridgeshire PE19 3EU,
England.

New steam generation system

A range of new small-scale steam generation systems has been launched by Warwick-based Cubit Limited. Modular in design, they can be operated in series or individually, offering the benefit of power close to the process facility. The systems offer four precise steam conditions, from wet, dry saturated, and dry through to superheat. The units are fully self-contained, with their own in-built water treatment, and can be installed with virtually no disruption. All Cubit steam systems can run on oil, gas or LPG and provide constant steam from 250 lb/hr to 5000 lb/hr, according to a user's needs. Steam with a dryness fraction of 0.95 can be generated at 275 lb/hr. With a fraction of 0.5 the rate increases to 450 lb/hr and steam at 0.1 dryness is delivered at 1300 lb/hr. Overall energy usage is 315,000 BTU/hr with a thermal efficiency of 82.5%. The steam is unique; its injection system offers unprecedented accuracy of steam condition, while an integral accumulator ensures complete differential controls for peak demands delivering steam at the right pressure – instantly with no waste. And inherently Cubit systems cost less to run and maintain than other competing systems. It is planned to introduce computer linked systems, further extending their technological lead.

Further details:

Cubit Ltd.,
Harriott Drive,
Heathcote Industrial Estate,
Warwick CV34 6TJ,
England.

Vortex pumps

Victor Pyrate Ltd., the manufacturers of the extremely reliable VP Balco pumps, have published new literature illustrating the quite outstanding capabilities of their range of vortex pumps. Some of the impressive features of the pumps are that they will not clog or stall and require only a minimum of maintenance. There are no wearing rings or other close running fits to affect performance when erosion occurs. Unlike most other pump types the VP Balco vortex pumps are specifically designed to retain constant performance characteristics throughout a range of erosion. The publication illustrates the pumps with various drive configurations.

Copies are available from:

Victor Pyrate Ltd.,
Arisdale Avenue,
South Ockendon,
Essex RM15 5DP,
England.

Glucose refinery automation

Cerestar UK have chosen Foxboro Intelligent Automation series systems for the integrated control of their new glucose refinery – part of a £42m extensive modernization and expansion program at their Manchester plant. The initial Foxboro contract, valued at over £1.25m, is for a distributed control system to provide refinery wide communications between operating staff and the process and will give universal access to the process plant from any local operator station. The modernization contract includes the replacement of all instrumentation in the wet mill and a new system for the combined heat and power plant to serve the entire complex. The application software will be developed to meet the Cerestar requirements.

Further details:

Foxboro Great Britain Ltd.,
Redhill,
Surrey RH1 2HL,
England.

New water treatment contractor

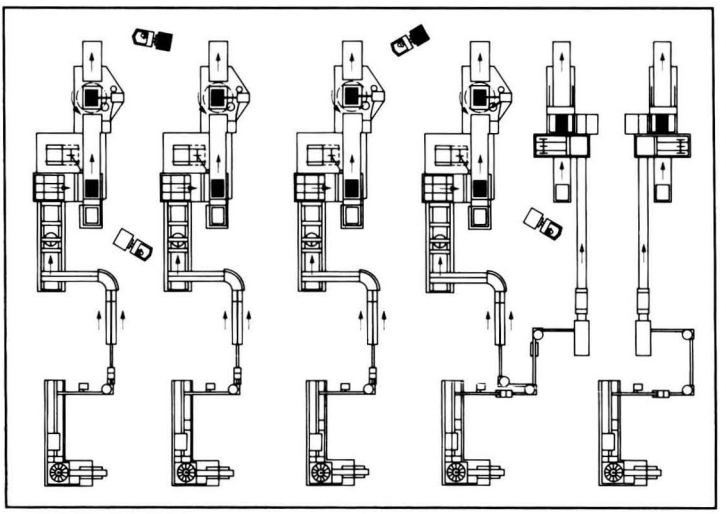
Portals Water Treatment Ltd. has formed a new, UK-based design-and-contracting company – PWT Projects Ltd. – to meet the needs of both the municipal and industrial water treatment sectors, worldwide, through the 1990's. It results from merging Permutit-Boby Projects and Paterson Candy International Limited – both companies having over 100 years international experience in major water and waste water treatment projects. The new company will provide a complete water and waste water engineering and contracting service from feasibility studies, finance packages, plant design and process engineering, through to construction, operation and maintenance.

Further details:

PWT Projects Ltd.,
Permutit House,
632/652 London Road,
Isleworth,
Middlesex TW7 4EZ,
England.

New sugar packaging lines for Tate & Lyle

Tate & Lyle have placed an order with SIG Swiss Industrial Company for six packaging lines, five for their refinery in London and one in Scotland. The requirements were: packaging of



granulated and caster sugar in 1 kg bags either palletized as individual bags or collated and loaded as bundles on pallets and secured by a wrap of stretch film. The results of this packaging system include the highest degree of automation for packaging sugar, more output from fewer machines, and considerable reductions in personnel and packaging material costs. The SIG mandrel turret packaging machine, type PRD, handles printed paper from reel with an outer diameter of up to 1 metre. A 12 mandrel forming wheel produces glue-sealed 1 kg sized bags which are conveyed open-topped by a conveyor chain under a triple volumetric tipping filler for bulk filling. The topping-up to the precise final weight is made by an electronically controlled auger which receives signals from a checkweigher. Before the bags are closed, they pass over a second checkweigher; thereafter under- or over-weight packets are ejected. The upright standing bags of sugar pass through a metal detector and are then conveyed directly or via a Doboy shrink wrapper to the palletizer. Data are received, recorded, evaluated and converted into optimum control signals by the PLC unit of the SIG packaging installation. If required every line can be equipped with its own operator guidance system and the complete installation with a overriding management support system. The calculator for both systems supplies extensive information on a colour monitor and printer, such as; state of silo fill, paper and glue supply, condition of machines and installation with instructions to rectify any problems, or customer specific data, trend reports, etc.

Further details:

SIG Swiss Industrial Company,
CH-8212 Neuhausen am Rheinfall,
Switzerland.

Czech power plant for Syrian sugar refinery

A 32 MW power generating unit has been put into operation at the Homs sugar refinery in Syria and involved the delivery of boilers, turbines and accessories from Technoexport of Prague. The boilers are designed for fuel oil and gas firing. Single-drum, natural circulation and double-drum boilers are used; their output is 190 tonnes/hr, the superheated steam parameters being 9.4 MPa and 540°C. Measurements effected during commissioning proved the attainment of all guaranteed performance, including 94% efficiency and 50% boiler flexibility. The boilers, of the pressurized type, are provided with nine combined burners and blowers designed in Czechoslovakia, Ljungström-type regenerative air heaters, and turbine-driven air fans.

New conveyor belt scraper

Material build-up on conveyor belts is a problem common to food manufacture and bulk materials handling. The new Hosch B10 sprung blade scraper, made in stainless steel to eliminate corrosion, has self-adjusting elastic mounts so that blades maintain constant contact with the belt, even if some wear more quickly than others, and will automatically deflect on contact with a damaged surface. This latest model works on the same unique principle as other Hosch scrapers, the efficiency of which lies in the blades being inclined *against* the direction of belt travel, so exerting low tracking pressure. The new scrapers are assembled in modules and can function both as single-and double-row belt cleaners.

Further details:

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

Hydro-Titan pumps for the Australian sugar industry

There is more than a century of Australian experience and know-how behind every Thompson, Kelly & Lewis pump. Available in 28 different sizes, their Hydro-Titan range are hard at work in the sugar and many other industries. Rugged, durable and versatile, the pumps meet all the appropriate Australian and international standards and are made with a thicker case than specifications require to give long life. They are both easy to install and easy to maintain. The Hydro-Titan provides a world class pump which is robust, low-cost and highly efficient.

Further details:

Thomsons, Kelly & Lewis Ltd.,
P.O. Box 160,
Springvale, Vic.,
Australia 3171.

New books

The Gilmore sugar manual 1988: Louisiana, Florida, Texas, Hawaii and Puerto Rico and the US sugar beet industry

Anon. 136 pp; 21.5 × 28 cm. (Sugar Publications, Gilmore Sugar Manual Division, 503 Broadway, Fargo, ND 58102, USA.) 1988. Price: $45.00.

Gilmore Sugar Manuals have been published in various forms since 1911 and have been regarded as the principal source books for the US sugar industry. As regards the cane sugar industry, the layout of the current work is similar to that of past editions, with each section having a sugar factory index giving the name of the plant, that of the owning company, post office with zip code, telephone number and the page on which fuller details are to be found in the section; these details include general information and indications of the agricultural equipment used, followed by descriptions of factory processes and equipment and a table which summarizes results for 1986 and 1987 or 1986/87 and 1987/88. The beet sugar section gives only details of the companies and their factories followed by brief histories of the sugar industries in each state. The manual will be of great value to readers wishing to know more about the US sugar industry.

Proceedings of the opening of the new central laboratory facilities, CSM Suiker B.V.

Eds. P. W. van der Poel and J. M. de Bruijn. 112 pp; 21 × 29.5 cm. (CSM Suiker B.V., Valveeken 6, 4815 HL Breda, Holland.) 1988.

A number of lectures were presented on March 7, 1986, to mark the opening of the new central laboratory of CSM Suiker B.V. which operates beet sugar factories and, among other things, is the largest manufacturer of lactic acid in the world.These are now available in bound form together with the opening remarks of P. W. van der Poel (Director of the Central Laboratory), a history of the Central Laboratory provided by G. M. van Loon (Chairman of the Board of Management of NV Centrale Suiker Mij.) and a list of participants at the opening ceremony. The lectures are: "Chemistry of pectic substances" by W. Pilnik, A. G. J. Voragen and F. M. Rombouts; "Alkaline degradation of hexoses" by H. van Bekkum, J. M. de Bruijn and A. P. G. Kieboom; and "Zucker und andere Süssungsmittel, ihre Bedeutung für die industrielle Lebensmittelherstellung" (Sugar and other sweeteners, their significance for industrial food manufacture) by H. Schiweck.

Zuckerwirtschaft (Sugar economy) 1988/89

Ed. K. Dankowski, R. Barth and G. Bruhns. 279 pp; 10.0 × 14.5 cm. (Verlag Dr. Albert Bartens, Lückhoffstr. 16, D-1000 Berlin 38, Germany.) 1988. Price: DM 44.00.

The latest edition of this small book is the 35th in the series and maintains the tradition of small but clear print and the inclusion of a remarkable amount of information on West German, European and world statistics. These are given in the form of 57 tables, the German headings of which are translated into English and French and include crop areas and yields, production, consumption, trade, balances, prices, etc. up to calendar year 1987 and crop years 1987/88 in many cases. Also included are four graphs and three maps, while a section on trade regulations gives (in German) information on the International Sugar Agreement and the basic sugar regulations of the EEC, the latter summarized in English and French. A trilingual glossary of EEC sugar terms is provided as well as West German trade rules for beet pulp and molasses. The third section of the book is one of addresses: international, EEC, other West European and West German, with government organizations, associations, trading concerns, sugar companies and their plants, etc. While a knowledge of German is clearly of advantage for a reader, the book provides a convenient source of information and data for others.

Handbook on diseases of sugar beet, Volumes I and II

A. N. Mukhopadhyay. 195 + 177 pp; 17.5 × 25.4 cm (CRC Press Inc., 2000 Corporate Blvd. N.W., Boca Raton, FL 33431, U.S.A.) 1987. Price: $306.00 (both volumes).

The author notes that, in spite of the fact that sugar beet provides some 40% of the world's sugar, there has been no comprehensive, up-to-date account of the diseases attacking the crop and his work is in an effort to remedy this situation. He has classified the diseases in sections by their causal organisms (fungi, bacteria, mycoplasma, viruses and nematodes) and, after an introduction to the nature of such organisms, provides an account of the history, occurrence and severity of the disease symptoms, etiology, physiology, variability, host-parasite relations, disease cycle, epidemiology and control. The literature references are not recent and most of the photographs in black-and-white, but this does not detract from the advantage of having available in two quite slim volumes a considerable amount of information which would otherwise need to be sought from a wide range of journals and books. The Handbook is very well printed and in the substantial binding for which CRC Press is noted.

Polysaccharides: syntheses, modifications and structure/property relations

M. Yalpani. 449 pp; 16.4 × 24.4 cm (Elsevier Science Publishers, P.O. Box 330, 1000 AH Amsterdam, Holland.) 1988. Price: Dfl. 325.00.

Carbohydrate polymers have been known for a very long time but have been overshadowed during this century by the polymeric products obtained from unsaturated hydrocarbons and like molecules which have filled the world

continued on page 116

New magnesia clarifying process for sugar refining

By Tadasi Nakamura, Hiromi Iwabe and Masayuki Kawakami
(Tobu Refinery, Mitsui Sugar Co. Ltd., Shibaura, Tokyo, Japan)

continued from page 95

Operation results of the magnesia process

The operation results illustrated in the following Table II, Figures 7 - 9, and Table III, are compared with those of the conventional process. All the results were obtained at the MSC Tobu refinery in Shibaura, Tokyo.

Merits of the magnesia process

Table II. Process liquor characteristics

Comparative items	Conventional process (average 8/81 - 1/82)	Magnesia process (average 8/87 - 1/88)
Raw liquor colour, IU	1,650	2,250
Brown liquor colour, IU	860	490
Clarification decolorization, %	48	78
Clear liquor colour, IU	340	-
Powdered carbon decolorization, %	60	-
Fine liquor (1) colour, IU	56	115
Resin decolorization, %	84	77
Fine liquor (2) colour, IU	-	71
Powdered carbon decolorization, %	-	38
Raw liquor pH	8.4	7.4
Brown liquor pH	8.1	9.5
Clear liquor pH	7.0	7.9
Fine liquor (1) pH	6.4	7.3
Fine liquor (2) pH	-	7.2
Raw liquor Brix	66.2°	67.3°
Brown liquor Brix	65.4°	67.1°
Clear liquor Brix	65.1°	67.0°
Fine liquor Brix	64.0°	66.6°

The magnesia clarifying process has in practical operation shown itself superior to the conventional process in several ways:

(1) Initial costs for new refinery equipment are less, fewer people are required because of the simplified clarifying process, and start-up and shut-down times are shorter, as the holding volume of sugar necessary in the process is smaller.

(2) Because of lower consumption of expensive activated carbon, clarifying costs are lower. The amount of activated carbon powder used in the process as a support is about 20% that of the conventional carbonatation/powdered activated carbon systems.

(3) Since the new process enables treatment of sugar liquor at a higher density, energy consumption for evaporating moisture in boiling can be reduced. The concentration of fine liquor can be increased by 3 - 4°Bx.

(4) Electricity consumption is about 85% that of the conventional

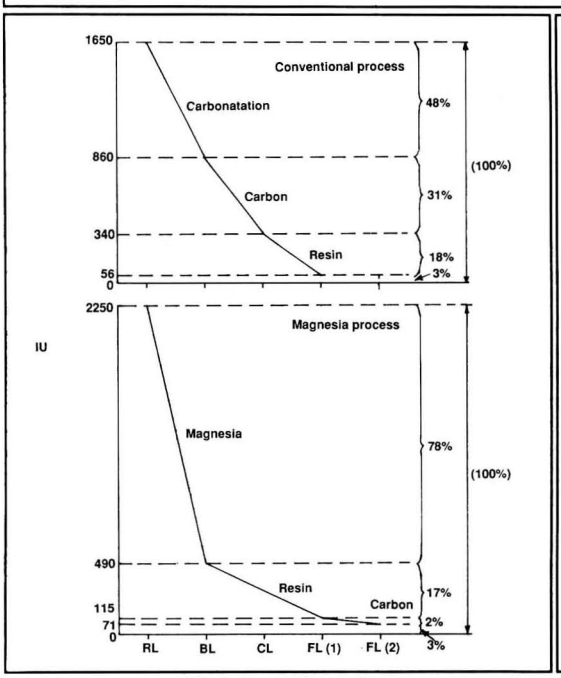


Fig. 7. Process liquor colour

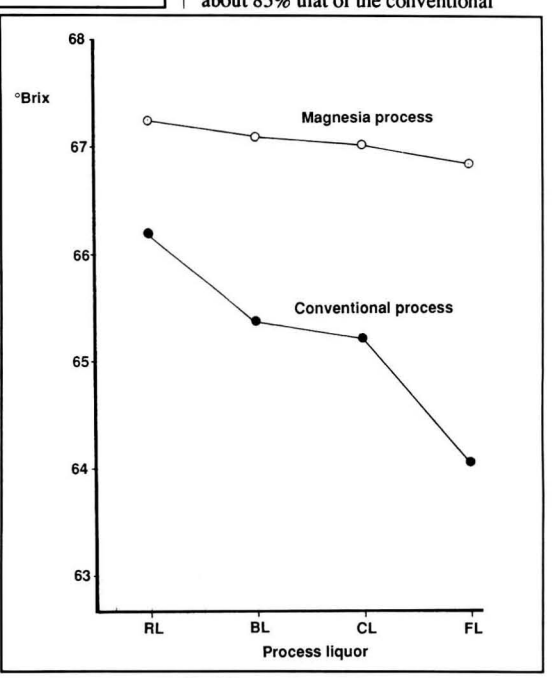


Fig. 8. Process liquor Brix

process, because gas pumps and gas washing facilities for carbonatation are not required.

(5) Since the magnesia is regenerated and used over again, the amount of wasted cake is reduced to about 15% that of the conventional processes. This means a sharp reduction in environmental pollution from industrial waste. Furthermore, magnesia cake has been found to be effective as a fertilizer, which renders possible even further reductions in the amount of industrial waste.

(6) Owing to the high capacity of magnesia to adsorb floc-forming substances such as silica, the quality of fine liquor is superior to those produced by conventional processes.

(7) The reduced volume of water required by the process results in a lower volume of effluent, about 75% that of the carbonatation/powdered activated carbon process, about 50% of that of the carbonatation/granular carbon method, and about 35% of that of the carbonatation/bone char method.

(8) Since stack gas (carbon dioxide) for carbonatation is not required, it is possible to use a variety of heat sources and fuels.

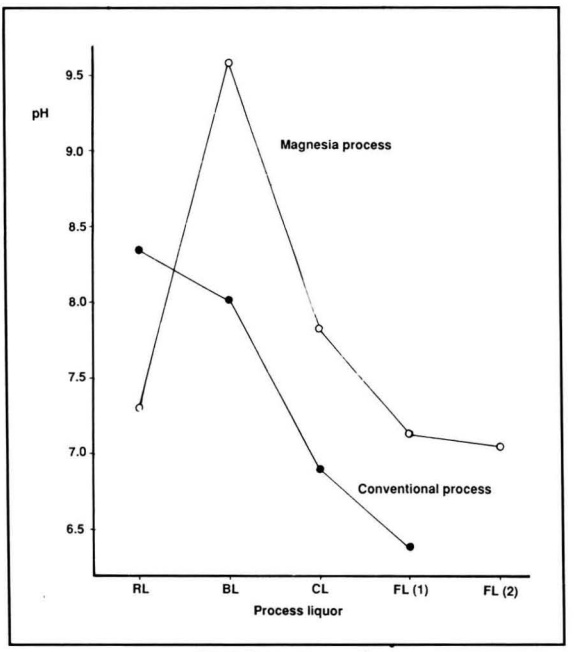


Fig. 9. Process liquor pH

Table III. Clarifying materials used and other quantities

Comparative items per tonne raw sugar	Conventional process (average 8/81 - 1/82)	Magnesia process (average 8/87 - 1/88)
Slaked lime, kg	7.55	-
Powdered activated carbon, kg	1.38	0.26
Perlite, kg	2.13	0.97
Magnesia, kg	-	1.01
Decolorizing resin, litres	0.15	0.22
Demineralizing resin, litres	-	0.015
NaCl, kg	8.85	9.68
NaOH, kg	-	1.26
HCl, kg	-	3.73
Kiln gas, kcal	-	26,000
Cake waste, kg	26.7	3.8
Sucrose left in the cake, kg	0.06	1.42
Water, kg	2.41	1.83

MSC is confident that the new sugar liquor clarifying process has great merit for sugar refineries around the world, especially for those wishing to cut the costs of clarifying material and fuel, for those suffering from the cost of treating industrial wastes and effluent, and for those wishing to build a simplified and low cost refinery.

(Notes: Patents on the new clarifying process have been obtained in Japan, United States, Australia and the Republic of Korea[3-6]. This report deals with the first examples of commercial operation.)

Acknowledgements

MSC wishes to acknowledge the contributions made to development and operation of the decolorization plants by the following: Mr. Yoshikatsu Ikari (formerly of the National Chemical Laboratory for Industry); Mr. Shoichiro Yokoyama (National Chemical Laboratory for Industry): Sumitomo Jukikai Envirotech Inc., and Hokkaido Soda Co. Ltd.

Summary

Mitsui Sugar Co. Ltd. (MSC), together with the Japan National Chemical Laboratory for Industry, has invented a process using magnesia and ion-exchange resin to replace the conventional refinery clarification process which uses carbonatation, bone char (or activated carbon) and ion-exchange resin.

MSC have completely overcome the shortcomings commonly supposed to attend any process using magnesia (such as high costs, poor filtrability and comparatively high sucrose adsorption) by reactivating and recycling the magnesia with perlite filter aid. The perlite greatly improves the filtrability and at the same time helps the regeneration of the adsorptive power of the magnesia. Sucrose left in the magnesia mud is mostly recovered by a hot water treatment. After repeated test operations at their pilot plant, in 1982 MSC scaled-up the process to a commercial level (600 tonnes/day) and have already put about

3 Japan Patents 1,138,318 and 1,169,168 (1980).
4 US Patent 4,362,571 (1980).
5 Australia Patent 541,936 (1980).
6 Republic of Korea Patent 21,253 (1980).

600,000 tonnes of refined sugar, made by this method, on the Japanese market where it has been favourably received. Through practical operation of the process, MSC have established a novel cost-saving clarification method and have found the following merits: (1) simplicity (reduced initial cost, person nel and the retention time of sugar liquor in the process), (2) reduced consumption of clarifying materials, (3) reduced energy consumption and diversified heat energy, (4) reduced environmental pollution, and (5) improved quality of fine liquor.

Nuevo proceso de clarificacíon con magnesia en la refinería del azúcar

La Mitsui Sugar Co. Ltd. (MSC) junto con Japan National Chemical Laboratory for Industry han inventado un proceso usando magnesia y una resina de intercambio iónico para reemplazar los procesos de clarificacíon convencionales de las refinerías los cuales usan carbonatación, carbón animal (o carbón activado) y resina de intercambio iónico. La MSC ha resuelto completamente los problemas que comúnmente se suponen están presentes en cualquier proceso en que se use magnesia (tales como costos altos, baja filtrabilidad y adsorción de sacarosa comparativamente alta) al reactivar y reciclar la magnesia con perlita como adyuvante de filtración. La perlita mejora enormemente la filtrabilidad y al mismo tiempo ayuda a la regeneración del poder de adsorción de la magnesia. La sacarosa que queda en el barro de magnesia se recupera casi totalmente con un tratamiento de agua caliente.

Después de varias operaciones de pruebas en su planta piloto, en 1982 la MSC aumentó su proceso a escala comercial (600 toneladas/día) y ya ha puesto cerca de 600,000 toneladas de azúcar refinado, hecho por este método, en el mercado Japonés donde ha tenido una recepción favorable. A través de la operación práctica del proceso, MSC ha establecido un método de clarificación nuevo que ahorra costos y que se ha encontrado que tiene los siguientes méritos: (1) simplicidad (reducción del costo inicial, personal y del tiempo de retención de la solución de azúcar en el proceso), (2) reducción en el consumo de materiales de clarificación, (3) reducción en el consumo de energía y diversificación de la energía calórica, (4) reducción de la contaminación ambiental, y (5) una mejor calidad del licor fino.

Nouveau procédé de clarification à la magnésie pour la raffinage du sucre

Mitsui Sugar Co. Ltd (MSC), en collaboration avec le Laboratoire National de Chimie Industrielle du Japon a inventé un procédé mettant en oeuvre la magnésie et des resines échangeuses d'ions pour remplacer le processus conventionnel de raffinage qui utilise la carbonatation, le noir animal (ou le charbon actif) et des résines échangeuses d'ions. En réactivant et recyclant la magnésie avec un adjuvant de filtration à la perlite, MSC a réussi à éliminer entièrement les défauts habituellement inhérents à tout procédé faisant usage de la magnésie (comme coût excessif, mauvaise filtrabilité et adsorption relativement importante de saccharose). La perlite améliore sensiblement la filtrabilité et aide en même temps la régénération du pouvoir d'adsorption de la magnésie. Le saccharose resté dans la boue magnésienne est généralement récupéré par un traitement à l'eau chaude.

Après des essais répétés dans leur usine pilote, MSC en 1982, a porté l'installation à une échelle commerciale (600 tonnes par jour) et on a déjá mis sur le marché japonais près de 600,000 tonnes de sucre raffiné selon cette méthode. Le marché lui a réservé un accueil favourable. L'utilisation en pratique du procédé a permis à MSC d'établir une méthode de clarification originale et à moindre coût. On lui a trouvé les mérites suivants: (1) sa simplicité (moindre coût initial, personnel réduit et temps de rétention plus court pour le sirop, (2) moindre consommation de réactifs de clarification, (3) consommation réduite d'énergie et énergie calorifique diversifiée, (4) moindre pollution de l'environnement, (5) meilleure qualité du sirop final.

Neue Reinigungsverfahren mit Magnesia für Zuckerraffination

Mitsui Sugar Co. Ltd. (MSC) zusammen mit Japan National Chemical Laboratory for Industry haben ein Verfahren erfunden, in dem Magnesia und Ionenaustauschharz die Carbonatation, Knochen- oder Aktivkohle und Ionenaustauschharz im konventionellen Raffinerie-Reinigungsverfahren ersetzen. MSC hat die weithin vermuteten Nachteile jedes Magnesiaverfahrens (z.B. hohe Kosten, schlechte Filtrierbarkeit und verältnismässig hohe Saccharoseadsorption) durch Reaktivierung und Rezirkulation der Magnesia mit Perlitfiltrationshilfsmittel völlig uberwunden. Der Perlit verbessert bedeutend die Filtrierbarkeit und gleichzeitig hilft, die Adsorptionskraft der Magnesia zu regenerieren. Rückständige Saccharose im Magnesiaschlamm wird durch Heisswasserbehandlung meistens wiedergewonnen.

Nach wiederholten Probefahrten der Versuchsanlage hat MSC 1982 das Verfahren bis zu einem kommerziellen Niveau (600 t/d) erhöht; die Firma hat ungefähr 600,000 t mittels dieses Verfahrens erzeugte Raffinade schon auf den japonischen Markt gebracht, wo der Zucker wohl empfangen wurde. Durch praktische Anwendung des Verfahrens hat MSC eine neuartige, rentable Reinigungsmethode etabliert und die folgenden Vorteile gefunden: (1) Einfachheit (Verminderung von Anfangskosten, Personalbedarf und Verweilzeit der Zuckerlösung im Verfahren), (2) vermindertes Gebrauch von Reinigungsmaterien, (3) verringertes Energiegebrauch und diversifizierte Wärmeenergie, (4) verringerte Umweltverschmutzung, und (5) verbesserte Qualität der Feinkläre.

TWO NEW QUALITY INSTRUMENTS

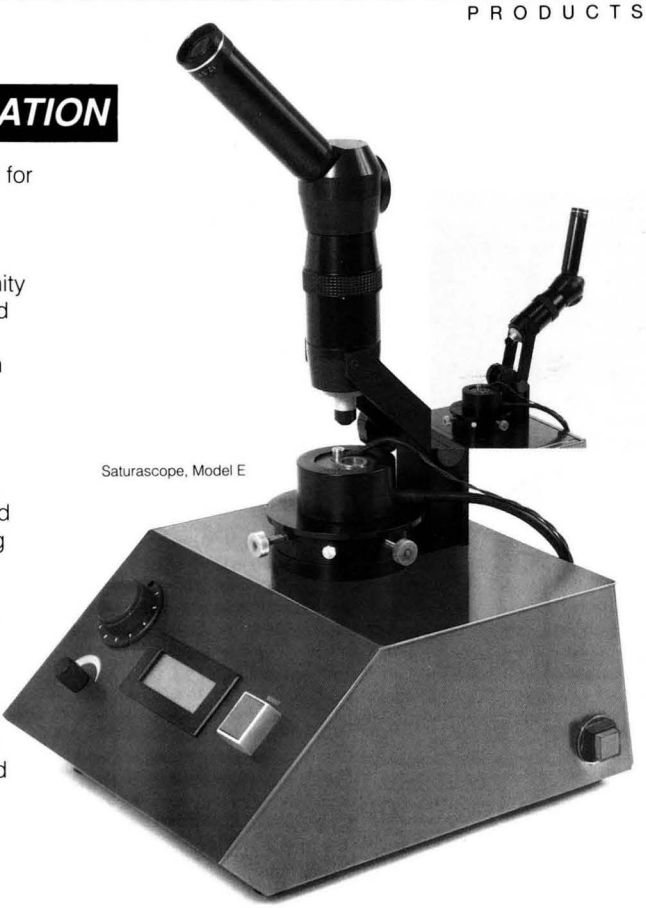
SUMA PRODUCTS

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 ±0.1°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.

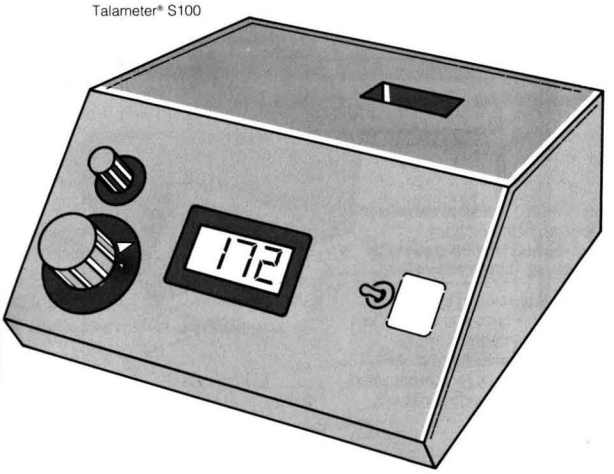
The microscope is attached to the instrument by means of a pivotal mount, thereby allowing increased accessibility to the sample cup and minimum re-adjustment of the focusing system.



Saturascope, Model E

SUGAR COLOUR

Talameter® S100



The **Talameter® 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.

The Sugar Manufacturers' Supply Co. Ltd., 3A Albert Court, Prince Consort Road, London SW7 2BJ

For information on the full Suma Product range please see page 4 of this advertising feature

A RANGE OF QUALITY INSTRUMENTS

SUMA PRODUCTS

BAGASSE ANALYSIS

Moisture Teller

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.

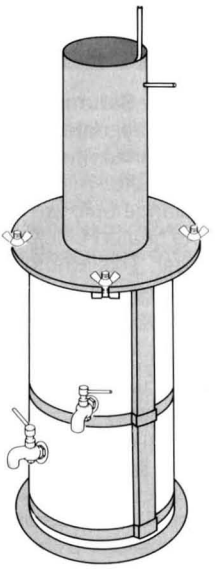
The outer vessel is lagged to prevent heat losses. The spiral conductor tube, surrounded by a water jacket with cooling water inlet and outlet, is permanently connected to the digester body top cover which in turn is fitted to the body by means of thumb screws and rubber gasket.

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.

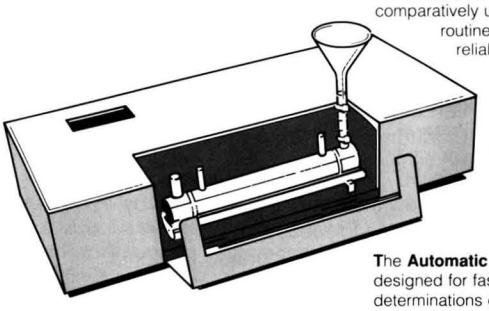
It has an automatic time switch from 0 - 60 minutes and a temperature range of 90 - 170°C.



Deerr Type Bagasse Digester

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

The Sugar Manufacturers' Supply Co. Ltd., 3A Albert Court, Prince Consort Road, London SW7 2BJ

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Crystallization rate of sucrose at high impurity concentrations

By Michael Saska and Youssef Oubrahim*
(Audubon Sugar Institute and Department of Chemical Engineering, Louisiana State University, Baton Rouge, Louisiana, U.S.A.)

Introduction

The kinetics of crystallization in pure or nearly pure/synthetic solutions, as well as the effects of the major variables, are well established and detailed theories have been proposed[1-3]. By contrast, crystallization from highly impure solutions (I/W† from 3 to 5) still remains only sparsely documented. This is largely attributable to the considerable experimental difficulties as well as complications stemming from geographical differences in composition of the impurities that make the comparison of the experimental data difficult.

Some insight is gained from the more extensive investigations of the low-grade beet sugar solutions that usually cover the I/W range up to about 3.0 but extrapolation is of dubious validity because of the non-linear character of viscosity, diffusivity and, presumably, crystal growth kinetics at high I/W. Even though somewhat idealized, the two-step model of crystal growth is useful for the following discussion.

The model assumes that diffusion of the solvent and solute on one hand and the interfacial processes (desolvation, break-up of associates, orientation of the molecules) on the other can only occur consecutively and thus the overall resistance (inverse of the rate constant) is the sum of the respective resistances


M. Saska


Y. Oubrahim

of the diffusion and interfacial processes. While diffusion can be studied independently, albeit with great difficulty in supersaturated solutions, information on the rate of the surface process is inferred from measurements of the crystallization kinetics.

The principal question concerns the effect of the concentration and composition of impurities on the rates of the two respective processes. The answer will, in turn, provide a basis for optimizing the low-grade crystallizers in terms of feed composition (purity, Brix), cooling rate, rate of stirring, retention time (capacity), etc.

A comparison of literature data[4-6] from three major sugar cane regions (Louisiana, Australia and South Africa) is given in Figures 1 - 4 for four combinations of I/W and temperature. Here, the growth rate equations given by the respective authors were applied to hypothetical solutions with the sucrose solubility given (for I/W > 3.0) by[7]

$$SC = 0.25 + 0.19\ I/W \qquad (1)$$

Since the solution viscosity is required in the equations of Rouillard, Saska & Garandet and this work, an equation[8]

$$\eta = 0.11\ (X_s/X_{TDS})^{-1.3}\ \exp[3.7(X_{TDS} - 0.19(T - 50)]/[113.5 - (100\ X_{TDS} - 0.19(T - 50)] \qquad (2)$$

was used. The mass growth rate G (kg/m²/sec) was converted to the linear growth rate R (m/sec) as

$$R = G\beta/6\alpha\rho \qquad (3)$$

where the shape factors were taken from Hrubisek[9]. It should be pointed out that their values depend on the choice of the characteristic length of the crystal, which was defined in this work as the longest dimension of the crystal. Thus the growth rate R given throughout this work represents one half of the rate of the apparent crystal size increment along this direction.

† Here and in the following we use, as commonly in the sugar literature, the ratios I/W and S/W to express the concentrations of impurity (I) and sucrose (S) relative to water (W)

* Centre Technique de la Canne à Sucre (CTCAS), Kenitra, Morocco.

1 Smythe: *Australian J. Chem.*, 1967, **20**, 1097 - 1131.
2 Idem: *Sugar Tech. Rev.*, 1971, **1**, 191 - 231.
3 Maurandi *et al.*: *ibid.*, 1988, **14**, 29 - 118.
4 Saska & Garandet: *AIChE Symposium Series*, 1987, **83**, (253), 42 - 46.
5 Wright & White: *Proc. 15th Congr. ISSCT*, 1974, 1546 - 1560.
6 Rouillard: *Proc. 17th Congr. ISSCT*, 1980, 2279 - 2295.
7 Saska: Unpublished data for Louisiana molasses.
8 Awang & White: *Proc. Queensland Soc. Sugar Cane Tech.*, 1976, **43**, 263 - 270.
9 in Bretschneider *et al.*: "Sugar technology tables", (SNTL, Prague), 1975, p. 241.

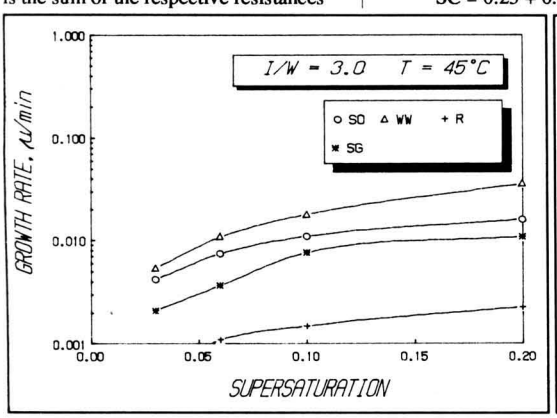

Fig. 1: Crystal growth rate of sucrose at I/W = 3.0 and 45°C. WW = Wright & White, R = Rouillard, SG = Saska & Garandet, SO = this work

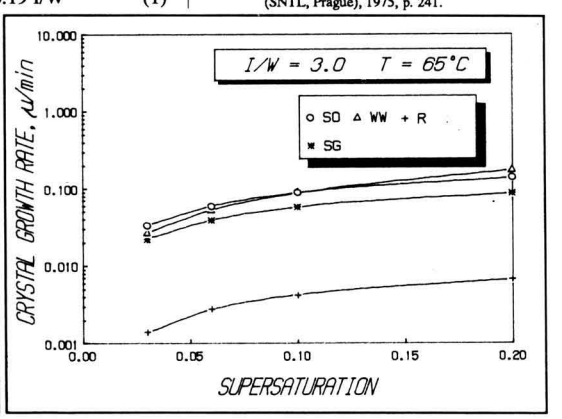

Fig. 2: Crystal growth rate of sucrose at I/W = 3.0 and 65°C. (Symbols as in Figure 1)

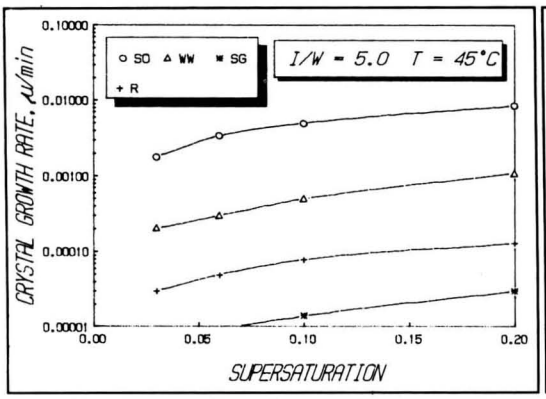

Fig. 3: Crystal growth rate of sucrose at I/W = 5.0 and 45°C. (Symbols as in Figure 1)

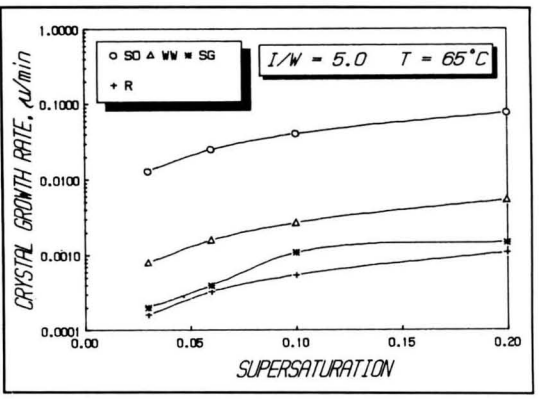

Fig. 4: Crystal growth rate of sucrose at I/W = 5.0 and 65°C. (Symbols as in Figure 1)

Agreement between the equations of Wright & White (WW) and Saska & Garandet (SG) is very good at I/W = 3.0, the calculated growth rates agreeing mostly within a factor of two. The mass transfer correlation of Calderbank & Moo Young, modified by Rouillard to fit his crystallization data, gives values considerably lower. This is consistent with findings of Rouillard[6] which indicate that the mass-transfer correlation of Calderbank & Moo Young underestimated the growth rate in the low-grade crystallizers by a factor of two even after the applied empirical correlation that may have been biased by the more numerous high-purity data included in the correlations. At I/W = 5.0, the WW equation gives the highest growth rates (discussion of the results of this work will be deferred until later).

It has to be pointed out that, although later used by Maudarbocus & White[10] to simulate behaviour in low-grade cooling crystallizers, the WW equation was derived from growth rates measured in a low-grade vacuum pan at I/W below 4.0. By the same token, the growth rate equation of Saska & Garandet was determined for the I/W range from 2 to 3. Thus both equations were extrapolated well beyond the experimental ranges. The present work is a continuation of the investigation by Saska & Garandet and is aimed at extending the experimental basis to cover the whole range of I/W encountered in low purity crystallization of cane sugar solutions.

While Rouillard measured crystallization rates using industrial crystallizers, the data of Saska & Garandet were obtained with a laboratory cooling crystallizer using industrial solutions of medium purity. Similarly to the WW procedure[5], the growth rate expression was obtained by fitting the crystallization data with an empirical expression

$$R = Q_1 \eta^{Q_2} \sigma \qquad (4)$$

thought previously[11,12] to be appropriate to the low-grade conditions where the mass transfer is likely to be rate-determining. Details of the procedure will be given in the following sections. In equation 4, η is the viscosity of the mother liquor, calculated from equation 2. The values of $Q_1 = 58.2$ μ/min and $Q_2 = -1.8$ were found to represent well the limited experimental data. It should be pointed out that equation 4 does not necessarily imply the predominance of the mass-transfer step on the growth process. The usual assumption[3] that the viscosity affects the mass-transfer rate (through the Einstein-Stokes and Froessling correlations) but not the surface processes does not appear justified considering that the rates of such surface-related steps as molecular re-orientation and break-up of associates must be strongly functions of temperature and composition as well as viscosity of the medium. The Einstein-Stokes relationship itself, used frequently for its simplicity to relate the mass-transfer rate to the solution viscosity[3], was found experimentally not to hold[13,14], the product of diffusivity and viscosity increasing with the sucrose concentration, presumably on account of clustering in high concentration sucrose solutions. The relatively high amounts of macromolecules in the sugar solutions may still further contribute to the failure of the Einstein-Stokes relationship. While increasing the viscosity several-fold[15], the diffusion of small molecules (sucrose, water) may not be reduced accordingly, resembling perhaps movement through a three-dimensional mesh of openings hundreds of times larger than the size of the diffusing molecules.

Description of cooling crystallization

In the absence of nucleation, in a batch cooling crystallizer with no solvent removal (evaporation), the mass balance for sucrose over a time element dt gives a first-order, non-linear differential equation

$$dC_s/dt + g = 0 \qquad (5)$$

10 Maudarbocus & White: *Proc. Queensland Soc. Sugar Cane Tech.*, 1978, **45**, 45 - 52.
11 Jvirblianski: "Crystallization of sugar" (Pishchepromizdat, Moscow) 1958, 15 - 21.
12 Silin: "Technology of beet sugar and refining", (Pishchepromizdat, Moscow), 1958, p. 404.
13 English & Dole: *J. Amer. Chem. Soc.*, 1950, **72**, 3261.
14 Emmerich *et al.*: *Zucker*, 1976, **29**, 302 - 307.
15 Greenfield & Geronimos: *I.S.J.*, 1978, **80**, 67 - 72.

ISJ Abstracts

Cane sugar manufacture

Use of cavitation in the sterilization of cane juices

O. Rodríguez C., P. V. Pérez G. and J. Lodos F. *CubaAzúcar*, 1986, (April/June), 15 - 18 *(Spanish)*.

A device was designed in which a rotor, driven at 2600 r.p.m. within a housing, produces cavitation in a flow of juice passing through the housing. The vacuum bubbles then collapse, but during the retention time of 4 seconds a sterilization effect is obtained as shown by the variation in the population of *Leuconostoc mesenteroides*.

Comparative study of the exploitative technical indices of the Pablo Noriega cleaning centre and the El Colorado cleaning centre

I. Hernández S., A. Ramos Q. and P. Cartaya V. *CubaAzúcar*, 1986, (April/June), 19 - 24 *(Spanish)*.

Comparative tests were carried out at the two centres in 1983/84 and it was found that their efficiencies could be improved by increasing the speed of some of the conveyors.

Study of the optimum scheme for recirculation and exhaustion of bagacillo in the tandem

A. Aguilar, L. Gutiérrez and J. Núñez. *CubaAzúcar*, 1986, (April/June), 35 - 40 *(Spanish)*.

By lixiviation of bagacillos from earlier mills, having higher pol contents, and mixing with bagasse from subsequent mills, further lixiviation, and so on, the capacity of the tandem is increased and extraction improved while retaining the quality of the bagacillo which is returned to the tandem before the last mill.

An economic limit does exist for the application of imbibition water and wash water in the filters

A. Valdés. *ATAC*, 1986, **45**, (3), 46 - 52.

While higher amounts of water used for imbibition and filter washing will increase the sugar recovery, they involve costs in evaporation and an account is given with examples of a method of working out the economics.

Usina Trapiche S.A.

Anon. *STAB*, 1986, **5**, (1), 4 - 7 *(Portuguese)*.

Details are given of the management, history, cane agriculture, sugar factory and alcohol production equipment and ancillaries, as well as the average results achieved during the 1985/86 season in the title sugar factory, which is located in Pernambuco, Brazil.

Digital control of the vaporation sector in sugar factories

J. C. L. Mazzoco. *Bol. Técn. Copersucar*, 1987, (36/87), 36 - 44 *(Portuguese)*.

Cooperation between the Copersucar Technical Centre and Usina Santa Adélia in respect of development of automatic control of the evaporator stations is discussed and the results illustrated by graphs showing the improvement achieved in syrup Brix regularity.

Recovery of sucrose from molasses and alkaline treatment of syrups

E. L. Ramos, J. A. Urrutia and A. Alamo. *ATAC*, 1986, **45**, (4), 20 - 27 *(Spanish)*.

In an effort to reduce losses by chemical deterioration of raw sugar, a method has been developed whereby syrups are treated with alkali so as to eliminate the amino-acids. While the treatment permits stabilization of the sugars and much less formation of colour, there was a need to clarify the effect of the sodium salts formed on the solubility of sucrose in the syrups and molasses. These effects have been studied, as has the viscosity of the molasses, and it is concluded that the amount of sodium salts formed has no appreciable effect on the molasses exhaustion.

Simulation of a raw sugar factory and comparison of the results with parameters measured in the factory

L. Hernández C. and P. Kadlec. *ATAC*, 1986, **45**, (4), 50 - 55 *(Spanish)*.

A flow diagram was prepared and a computer program written in Fortran to simulate the factory process between milling and clarification and filtration. The results obtained by calculation were in good agreement with the actual figures obtained.

Industrial application of the sugar deterioration retarding treatment using lime as alkalizing agent. II

E. L. Ramos A. and J. A. Urrutia F. *CubaAzúcar*, 1986, (July/Sept.), 32 - 38 *(Spanish)*.

Treatment of syrup with lime has been shown to stabilize the raw sugar produced and prevent deterioration in storage[1]. This work has been extended by analysis of the sugar to see if the treatment affected its quality or the composition of the final molasses; the calciuum salts introduced did not bring about appreciable changes in either or affect sugar recovery.

Behaviour of the technetium-99M tracer in cane juices during the processes of clarification and evaporation

S. R. Mesa and J. Griffith. *CubaAzúcar*, 1986, (July/Sept.), 51 - 56 *(Spanish)*.

Sodium pertechnetate was added to cane juices and radioactivity measured in the juices and sediments produced by clarification, whereby it was possible to study its elimination as a function of time, pH, phosphate content, etc. in the laboratory. Radio-technetium is considered better than the radio-isotopes used previously.

The application of flotation clarification in sugar processing

P. W. Rein. *Paper presented at Conf. on*

1 *I.S.J.*, 1988, **90**, 51A, 108A.

Sugar Processing Research, 1988, 19 pp.

Laboratory studies on flotation clarification of cane syrup, *B*- and *C*-molasses, filtrate from rotary mud filters, raw sugar melt and refinery sweetwater are reported including the effects of flocculant dosage and temperature on turbidity removal, the performances of specific flocculants, the superiority of flotation over standard clarification in regard to turbidity and colour removal (but less so in respect of ash removal) and the advantage of gassing with CO_2 as against SO_2 in melt clarification. The method developed for performance assessment gave values in good agreement with full-scale syrup clarification results and allowed optimization of the process on a small scale before a new system was installed in a factory. Experience in syrup clarification at Empangeni and Felixton in South Africa and at Triangle in Zimbabwe is discussed. Results have shown that treatment has raised sugar quality at all three factories while also improving molasses exhaustion at Empangeni; at Felixton, an initial syrup heating problem has been overcome so that turbidity removal is now of the order of 80%, while flotation clarification at Triangle has overcome the major problem of a high suspended solids content in white sugar. In refinery melt clarification, encouraging results have been achieved in turbidity and colour removal if a small amount of lime is added and gassing with CO_2 or SO_2 carried out beforehand; 50% colour removal is possible at a much lower lime consumption than in conventional carbonatation, thus eliminating the need for a filter station. The process could be highly cost-effective in a refinery attached to a raw sugar factory, especially since the scum removed by clarification could be recycled to the factory instead of having to be sweetened-off in a solid-bowl centrifuge or by further flotation clarification steps, while the reduction in lime consumption would result in a significant decrease in the quantity of cake by comparison with conventional carbonatation. (See also Rein *et al.*: *I.S.J.*, 1988, **90**, 61A.)

Cane separator technology - a way to diversify from conventional sugar making

H. C. C. Bourzutschky. *GEPLACEA Bull.*, 1988, **5**, (8), 4 pp.

The cane separator designed by Tilby and its principle of operation are described and details given of the project initiated in Jamaica[2].

Storage bins and automatic weighment for sugar

B. S. Gurumurthy. *Indian Sugar*, 1988, **38**, 87 - 90.

The sugar bagging and automatic weighing system at the author's factory is described and its advantages discussed.

A cane sugar production computer program. Material balance calculations in white or raw sugar production process

C. Castillo. *Sugar y Azúcar*, 1988, **83**, (9), 35.

A program used at Ingenio del Cauca S.A. in Colombia calculates balances at each stage of the sugar manufacturing process and is applicable to both raw and white sugar production; it may be used to assess the effect of changes in a given variable on a particular process and hence is a useful tool for optimization.

Improving flow of massecuite in the crystallizers

M. Saska and Y. Oubrahim. *Sugar J.*, 1988, **51**, (2), 6 - 9.

Computer models of the operation of a series of continuous crystallizers, in which the massecuite temperature was raised and dilution water added to reduce viscosity and improve flow, showed that the molasses purity would have been about 5.2 units lower without addition of water; replacement of the water with 60° or 80°Bx final molasses gave somewhat lower purity rise and sugar losses, but these were still substantial, so that dilution with either material is not recommended. Instead, flow problems in crystallizers should be solved by attention to the design and size of connectors and differences in height between the individual crystallizers.

Permeability of cane juice in ultrafiltration membranes of acrylic vinyl copolymer and cellulose acetate

M. Tako, K. Nakamoto, S. Nakamura, Y. Kohda and D. Nomura. *J. Jap. Food Sci. Technol.*, 1988, **35**, (2), 120 - 125; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (17), Abs.17 R501.

Results are given of 2 - 3 hours of investigations on the effect of permeability of various membranes retaining substances of 50,000 - 100,000 M.W. on the ultrafiltration rate and quality of raw and limed cane juices. It was found that the ultrafiltration rate through XM-50, XM-100 and A-50T membranes for the first 250 ml of juice was approx. 0.1 ml/cm²/min after which it gradually fell; the greatest permeability (0.14 ml/cm²/min) occurred at the start of filtration through A-50T membrane. The rate gradually fell for juice limed to pH 8.1 at 10°C; the highest rates were obtained for juice limed to pH 7 at 85°C (at the start of the filtration process), although they fell sharply with increase in the amount of juice filtered. The quantity of juice filtered through A-50T membrane was smaller than with XM membranes. Sucrose losses in juice passed through XM-50, XM-100 and A-50T membranes were 2, 2 - 5 and 5 - 7%, respectively.

New standard specifications for an evaporator station for 2500 tcd plants - a study

A. P. Chinnaswamy, K. Theerthamalai and S. Viswanathan. *Indian Sugar*, 1988, **38**, 169 - 180.

New official standard specifications

2 Bourzutschky & Ricketts: *I.S.J.*, 1989, **91**, 48A.

involve either (1) a double-effect vapour cell plus a semi-Kestner as the 1st effect and a conventional Roberts vessel as the 2nd effect followed by a quadruple-effect station, or (2) a semi-Kestner vapour cell followed by a quintuple-effect evaporator. However, sugar technologists who feel that high inversion losses will result if a double-effect vapour cell is used have suggested another possibility: a semi-Kestner as 1st effect followed by a quintuple-effect evaporator. Examination of the three systems shows that while (1) and (2) would be capable of handling all the juice produced from 2500 tcd, system (3) would not; moreover, the fears about high inversion losses with a double-effect vapour cell are shown to be unfounded.

Incentive control of dirt in cane supply

R. Cargnello, R. J. B. McLean and S. Dibella. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 33 - 37.

Tully factory is situated in the northern wet cane belt and encourages harvesting under wet conditions but has had continual problems with excessive quantities of extraneous matter (EM), particularly dirt, accompanying the cane. Periodical changes have been made to the process of evaluating the physical parameters of EM in an effort to improve the condition of the cane supplied. Since 1983, the cane crushing rate has been limited by the capacity of the filters to handle the excessive amounts of mud associated with soil. The various EM assessment and cane payment/penalty schemes from 1983 to 1986 are outlined and the results for 1987 examined; although the average dirt in filter cake % cane was, at 0.83%, higher than the target of 0.70 - 0.75%, and the pol loss in mud (0.70%) was also above the target, these values represented a marked improvement on previous seasons, and over 1 million tonnes of cane was processed in just under 21 weeks, corresponding to a crushing rate of 431.8 tch. The relative economics are briefly discussed.

Energy utilization at the Muhoroni sugar mill and ethanol plant

M. H. Thomas and E. G. Williams. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 47 - 52.

Details are given of the energy balance for 1984 of the 85 tch Muhuroni sugar factory in Kenya and of the adjacent distillery operated by a separate company for fuel alcohol and baker's yeast manufacture from molasses. Relatively high losses from the 3-unit bagasse boiler station are noted. The factory currently imports the balance of its electricity requirements (about 1700 MWh per year) but exports about 16 tonnes/hr of process steam to the distillery which also purchases 655 MWh per year from the utility. Self-sufficiency in energy could be achieved if the sugar factory were to install a back-pressure turbo-alternator in the high-pressure steam line to the distillery (which would create a net export in electricity) and increase boiler efficiencies by improving bagasse combustion and thus reduce the need for supplementary wood or oil. It is also suggested that the factory could operate as a power station during the short off-season, although there would be a considerable problem with bagasse storage, or manufacture paper (possibly a more attractive propostion in view of a shortage of fibre in Kenya).

Spontaneous combustion in bagasse stockpiles

T. F. Dixon. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 53 - 61.

Bagasse is stored at Australian factories in external piles of 200 - 3000 tonnes capacity for periods ranging from 6 months to 3 years, depending on steam production requirements. Three cases of spontaneous combustion have occurred since 1983; that at Mourilyan involving 700 tonnes is analysed. Laboratory and small-scale investigations have centred on the spontaneous combustion behaviour of dry bagasse, microbial heating and the effects of moisture. Results indicate that: pile size and geometry are not significant; maximum temperatures occur at a depth of 1.5 - 2.0 m perpendicular to any external surface; the maximum pile temperature increases to about 65°C within the first 2 days of storage regardless of initial bagasse conditions, this being followed by slow heating or cooling; spontaneous combustion of dry bagasse will occur at >94°C; and little change takes place in the moisture content of the bulk of the stored bagasse during normal heating. However, the factors determining heating of the pile and which increase temperatures from 65°C to 94°C have not been identified. It is recommended that the temperature should be periodically monitored in the zone of maximum temperature until it exceeds 80°C, after which the monitoring frequency should be increased at several levels (e.g. 0.5, 1.0 and 1.5 m) in the same spot.

Automation of the cane receivals station at Racecourse mill

P. R. Stuart and B. McEachran. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 63 - 68.

The automatic cane reception system installed at Racecourse in 1987 is designed for a tipping capacity of 700 tch and was planned to allow a cut in labour requirements and to reduce the turn-around time of locomotives. A diagram is presented of the system and various operational aspects described, including the computerized controls and weighbridge data handling.

The validity of the three and five formulae for the analysis of cane in the 1980's

W. B. Clarke and M. R. Player. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 81 - 87.

The 3 and 5 formulae were developed at the turn of the century by Dr. Kottmann of CSR Ltd. They relate Brix and pol % cane to Brix and pol % 1st expressed juice (IEJ): Brix % cane = Brix % IEJ ×

(100 - F - 3)/100 and pol % cane = pol % IEJ × (100 - F - 5)/100, where F = fibre % cane. The values of 3 and 5 are based on the assumption that some of the water in cane is not associated with the soluble solids and that there is a difference in behaviour between sugars and non-sugars. Comparison of values given by the two formulae with the results of direct cane analysis (using a disintegrator) and juice weighments shows that up to 1973 there was no effect on 1st expressed juice composition that would have distorted pol analysis using the formulae while the same is considered, on a probability basis, to be true for the period since 1973. The formulae are also thought to give a proper reflection of changes in extraneous matter contents. The findings are believed to refute the suggestion that processors have gained advantages in cane payment by distorting cane analysis through installation of powerful shredders and 1st mills.

Pan stirrer evaluation at Condong mill

G. A. Bentley, K. F. Miller and B. C. Palmer. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 193 - 202.

A 4-bladed impeller installed at the bottom of the central downtake in a low-grade pan increased heat transfer and the working volume as shown by a higher massecuite level, a 17% reduction in the overall cycle time and a 9% increase in massecuite quantity per cycle by comparison with the previous year. Fine grain formation, which had caused problems previously, was almost completely eliminated. A blade angle of 20° to the horizontal and a stirrer speed of 56 rpm were preferred to 15° and 43 rpm; even better circulation and higher boiling levels are considered possible by increasing the speed to 62 rpm, and it is suggested that a smaller motor than the 56-kW unit currently used could achieve the same results.

Forecasting pan stage tank levels

K. F. Miller. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 203 - 209.

In pan supervisory systems it is important to determine when tank levels indicate the need for changes in operations to maximize throughput. While accurate forecasting of levels is technically possible, the required sensors, transducers and computer time make it rather complex and expensive. An alternative approach is described which uses correlations between successive tank levels to obtain a simple mathematical model for forecasting purposes. Preliminary trials showed that the method was reasonably successful in forecasting *B*-molasses tank levels 30 min ahead.

Entrainment separation devices in raw sugar processing

P. G. Wright. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 219 - 227.

After listing the factors to be considered in selection of an entrainment separator, the author surveys the various types of separator used in Australia and then considers pressure drop through separators and their efficiency as a function of maximum operating velocity and system layout. The possibility of using entrainment separators to strip sugar dust from the air as it is discharged from granulators is also discussed.

Aerodynamics of bagasse particles

C. N. Anderson. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 235 - 239.

When subjected to a change in velocity of the surrounding gas, bagasse particles accelerate or decelerate to minimize the velocity of slip between gas and particle. The literature on pneumatic entrainment of bagasse as occurs in drying and conveying as well as in a bagasse furnace is reviewed and the results summarized in the form of empirical equations. The aerodynamic response of particles to a change in the velocity of a free air stream is discussed and a method of calculating suspended bagasse velocities presented. The time for bagasse particles to accelerate after an instantaneous change in free stream velocity caused by a jet of air is also examined.

Installation of modified Beta boiler at Millaquin sugar mill

J. C. Fleming, I. G. Flanders, J. R. P. Warren and P. T. Curran. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 267 - 272.

The erection, commissioning and operation of a John Thompson Beta boiler (originally designed for coal firing but redesigned for coal, bagasse and woodchip firing) are described. The boiler, of 34 tonnes/hr maximum continuous rating (MCR), has proved suitable for the supply of steam to the refinery section and distillery during the slack period at an average load of 20 tonnes/hr; during the crushing period it supplies steam to the factory, refinery and distillery in parallel with other boilers, using bagasse as primary fuel but with a coal/bagasse mixture being burnt when conditions dictate. The unit has allowed a reduction in the loads on the existing suspension-fired boilers to MCR or below, leading to improvements in boiler station operation and a cut in maintenance costs. General operation has been excellent. Some teething problems and their remedies are mentioned.

Modular boiler installation at Mulgrave mill. II

P. L. Stark, M. J. McIntosh and H. Flanders. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 273 - 277.

Further details are given of the work involved in raising the rating of the No.7 bottom-supported boiler at Mulgrave from 113 to 181.4 tonnes/hr using modular extension of the heating surface. The difficulties of uprating a top-supported boiler are discussed as

well as the benefits of modular construction. Adding modules is shown to be much cheaper than installing a new boiler of comparable steam rating. (See also Stark *et al.: I.S.J.*, 1989, **91**, 35A.)

Bagasse spreader design for suspension firing

T. F. Dixon and G. M. Jorgensen. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 279 - 283.

The design and operating requirements of bagasse spreaders are discussed and a number of types reviewed. Problems with a 59 tonnes/hr boiler at Mossman factory during the 1987 season included excessive bagasse accumulation on the grate and poor bagasse distribution with associated uneven air distribution and combustion instability. Installation of a spreader of modified design (which is described) significantly improved combustion and reduced bagasse deposition on the grate while also enhancing boiler response to load variations.

Extended length two-bearing screw conveyors

D. E. Roach and R. J. Woodward. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 285 - 291.

The elimination of intermediate bearings from screw conveyors reduces drag and removes maintenance problems associated with bearing contamination by the product and vice versa; there are also other benefits, including a considerable reduction in power consumption. A two-bearing screw conveyor 9.4 m long between bearing centres was installed for stored sugar reclamation at Broadwater factory for the 1980 season, since when a number have been introduced at the factory, having lengths in the range 4.5 - 10 m. The conveyors have presented no problems and require only routine bearing maintenance, and it is now the policy at Broadwater to install two-bearing screw conveyors for duties where belt conveyors are unsuitable. The mechanics of vertical, horizontal and inclined conveying are examined and design aspects discussed.

Advantages of solid-state A.C. motor controllers

N. E. R. Blackmur. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 293 - 294.

The advantages and disadvantages of traditional A.C. motor starting systems are discussed and the benefits of A.C. solid-state controllers indicated: a significant reduction in motor starting current peaks and in mechanical maintenance. The savings resulting from installation of the controllers on induced-draught fans and an injection water pump at Rocky Point factory are mentioned; it is planned to install more units for various applications.

Management of replacement parts for a sugar factory

G. M. Jorgensen. *Proc. 10th Conf.Australian Soc. Sugar Cane Tech.*, 1988, 295 - 297.

The importance of being able to repair components or provide replacements so as to avoid long periods of breakdown is discussed against the backcloth of present-day conditions under which the sophistication of modern machinery components makes it impossible to manufacture replacements in the factory workshop. Some advice is given on how to maintain an adequate stock of replacement parts and/or know where they can be obtained promptly if they are not repairable.

Impact wear on ceramic surfaces

A. G. Crooks. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 307 - 310.

While modern ceramics are sufficiently tough to withstand abrasion and are highly resistant to corrosion, they do have a low resistance to fracture. Tests conducted on partially stabilized zirconia (PSZ) showed that it had good shrink fit properties but, when subjected to simulated shredder hammer tests, proved to have heavy impact/sliding wear resistances lower than those of tungsten carbide or Dua block (also composed of carbides).

Developments in gear technology

P. A. Mayo. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 311 - 323.

Aspects of gear technology discussed include single helical gearing and its load transferring properties by comparison with straight spur gearing, high pressure angles to maximize tooth bending strength, addendum modification as a means of improving the meshing condition of involute gears, tooth root polishing and shot peening, hardened and ground gearing, enhanced gear steels that have a greater life expectancy than normal gear steels, stress and stiffness evaluation by finite element analysis, gear designing, drafting and engineering with the aid of computers, and gear metrology.

A new model for the uniaxial compression of prepared cane

J. G. Loughran and C. R. Murry. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 325 - 331.

A new model of bagasse compression is proposed which does not rely on specification of the volume of solids present in the sample, thus omitting the need to quantify such difficult aspects as the proportion of juice in unbroken cells, hygroscopic water, etc. The accuracy of prediction of the model is assessed by comparing the results with the experimental records of Holt who carried out a series of dynamic compression experiments between grooved platens to simulate the resistance offered by a sample of prepared cane to compression in a 2-roller mill[1]. Although further validation is required over a wider range of test conditions, the model values seem to agree with those obtained at low-to-medium compression ratios for a cane preparation fineness of 750/15.

1 ME Thesis, University of Queensland, 1963.

Beet sugar manufacture

Quality assurance

G. Wilson. *Paper presented at Conf. on Sugar Processing Research*, 1988, 5 pp.

White sugar quality control at British Sugar plc is described with mention of the successful independent assessment of the system at Newark factory using British Standard BS 5750 (identical to ISO 9000) as yardstick. The work at Newark was being replicated at the 13 other British Sugar factories, and successful assessment was expected by the end of 1988.

Features of the hydrodynamics of extraction in inclined twin-scroll diffusers

V. I. Salyuk *et al. Sbornik Pishch. Prom.*, 1987, **33**, 46 - 49 *(Russian)*.

In a study of cossettes flow in DDS diffusers of four different sizes, slices of carrot were introduced in batches at regular intervals; every 5 minutes, samples were removed at points along the diffuser and the proportion of carrot determined, from which response curves for pulsed flow disturbance were obtained. Cossettes movement was considered as a combination of two interacting flows: a circulating zone in which the retention time did not exceed the mean integral retention time for any of the sections investigated, and a lag zone which fell in proportion to the circulating zone with progress along the diffuser. The ratio between the two was greatest in the initial section of the largest unit (having a daily nominal capacity of 4200 tonnes) but was smallest overall, indicating the highest rate of material transfer between the two zones and least deviation from counter-flow of the diffusers investigated. Dead zones occur when low-quality cossettes are processed and/or overheating causes a loss in elasticity; addition of 0.015% by weight of industrial fat as surfactant every 30 min reduced these by 42%, cut the mean time in the lag zones, almost halved the coefficient of longitudinal mixing and reduced sugar losses by 0.08% on beet.

Electrical treatment of beet cossettes by a combined method

V. A. Shulika, I. S. Gulyi, M. P. Kupchik and L. G. Vorona. *Sbornik Pishch. Prom.*, 1987, **33**, 61 - 65 *(Russian)*.

Experimental electrical treatment of the juice-cossettes mixture before diffusion reduced losses as well as lime consumption in purification and increased juice purity and sugar yield. A.C. gives effective plasmolysis while D.C. coagulates the colloidal material; because of the differences in action between the two forms of current, a combined process was developed in which A.C. was applied at 100 V/cm followed by D.C. at 20 - 30 V/cm for 0.5 and 5.0 min, respectively. For the same level of raw juice decolorization, 0.5 - 1.0 min was required when the combined pre-treatment was used as against 10 - 15 min when only D.C. was used.

Application of electrothermal analogy to analysis of white sugar drying by thermal radiation

Le Chan Bin', A. F. Bulyandra, V. A. Tarapon, B. I. Verbitskii and Yu. P. Lutsik. *Sbornik Pishch. Prom.*, 1987, **33**, 65 - 67 *(Russian)*.

Experimental infrared drying of white sugar from the centrifugals is discussed. At a heat flow of 4500 W/m^2, the maximum drying rate (6 - 8°C/min) for a 16 mm bed of sugar occurred when the moisture level was 0.63%; at moisture levels in the range 0.40 - 1.10% there was negligible reflection of the infrared rays from the sugar and over the entire wavelength range there was no boundary layer resistance such as found in convection drying. A temperature gradient of 1 - 1.5°C/mm was evidence of considerable thermal diffusion of moisture within the bed. Reducing the moisture level from approx. 1.10% to a standard level of 0.14% was achieved in 10 min. Results of electrothermal analogy used to analyse the drying process are examined and a formula presented for heat flow.

A computer model of a diffuser

P. Slugocki. *Gaz. Cukr.*, 1988, **96**, 97 - 99 *(Polish)*.

A model of beet diffusion at Chelmza sugar factory is described, with details of all the input parameters and, as example, a table of outputs showing the effects of changes in the Silin number in the range 7.3 - 8.3 m/100 g on performance and sugar production costs per 100 tonnes of beet.

The effect of certain parameters on the process of sugar extraction from beet cossettes

I. A. Oleinik, A. V. Sadych, V. V. Mank and V. T. Kober. *Gaz. Cukr.*, 1988, **96**, 100 - 101 *(Polish)*.

See *I.S.J.*, 1988, **90**, 54A.

Juice liming systems

S. Ginal. *Gaz. Cukr.*, 1988, **90**, 101 - 103 *(Polish)*.

Descriptions are given of a conventional flowmeter-type system for automatic juice liming and of a modified dosing system in which the milk-of-lime at controlled density is fed to a constant-level tank in which a bucket wheel rotates. Under control from a juice flowmeter, the wheel discharges milk-of-lime as a section finds itself opposite the exit port leading via the collector to the liming tank. Lime discharge automatically stops when juice flow is inadequate. The system operated successfully during the 1986/87 campaign.

The industrial importance of the recrystallization process and its computer modelling

L. I. Trebin, Yu. I. Skripko, V. V. Mank, N. I. Shtangeeva and A. P. Lapin. *Sbornik Pishch. Prom.*, 1988, **34**, 10 - 13 *(Russian)*.

While recrystallization increases the final size of the crystals dropped from the pan, it fails to eliminate all fine crystals (leading to greater losses in the

centrifugals) and reduces both pan yield and average crystallization rate. To maximize the positive aspect of recrystallization, a mathematical model was derived which permits approximate evaluation of the mean crystal size as a function of amplitude and number of fluctuations in temperature of the massecuite.

Pressure of water vapour during boiling of sugar solutions

D. E. Sinat-Radchenko. *Sbornik Pishch. Prom.*, 1988, **34**, 42 - 46 *(Russian)*.

Nomograms are presented for determination of: the temperature fall between heating vapour and juice, pressure of the water vapour above the juice, and hydrostatic pressure of a column of juice and of the vapour-juice mixture. The nomograms apply to temperature, pressure and Brix ranges normal for evaporation. Worked examples are given.

The effect of non-sugars on the rheological properties of sugar solutions

R. Ts. Mishchuk, L. G. Belostotskii, S. I. Sagan', A. A. Lipets and A. E. Arkhipets. *Sbornik Pishch. Prom.*, 1988, **34**, 46 - 50 *(Russian)*.

Investigations of the effects of electrolytes on the viscosity of sucrose solutions at 10 - 90°C over a wide range of electrolyte and sugar concentrations demonstrated how some increased it while others decreased it and how the temperature effect depended on the non-sugar in question. An explanation of the mechanism of the action on viscosity is offered.

Non-sugars adsorption on refrigerant crystalline hydrates

I. S. Gulyi, V. E. Banashek and Yu. I. Fedotkin. *Sbornik Pishch. Prom.*, 1988, **34**, 52 - 55 *(Russian)*.

An experimental unit for non-sugars removal from factory products by adsorption on crystalline hydrates of a refrigerant such as freon-12 (dichlorodifluoromethane)[1] is described. Hydrate formation and non-sugars adsorption take place in a vessel housing a U-shaped mixer rotating at constant speed within a wide range of values; coolant is pumped to a cylinder inside the vessel to maintain a constant temperature. A sugar solution or other product to be purified is pumped up into the process vessel simultaneously with the liquid freon-12; since the pressure in the vessel is somewhat lower than that in the tank from which the sugar solution is transferred, the freon-12 boils and, with intensive mixing, forms crystalline hydrates; these adsorb the sugar solution and, being of sufficiently low weight, float to the top of the vessel and are caught up by a horizontal screw press astride it. The purified solution is squeezed out and discharged via the jacket surrounding the screw press to a heated receptacle, while the hydrates are discharged to another heated vessel where they melt. Freon-12 vapours from both vessels are condensed, so that practically all the refrigerant is recovered. Experiments with sugar solutions of approx. 86 - 97 purity showed that decolorization efficiency fell with rise in purity and was also governed by concentration.

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

M. Tömördi and L. Németh. *Cukoripar*, 1988, **41**, 103 - 106 *(Hungarian)*.

The performances of a number of Hungarian and other anti-foam agents applied to diffusion juice were assessed and the effects of pH, temperature and concentration determined. Glanapon DS 44 and BASF RPE 2520 were more effective than the Hungarian products Sugar KTC-2 and Sugar KTC-4, but Sugar KTC-2 considerably reduced the amount of foam under optimum conditions (pH 5.4, 30 - 70°C and 5 - 25 ppm) by comparison with the untreated control.

Energy economy in the sugar industry during the 1987/88 campaign

P. Wertán. *Cukoripar*, 1988, **41**, 107 *(Hungarian)*.

The energy consumption in the Hungarian sugar industry is briefly discussed and the level indicated at each of the 12 sugar factories.

Potential applications of the Siemens automatic control system in the sugar industry - the Teleperm-M automatic system at Selyp sugar factory

J. Németh. *Cukoripar*, 1988, **41**, 61 - 65, 112 - 115 *(Hungarian)*.

The components of the Siemens Teleperm-M system of automation and its operation are described, with details of the automatic boiling scheme at Selyp.

Optimization of batch sugar centrifugal operation - molasses separation - determination of real-time loss and balance

D. Leconte. *Ind. Alim. Agric.*, 1988, **105**, 625 - 627 *(French)*.

Two patented systems are described. The first is designed to reduce enrichment of the mother liquor with dissolved sugar and thus improve separation between green and wash syrup; this is achieved by applying a fine mist spray of water just before separation of the two molasses so as to provide almost instantaneous dilution of the green syrup and its very rapid removal. The second system is designed to provide a real-time measurement of losses in washing and of the sugar yield relative to massecuite and is based on the ratio between the thickness of the sugar layer before and after washing as measured by a sensing element mounted on the end of a rotary arm and in contact with the layer surface; a simple trigonometrical calculation requiring knowledge of only the geometry of the element and its angle of rotation gives the layer thickness.

1 Fedotkin *et al.*: *I.S.J.*, 1989, **91**, 64A.

Laboratory studies

Evaluation of ICUMSA methods for the determination of ash in final molasses

A. Perdomo M., F. Fernández A. and C. Almenares A. *ATAC*, 1986, **45**, (3), 36 - 39.

The official method involves measurement of the conductivity of a solution of 5 g of the sugar in 100 cm^3 of twice-distilled water; if the conductivity exceeds 500 µS/cm part of the sugar is substituted by refined sugar of low ash content and a correction made. In a tentative method addition of the refined sugar is omitted. Samples of 15 sugars were analysed by both methods and a correlation of 0.966 was obtained between the two methods while the tentative method showed better repeatability, was faster and used less reagents. Its adoption is thus recommended.

Buffer capacity of cane juices as an indicator of microbial activity. Its influence on the process

M. T. Hernández N. and H. Cuéllar F. *ATAC*, 1986, **45**, (3), 40 - 46.

The buffer capacity of different mill juices was studied in parallel with known contamination indicators such as the resazurine test and dextran formation. The buffer capacity was found to behave as an indicator of microbial activity with a sensitivity higher than that of the other tests. The effect of increase in buffer capacity on lime consumption in the factory was studied. An abnormal distribution of calcium during the crystallization process was detected, with a higher accumulation in sugar.

Adsorption by activated carbon of high molecular weight compounds in the cane sugar industry

M. A. García, I. F. Bugayenko and J. R. Pérez R. *CubaAzúcar*, 1986, (April/June), 3 - 7 *(Spanish)*.

High molecular weight compounds were separated from molasses by membrane filtration and static adsorption isotherms determined at 20°C using Norit activated carbon and different amounts of the compounds. The results were compared with those obtained by carbon treatment of the original molasses. By variation of the time of contact, the optimum for adsorption was found to be 20 hours. It was also demonstrated that a linear relationship existed between optical density and the concentration of high M.W. compounds. Graphs of the isotherms show that there was a significant increase in adsorption with higher concentration, and it was also concluded that, for the most effective use of the activated carbon it was best to extract high M.W. compounds from sugar products with the highest concentrations.

Chemical deterioration of raw sugars

E. L. Ramos, J. A. Urrutia and A. Alamo. *CubaAzúcar*, 1986, (April/June), 8 - 14 *(Spanish)*.

The literature on deterioration of raw sugar stored in bulk is reviewed and methods for its reduction are listed. The correlation coefficients are worked out between the degree of deterioration and five variables (amino-acids concentration, pH of a 50°Brix solution, initial colour, buffer power and safety factor), whereby the susceptibility of a particular sugar may be assessed. If sugar is to be stored for more than five months, the least expensive method of avoiding deterioration is to treat the syrup from which it is boiled with alkali.

Comparative study of the variation in value per tonne of cane calculated from polarimetric and chromatographic sucrose

M. S. G. de Melo, I. C. Costa, G. Martins and F. G. Pinto. *STAB*, 1986, **5**, (1), 40 - 42 *(Portuguese)*.

Over a period of 120 days cane juice samples were analysed by polarimetry and using HPLC for determination of sucrose, and the values of the cane calculated. The differences in the values of the sucrose were only slight in September and October but rose to around 7% in November before falling to 5% in December. The value of the cane followed a similar pattern, the difference rising to 10% in November and falling to 5% in December. The value of the cane can only be given reliably by polarimetry when there is no deterioration.

Study of high molecular weight compounds in the cane sugar industry

I. F. Bugayenko, M. García F. and V. D. Scherbujin. *CubaAzúcar*, 1986, (July/Sept.), 27 - 31 *(Spanish)*.

A membrane filtration technique was used for the separation of high molecular weight compounds from a 5% solution of cane molasses and the fractions examined by infra-red spectroscopy. The results showed the fractions to contain mixtures of polysaccharides, peptins or biopolymers, the polysaccharides being in the form of hemicellulose.

HPLC techniques in process control in sugar factories

W. S. C. Tsang, M. A. Clarke and M. M. Valdes. *Paper presented at Conf. on Sugar Processing Research*, 1988, 19 pp.

Results obtained from cane sugar factory studies are reported which demonstrated the advantages of using HPLC to determine sucrose and invert sugar in juices, invert formation and removal in clarification and its formation in evaporation, sucrose in bagasse and filter mud and trace amounts of sugar in waste water. HPLC analysis of sucrose degradation in stored cane juice that had been passed through a membrane filter revealed the presence of kestose (a trisaccharide) after 2 days; by comparison, unfiltered juice exhibited no trisaccharide peak after 4 days but was cloudy (probably as a result of dextran formation and bacterial growth). Kestose and invert sugar were found to be the major degradation products in filtered raw sugar solutions that were injected

daily into HPLC systems. It is suggested that the kestose found in both juice and raw sugar could be one known to be produced as the result of enzyme action on sucrose. The results obtained by the use of the three different HPLC columns in determining raffinose in beet molasses showed that an ion exchange system gave the highest reading since all three kestoses (1-, 6- and neo-kestose) were co-eluted with the raffinose, as against co-elution of only 1-kestose in a reverse-phase column; an amino-bonded phase silica system gave the most accurate analysis of raffinose since it was able to separate the kestoses and galactinol from raffinose, but it has the disadvantage of employing acetonitrile-water as mobile phase and a non-regenerable column compared with aqueous solvents and regenerable columns with the other two systems which also have a relatively short run time. Comparison of HPLC results with those given by an enzymatic method showed no statistically significant difference where the amino-bonded column was used. A new sweetener, Neosugar, is mentioned that is manufactured from sucrose using an enzyme obtained from *Aspergillus niger* ATCC 20611; the sweetener is a mixture of 1-kestose, nystose and 1'-β-fructofuranosylnystose.

Comparison of methods for determination of sugars in plant materials

A. Ya. Silin. *Zh. Anal. Khim.*, 1988, **43**, 2), 308 - 310; through *Anal. Abs.*, 1988, **50**, Abs. 9D94.

Plant samples, including sugar beet, were analysed for 0.6 - 67% of soluble reducing carbohydrates by conventional anthrone and Bertrand methods and by a photometric method with 2,4-dinitrophenol. The last method was found to be the most precise and is therefore recommended for routine determinations.

Investigation of the phase equilibrium in the system freon 12-sucrose solution

I. M. Fedotkin, E. I. Kleshchunov and V. E. Banashek. *Sbornik Pishch. Prom.*, 1987, **33**, 34 - 37 *(Russian)*.

Freon-12 (dichlorodifluoromethane, a refrigerant) forms crystalline hydrates under suitable pressure and temperature conditions; when this hydration takes place in a sucrose solution with subsequent cooling, crystals are deposited at the eutectic temperature. Application of this system to purification of intermediate products in place of e.g. carbonatation has also been studied. Experimental determination of phase equilibria for freon 12-sucrose at pressures of 78 - 323 kPa, temperatures of approx. 0.5 - 9.5°C and sucrose concentrations of 12, 30 and 50% is reported. An equation defining the critical temperature at which hydrates formed could be used to determine the phase equilibrium at any sucrose concentration.

The effect of dextran on sucrose solubility and crystal growth

A. P. Kozyavkin and L. R. Karrasana. *Sbornik Pishch. Prom.*, 1987, **33**, 52 - 54 *(Russian)*.

Studies showed that addition of dextran at 0.1 - 2.0% by weight to 20% sucrose solution increased solubility, the effect being greater up to 0.5% dextran than with the higher doses; equations were derived for the saturation coefficient as a function of dextran content in the two ranges. The viscosity of a 60% sugar solution rose considerably with increase in dextran content at 40 - 60°C. For investigation of the effect on crystal growth, flawless crystals were placed in a chamber through which a sucrose solution of low supersaturation was passed so as to give uniform crystals having characteristic faces and to exclude the surface effect on growth rate; a pure sugar solution and one containing 0.1% dextran were passed through a chamber containing 20 crystals for 120 min at 60°C and 1.02 supersaturation. Results showed a sharp fall in crystal growth rate in the presence of dextran, although the shape remained practically unchanged; however, the shape was affected by larger amounts of dextran, as demonstrated by further tests in which crystals having a length:width ratio of 1.6 were the ones to undergo greatest fall in numbers with increase in the amount of dextran from 0.1% to 0.5%.

Thermophysical properties of sugar beet root tissue

D. E. Sinat-Radchenko. *Sbornik Pishch. Prom.*, 1987, **33**, 59 - 61 *(Russian)*.

From data gathered on thermophysical properties of beet tissue, formulae are derived for density, heat capacity at constant pressure, thermal conductivity and thermal diffusivity at temperatures in the range 0 - 80°C and values of dry matter normally encountered in practice. Formulae are also derived for the cryoscopic constant of beet tissue of 10 - 30% dry solids and of ice in the tissue water when it is frozen. Calculated values are given.

Dextran analysis using an enzyme-linked immunoassay procedure

J. H. Curtin. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 229 - 234.

A competitive assay procedure for dextran determination in raw sugar is described in which an amount of standard dextran fixed on a solid support medium is reacted with dextran in solution from the sample and a fixed amount of dextran antibody (obtained from sheep) labelled with horseradish peroxidase. The resulting complex is isolated and quantitatively analysed by a simple spectrophotometric procedure for which a reagent consisting of 2,2'-azino-di-[3-ethylbenzthiazolin sulphonate(6)] diammonium salt dissolved in acetate buffer is used as indicator. Good correlation was found between results obtained using this method and the alcohol haze method; the new method is simple to use, requires no sophisticated equipment and is specific for cane dextran.

By-products

Heat exchangers – multitubular and spiral

H. P. H. Ackermann and C. F. Coelho. *Bol. Técn. Copersucar*, 1986, (35/86), 35 - 43 *(Portuguese)*.

Cane juice intended for fermentation to alcohol is initially pasteurized and clarified and then cooled to 30 - 32°C. Multitube and spiral heat exchangers have been designed at the Copersucar Technical Centre for this purpose and the designs are described and illustrated, with details of their performance and advantages, the latter including simple construction, low cost and high thermal efficiency with relatively low pressure drop.

Process alternatives in the treatment of juice for the distillery

D. T. Oliveira, W. Pizaia, H. P. H. Ackermann and C. E. V. Rossell. *Bol. Técn. Copersucar*, 1987, (36/87), 25 - 31 *(Portuguese)*.

The quality of juice is vital to the operation of the distillery and it must be treated to remove solid matter, colloids, etc., and to prevent microbial contamination. Various processes are employed in Brazil and comparative data for four different procedures are quoted with additional data on capital and operational costs involved for each.

Considerations on efficiency in the industrial production of sugar and alcohol

I. C. Macedo. *Bol Técn. Copersucar*, 1987, (36/87), 32 - 35 *(Portuguese)*.

The efficiency is calculated as the quantities of sucrose equivalent (i.e. of sugar, alcohol or other products) produced as a fraction of that entering the factory. Equations are developed for the calculation of efficiency and two examples presented.

Bagasec – bagasse dryer

A. Arrascaeta, P. Friedman and U. Pena. *CubaAzúcar*, 1986, (July/Sept.), 13 - 26 *(Spanish)*.

The development of the ICINAZ bagasse dryer, its evaluation and introduction into sugar factories are discussed (See also *I.S.J.*, 1987, **89**, 68 - 71).

Industrial steam cleaning tests. I

V. S. Malovichko. *Sbornik Pishch. Prom.*, 1987, **33**, 19 - 22 *(Russian)*.

The essence of steam cleaning lies in the penetration of the layer of scale by water which is then rapidly converted to steam by heating; with sufficiently intensive steam formation, the steam cannot escape through the pores of the scale, which therefore cracks and detaches itself from the surface. Reheating of the water inside vertical tubes causes its expansion and upward surge, but a counter force then causes deceleration of the upward flow; this cycle is repeated a number of times to generate a pulsating effect and to help remove the broken scale from the walls. However, a more effective variant of the method involves complete filling of the vessel with complete immersion of the tubes and the use of rapid rise and fall in pressure; the rise in pressure causes all the heat in the water to be used to raise the temperature in the tubes and to intensify the penetration of the water to the heating surface, while the rapid fall in pressure causes intensive boiling within the layer of scale which thus cracks and falls away, while the water is forced through the tubes at a considerable speed. This method has been used successfully on a quadruple-effect evaporator used to concentrate molasses vinasse at an alcohol distillery.

Microbial population of sugar juice that is neither affected nor deteriorated by frost - its relation to alcohol fermentation

Z. O. López, I. E. Moreño, F. A. Fogliata and H. G. Ayala. *Sugar y Azúcar*, 1988, **83**, (9), 21, 24, 26 - 27, 30 - 31, 34.

The effect of frost on the increase in bacterial counts in cane juice is discussed and the numbers of aerobic, anaerobic, lactic and coliform bacteria, yeast and fungi and *Leuconostoc mesenteroides* in juice from frost-affected and unaffected cane are compared. The activities of the homo- and heterofermentative sub-groups within the lactic bacteria group are discussed, including the formation of dextran; the micro-organisms responsible for the greater proportions of dextran and levan in juice from frosted cane compete with yeast for the sucrose as specific substrate and thus reduce the alcohol yield.

A note on the feeding of pregnant sows with pig manure silage and final molasses alone or enriched with other feedstuffs

J. Díaz, C. P. Díaz and A. Elías. *Cuban J. Agric. Sci.*, 988, **22**, 179 - 182.

Trials demonstrated the value as fodder for pregnant sows of a silage made from pig manure and molasses; replacement of some of the molasses with maize or other feed component was not justified since there was no improvement in the reproductive indices and feed costs were higher.

Partial substitution of cereals by dehydrated sugar cane meal for pre-fattening pigs

E. Lamazares, P. Lezcano, A. Elías and E. A. Valdés. *Cuban J. Agric. Sci.*, 1988, **22**, 183 - 187.

In experiments involving 160 pigs, replacement of cereal with up to 30% dehydrated ground cane gave results similar to those for the control ration and could be more cost-effective.

The inclusion of zeolite in final molasses diets for broilers

P. Pérez, L. M. Fraga, M. C. Boffil and N. Pérez. *Cuban J. Agric. Sci.*, 1988, **22**, 189 - 192.

The inclusion of 3% zeolite in broiler chicken diets containing 10% final

molasses improved feed conversion and reduced the metabolizable energy costs per unit live weight gain by comparison with the control.

Sugar and sucrose ester effects on maize and wheat starch gelatinization patterns by differential scanning calorimeter

J. S. Buck and C. E. Walker. *Starch/Stärke*, 1988, **40**, 353 - 356.

Investigations of the effects of added sugars (sucrose, fructose and glucose) on the gelatinization behaviour of maize and wheat starch showed that while any one of them increased the onset and peak temperatures it decreased the enthalpy required for gelatinization. The addition of 1% and 3% sucrose ester affected both gelatinization temperature and enthalpy only in the case of the wheat starch-sucrose combination; the onset and peak temperatures rose and the enthalpies decreased with increase in ester concentration. The implications of this are interesting for the baking industry which uses mainly wheat starch in combination with sucrose.

Ensilage of beet leaves with dry pulp and straw to reduce seepage

H. Honig, G. J. Schild and F. P. Engling. *Zuckerrübe*, 1988, **37**, 269 - 271 *(German)*.

Experiments are reported in which addition of dry pulp to beet leaf silage at 14% w/w on fresh leaves reduced seepage by 78% in the period from October to mid-February and dry matter losses by 83%. Placing the silage on a bed of straw contributed to seepage reduction. The additives caused little change in the nutrient composition of the silage, but the pulp reduced the buffer effect so that the pH fell markedly. When fed to dairy cows, the mixed silage raised milk yields slightly but without any effect on fat or protein content.

Beet leaves are no waste

K. H. Kromer. *Zuckerrübe*, 1988, **37**, 272 - 274 *(German)*.

The high moisture content presents seepage problems in the ensilage of beet leaves. However, experiments have shown that the addition of dry pulp to beet leaf silage will give a feed of 22 - 30% dry matter and of high energy concentration while minimizing seepage. Dry pulp is also suitable as a means of preventing seepage with other wet silages.

Xanthan gum: a microbial polysaccharide obtained from sugar with extraordinary properties and a wide range of applications

E. G. Fentaner. *GEPLACEA Bull.*, 1988, **5**, (9), 8 pp.

The physical and chemical properties of xanthan gum and its various applications in the food industry are discussed and details given of its production from glucose or sucrose by fermentation with *Xanthomonas campestris*.

Industrial steam cleaning tests. II

V. S. Malovichko. *Sbornik Pishch. Prom.*, 1988, **34**, 23 - 27 *(Russian)*.

Superheated steam was used in cleaning tests on the quintuple-effect evaporator at Chernovtsy alcohol distillery, where it is used to concentrate molasses vinasse from 5° to 65°Bx; the effectiveness of treatment was gauged from the increase in circulation and from the ability of water to flow through the tubes which previously had been blocked with scale. (See also Malovichko: *I.S.J.*, 1989, **91**, 65A).

Formation of exopolysaccharides by yeasts of the *Saccharomyces* genus

T. G. Pirog, E. V. Stabnikova and T. A. Grinberg. *Sbornik Pishch. Prom.*, 1988, **34**, 74 - 77 *(Russian)*.

Investigations are reported on synthesis of food-quality polysaccharide by culturing various strains of *S. cerevisiae* on a substrate of 4% sucrose, 4% sucrose + 1% ethanol or 2% ethanol. Highest biomass and polysaccharide yields were obtained from a substrate containing only ethanol, but a higher specific activity of polysaccharide synthesis was achieved with sucrose alone or with ethanol (the levels being identical), while sucrose alone gave the lowest polysaccharide yields.

Effect of X-rays on alcohol fermentation

P. N. Volovik *et al. Sbornik Pishch. Prom.*, 1988, **34**, 77 - 79 *(Russian)*.

Exposure of molasses to a 20 kP dose of X-rays substantially reduced the bacterial counts and particularly those of acid-forming bacteria, so that alcohol yield rose by 1.1%; X-ray treatment did not adversely affect basic fermentation parameters.

Fuel ethanol

J. F Molle. *Ind. Alim. Agric.*, 1988, **105**, 661 - 672 *(French)*.

The petroleum market is examined and the potential of a number of alternatives as automotive fuel discussed, with particular attention focused on ethanol as produced from sugar beet or grain. Various aspects of using blends of alcohol with gasoline are considered (including the economics and advantages of ethanol), and it is suggested that Europe could produce 30% of its automotive fuel needs from a renewable source.

Vertical mulching with filter cake

Anon. *Ann. Rpt. S. African Sugar Assoc. Expt. Sta.*, 1987/88, 27.

Vertical mulching with filter cake at 100 tonnes/ha fed into the subsoil caused a highly significant increase in cane and sugar yields and in estimated sugar recovery/ha (84.1, 9.2 and 7.8 tonnes/ha, respectively, compared with 67.9, 7.5 and 6.4 tonnes/ha without mulching) and gave better results than vertical mulching with topsoil or sand.

that can be solved for C_s numerically, subject to appropriate initial conditions, that is: $C_{s,o}$, C_{imp}, $X_{w,o}$, crystal content and mean crystal size at the beginning of crystallization. As usual, dSC/dT and dC_{imp}/dt are taken as zero and X°_s, the solubility of sucrose in pure solutions from Smelik *et al.*[16]. The cooling rate dT/dt is either a known function of time or, when a calculation of the so called optimum cooling profile $(dT/dt)_{op}$ is desired, the result of integration of equation 5 in conjunction with

$$(dR/dt)\ (dt/dT)_{op} = 0 \qquad (6)$$

The mass growth rate g (kg/kg water/s) is related to R, the linear growth rate by

$$g = 3\alpha N\rho L^2 dL/dt = 6\alpha N\rho L^2 R \qquad (7)$$

where R is in turn a function (equation 4) of σ, T, C_{imp} and, possibly, other parameters. The volume factor α (= 0.36) was calculated from data of Hrubisek, taking the characteristic length of the crystal L as longest dimension of the crystal.

Experimental/analytical procedure

Experiments were carried out in a stirred (4 rpm, 19 Watts input), jacketed, sealed 10-litre steel crystallizer connected to a water bath that, in turn, was controlled with a programmable temperature controller. The magma was prepared either in the laboratory by mixing screened refined sugar with upgraded and concentrated final molasses or, in a factory, by transferring *C*-magma into the experimental crystallizer. The magma was mixed for about an hour at a temperature close to saturation (usually between 70° and 75°C) and then cooled in a pre-programmed way and sampled periodically. The actual temperatures of the magma were read and used in the calculations as there was a noticeable lag at higher cooling rates between the programmed temperatures (water bath) and the actual temperatures of the magmas. After reaching the final temperature (usually around 40°C) the magma was kept at this temperature for another 40 to 50 hours. The solubility was then calculated for each run from the average of the last two or three measurements of the sucrose concentrations when no apparent drop in sucrose concentration occurred.

The sucrose content was measured in the mother liquor, separated on a pressure-filtration funnel, using an HPLC equipment with a column packed with an ion-exchange resin in the Ca form (Waters' Sugar-PAK 2). The true solids content of the mother liquor was obtained using an empirical correction[17] of the refractometric Brix (1:1 dilution):

$$1/X_{TDS} = 1.013/X'_{TDS} + 0.00932/X_s \qquad (8)$$

The crystal content was calculated from sucrose analysis of the magma and mother-liquor. The mean crystal size L was obtained either from the sieve analysis or microscopic observation that also confirmed the absence of nucleation. The low-purity solutions used in the investigations presented a cross-section of the 1986 and 1987 Louisiana molasses[18].

Derivation of the growth rate data

The solution of equation 5, i.e. C_s as a function of time, should give values of sucrose mother-liquor concentrations matching closely those measured experimentally, provided that a correct growth rate equation is used. Thus, matching the solution of equation 5 with the measured values allows us to find values of Q_1 and Q_2 from the tested growth rate equation for each experimental run. A two-parameter quasi-Newton search using the IMSL subroutine ZXMWD[19] for constrained minimization problems required from 500 to 1000 calculations of the minimized function (i.e. the sum-of-differences-squared between the measured and calculated values) and about 100 seconds of CPU time on an IBM 370/3033 computer. The explicit forward difference method was used to integrate equation 5 with a variable time step Δt, chosen such that

$$\Delta t = a/R;\ a = 0.05\mu \qquad (9)$$

in order to minimize the CPU requirements while preserving the accuracy and stability of the solution. Each run covers the full range of temperatures as well as a range of supersaturations (Figure 6) which, of course, is a result of the growth rate and the cooling profile applied. Thus, although not critical to the evaluation of the growth rate kinetics, the cooling profile should resemble industrial practice if it is to provide data relevant to the industry.

Results and discussion

An example of the raw data, calculated equilibrium concentrations and the fitted curves for one run are shown in Figure 5 (the curves corresponding to the models I and II, i.e. equations 4 and 13, differ only marginally and cannot be distinguished). Including the initial composition, a total of 8 experimental points were collected over a period of 60 hours. The sucrose content was lowered from the initial 37.9% (purity 42.8) to 29.6% (purity 33.9) while cooling from 73 to 39°C. The supersaturation, proportional to the vertical deviation of the experimental and equilibrium curves, was close to zero at the start of cooling, because of the initial delay before the cooling commenced as well as high growth rate at elevated temperatures. It became progressively larger as the growth rate and the temperature diminished and approached zero after the thermal equilibrium was reached. This is further illustrated in Figure 6 where the points represent supersaturations in each run calculated at each sampling time (usually 7 or 8 in each run). The curves approximately delineate the upper and lower bounds of the covered regions. This further reflects the fact that maximum supersaturations were reached at intermediate temperatures. At high temperatures, above 60°C, the supersaturations at the sampling times lie mostly between 0.02 and 0.1, while at the low end, around 40°C, the range covered was between zero and 0.14. Fitting of the measured values with the model equation 4 is illustrated in Figures 7a and b. Here each pair of Q_1 and Q_2

16 Smelik *et al.*: *Zucker*, 1970, **23**, 133 - 138, 595 - 599; 1971, **24**, 138 - 142.
17 Matthesius & Mellet: *Proc. S. African Sugar Tech. Assoc.*, 1976, **50**, 206 - 211.
18 Saska: *Sugar J.*, 1988, **50**, (12), 4 - 6.
19 IMSL Inc., Version 9.2, Houston, Texas, USA.

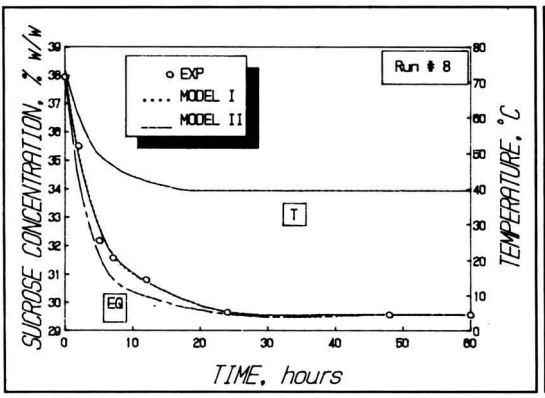

Fig. 5: Sucrose concentration in the mother liquor, Run 8. EXP = experimental points, EQ = equilibrium sucrose concentration, MODEL I = equation 4, MODEL II = equation 13, T = temperature

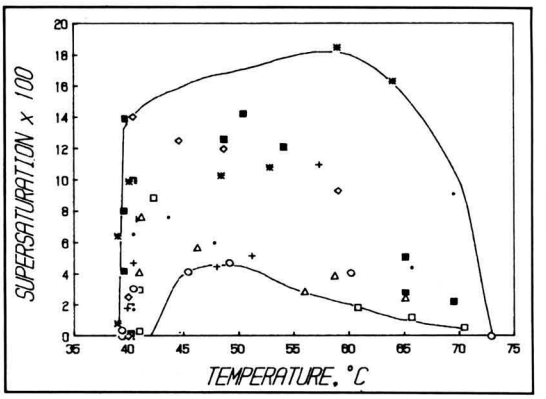

Fig. 6: Supersaturation of the mother liquor calculated at all sampling times for all runs. The curves represent the approximate upper and lower limits of the supersaturation and temperature ranges covered in the experiments

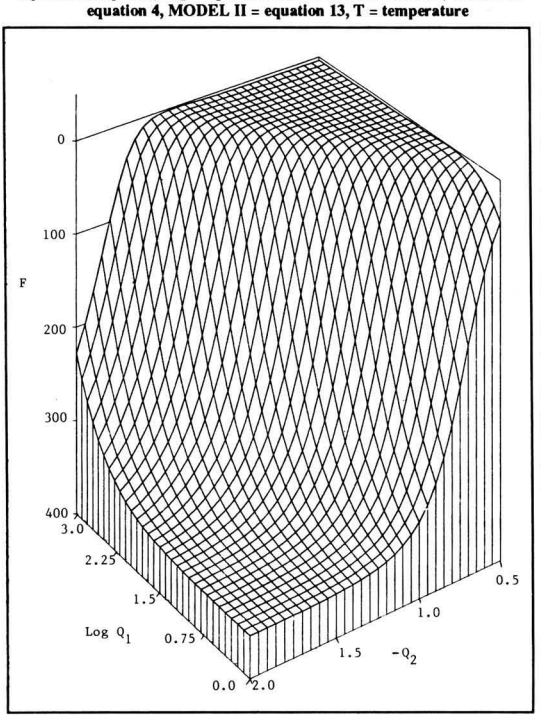

Fig. 7a: Fitting of the experimental data with equation 4, Run 8. F = sum-of -differences-squared, units of C_s^2; Minimum F at Q_1 = 91.7 μ/min, Q_2 = −1.01

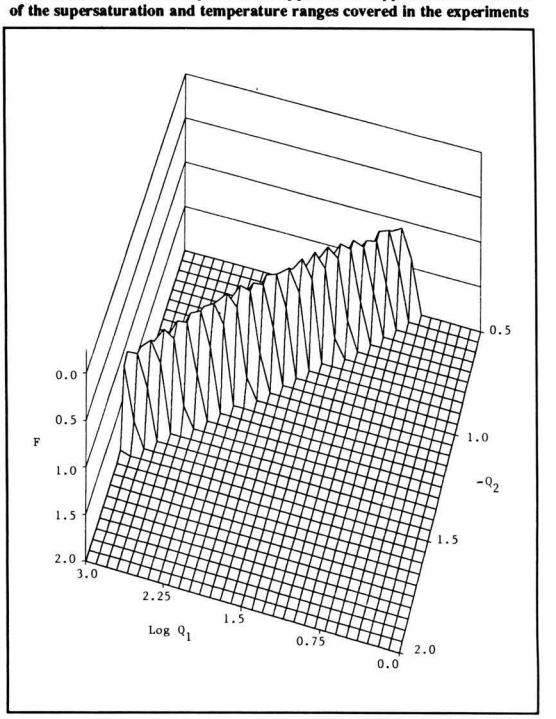

Fig. 7b

yields a $C_s(t)$ curve giving a single value of the sum-of-differences-squared (F), plotted on the vertical axis. The minimum (maximum of the inverted surface in Figure 7) is given at Q_1 = 91.7 μ/min and Q_2 = −1.010. Figure 7b, representing an exploded plot in the vertical direction, documents further the weak dependence of the minimum as well as the correlation between Q_1 and Q_2 along the diagonal. This will be exploited later to eliminate one of the parameters from

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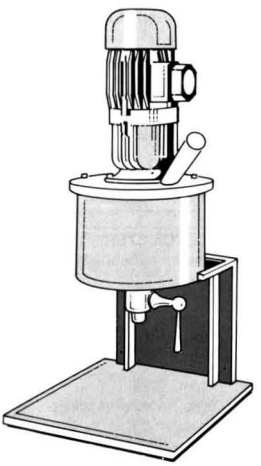

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1. Report of Crystallographic Laboratory University of Utrecht, Holland.

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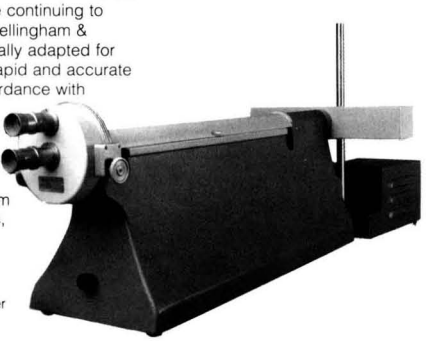

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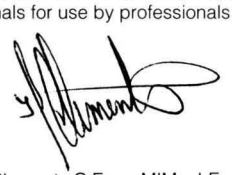

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2. E. Hugot - Handbook of Cane Sugar Engineering. 1960. p. 517

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7	0.99	4.55
8	0.99	4.52
9	1.02	2.75

Table II

Run	Q_1, μ/min	$-Q_2$	F	√F/N
1	113.7	1.584	0.3	0.18
2	173.2	1.614	0.6	0.26
3	14.0	1.309	0.9	0.32
4	5.1	1.048	0.8	0.32
5	48.8	1.012	0.9	0.33
6	18.4	1.019	0.3	0.19
7	48.0	1.110	0.6	0.27
8	91.7	1.010	0.8	0.32
9	53.6	1.724	0.4	0.21

F = sum-of-differences-squared, units of C_s^2
N = number of experimental points

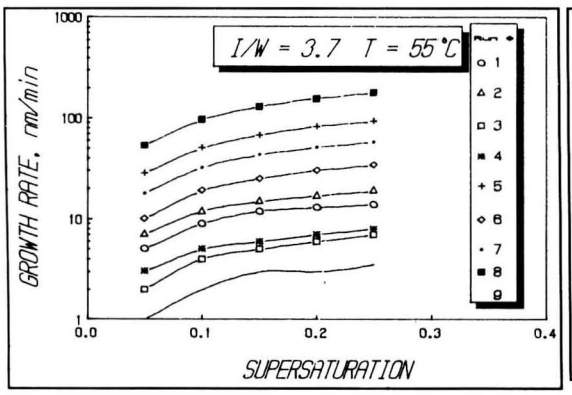

Fig. 8: Calculated growth rate of sucrose (equation 4) for all runs (parameters Q_1 and Q_2 from Table II); I/W = 3.7; temperature 55°C

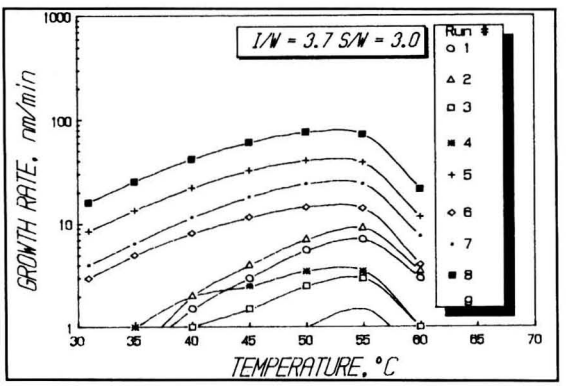

Fig. 9: Calculated growth rate of sucrose (equation 4) for all runs (parameters Q_1 and Q_2 from Table II); I/W = 3.7, S/W = 3.0 (Purity = 44.8, saturation temperature 61°C)

the growth rate expression.

The summary of all runs is given in Tables I and II. I/W varied from 2.8 to 4.7 with the lower values corresponding to the laboratory runs and the higher values to the massecuites boiled in a sugar factory. The values of Q_1 range from 5 (run 4) to over 170 μ/min (run 2); and of Q_2 from –1.01 (run 8) to –1.7 (run 9). The agreement between the measured and calculated values is excellent. The mean deviation is from 0.2 to 0.3, which is of the same order of magnitude as the estimated precision of sucrose determination.

The comparison of the growth rates corresponding to the nine sets of Q_1 and Q_2 from Table II is best done as documented in Figures 8 and 9 for an arbitrary temperature and composition within the range covered by the experiments. A temperature of 55°C, I/W of 3.7 and SC = 1.03, representing the mean values in our experiments, were chosen in Figure 8, while I/W = 3.70 and S/W = 3.0 (purity 44.8, saturation temperature 61°C) were used in Figure 9. The spread of the calculated values of R is considerable. For instance, at the maximum growth rate at around 55°C (Figure 9), the values range from 0.002 to 0.1 μ/min. Comparing with Table I, it is observed that the higher calculated values (curves) correspond to the runs with higher I/W. This suggested a modification of equation 4 to account for an additional (positive!) effect of impurities in the form

$$R = Q_1 \eta^{-Q'_2(W/I)\sigma} \quad (10)$$

where

$$Q'_2 = -Q_2(I/W) \quad (11)$$

In order to facilitate the parameter estimation as well as to save CPU time, further simplification was achieved by correlating Q'_2 and Q_1 (Figure 10) to give

$$Q'_2 = 2.934Q_1/(1 + 0.6Q_1) \quad (12)$$

so that the new growth rate equation becomes

$$R = Q/(2.934 - 0.6Q)\, \eta^{-Q(W/I)\sigma} \quad (13)$$

and the parameter search is a one-dimensional one.

The new parameter Q was obtained for the nine runs, again as described previously, by fitting the integrated equation 5 with the experimentally measured sucrose concentrations. The fitting is illustrated in Figure 11 for run 8. Here the best fit (least value of F, the sum-of-differences-squared) is found at Q = 4.77. With the mean value of Q of 4.74 (average of runs 1, 2, 3, 4, 5, 8 and 9). The new equation becomes

$$R = 52.7\eta^{-4.74(W/I)\sigma} \quad (14)$$

The value of the viscosity exponent ranges from –1.6 to –1.0 for I/W of 3.0 and 5.0, respectively, and is thus rather close to the values given by

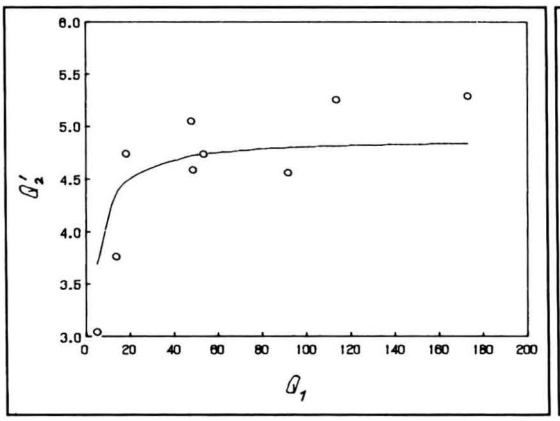

Fig. 10: Correlation of Q'_2 and Q_1

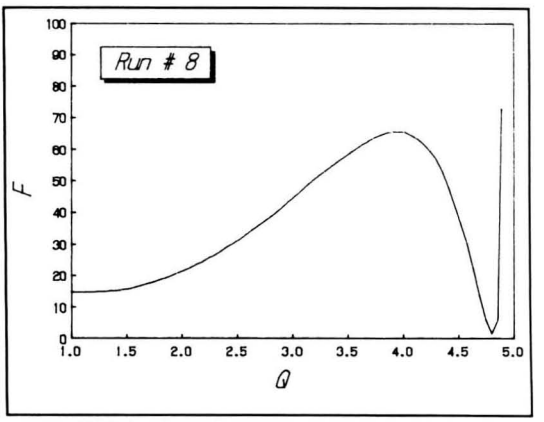

Fig. 11: Fitting of the experimental data with equation 13, Run 8. Minimum at Q = 4.77. F = sum-of-differences-squared

Table III

Run	Q	F	√F/N
1	4.73	0.31	0.18
2	4.74	0.59	0.26
3	4.70	1.30	0.38
4	4.73	1.20	0.39
5	4.75	1.55	0.44
6	4.18	0.10	0.11
7	4.63	0.62	0.28
8	4.77	0.90	0.33
9	4.73	0.45	0.22

F = sum-of-differences-squared, units of C_s^2
N = number of experimental points

Jvirblianski[11] (–1.4 to –2.2) for low purity beet sugar conditions, Smythe[1] (–1.4) for crystallization of sucrose in the presence of invert and Saska & Garandet[4] (–1.8) for crystallization of medium-purity cane sugar solutions. The increase of the exponent (increase of the growth rate at constant η) with increasing impurity concentration found here may be related to the rise in the diffusion coefficient of sucrose in impure solutions and the failure of the Einstein-Stokes equation in concentrated sucrose solutions. The effect of impurity concentration on viscosity predominates though so that the rate of growth R from equation 14 diminishes with increasing impurity concentration, the ratio of R at I/W = 3.0 and I/W = 5.0 being 2.2 at both 45° and 65°C and supersaturation 0.1 (Figures 1, 2, 3 and 4).

The results (Table III) indicate a much better agreement between the nine runs without a significant sacrifice of the fit between the calculated and measured values. This is confirmed when the results are plotted in Figures 12 and 13 for the same parameters as in Figures 8 and 9 for the model I (equation 4). The differences between the nine runs are reduced to about a factor of 2 from a factor of about 100 for model I. It appears that the form of equation 14 represents very well the experimental data and is also sufficiently flexible to cover data from a rather wide range of I/W. The agreement with the literature data (Figures 1 and 2), with the exception of Rouillard's correlation, is

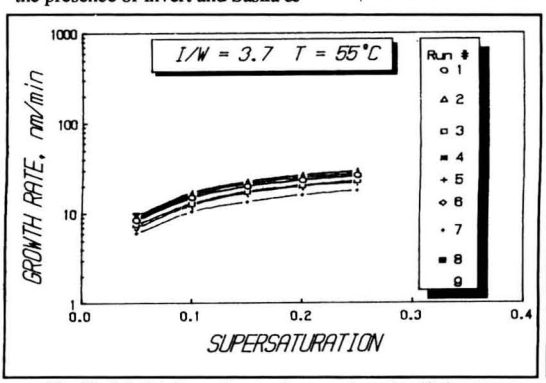

Fig. 12: Calculated growth rate of sucrose (equation 13) for all runs (parameters Q from Table III); I/W = 3.7, temperature 55°C

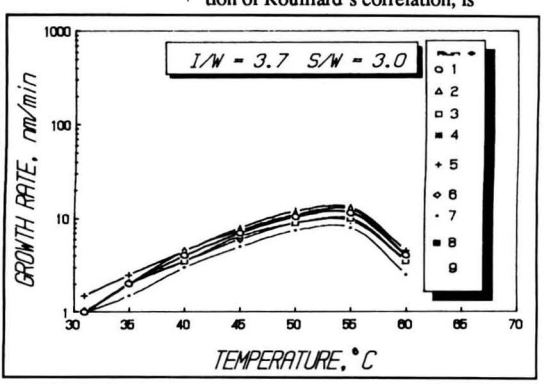

Fig. 13: Calculated growth rates of sucrose (equation 13) for all runs (parameters Q from Table III), I/W = 3.7, S/W = 3.0

Table IV

Parameters	Error, %	Q	F
SC	- 5	4.70	2.6
	- 2	4.76	1.0
	- 1	4.75	1.0
	0	4.77	0.9
	1	4.78	1.0
	2	4.78	1.1
	5	4.83	2.9
$C_{s,o}$	- 2	4.78	1.2
	- 1	4.77	0.9
	0	4.77	0.9
	1	4.78	1.2
	2	4.78	1.4
CC_o	- 10	4.77	0.9
	0	4.77	0.9
	10	4.78	0.9
L_o	- 50	4.78	0.9
	0	4.77	0.9
	50	4.78	0.9

CC_o = initial crystal content
L_o = initial mean crystal size

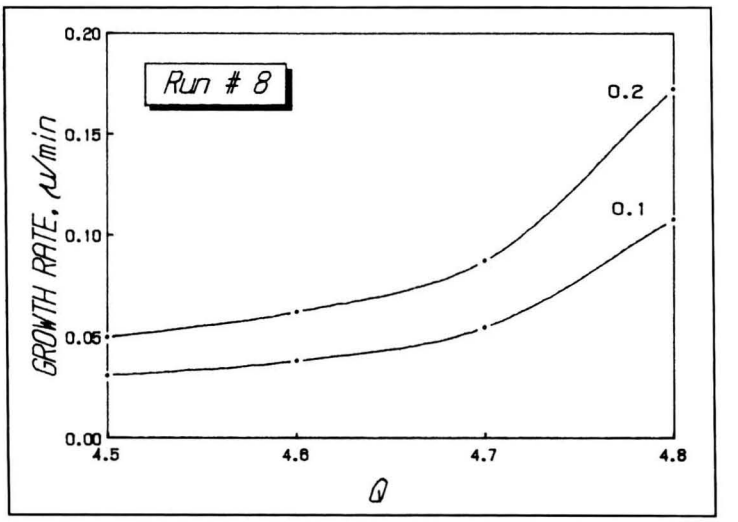

Fig. 14: Growth rate of sucrose as a function of the parameter Q. Conditions of run 8; Supersaturations 0.1 and 0.2

satisfactory at I/W = 3.0, considering the inherent limitations of experimental precision. By contrast, at the high limit of I/W (I/W = 5.0), the spread of the data is over a factor of 30. It has to be remembered, however, that both the equations of Saska & Garandet and Wright & White were extrapolated beyond the experimental ranges and thus are likely not to apply at I/W = 5.0. Equation 14 implies no effect of stirring on the crystallization velocity of sucrose and the rate of molasses exhaustion which is of considerable practical importance for the industry. Because of high viscosities at low-purity conditions (10^2 - 10^3 Pa.s), it is thought that the relative crystal-solution velocity is near zero and the Sherwood number (proportional to the mass-transfer coefficient) is independent of the rate of stirring within the range feasible in the industry. No effect of the rate of stirring was found previously on the rate of molasses exhaustion in our laboratory crystallizer[20].

The effect of possible analytical errors on the determined value of Q and, consequently, on the calculated value of R are analysed in Table IV and Figure 14. Here, Q was determined for the conditions of run 8 with the exception of one parameter (SC, C_s at t = 0, crystal content at time zero and crystal size at time zero) which was varied within wide margins. Even a small impact on the value of Q causes a significant error in the determined growth rate; the slope dR/dQ being about 0.4 µ/min at Q = 4.77 so that an error in Q of 0.01 translates into a relative error in R of about 10%.

Acknowledgements

A scholarship to YO from the German Academic Exchange Service (DAAD) is gratefully acknowledged. Continuous support of the American Sugar Cane League is appreciated.

Summary

Crystallization kinetics of sucrose from low-purity cane sugar solutions were measured in the impurity/water (I/W) range from 3.0 to 4.8 and temperatures of 40 to 75°C in a laboratory cooling crystallizer. A growth rate equation (µ/min)

$$R = 52.7\eta^{-4.74(W/I)}\sigma$$

was found to fit the experimental data reasonably well and is expected to provide a reliable basis for optimization of low-grade crystallizers in terms of optimum composition, massecuite cooling rate and the size of the equipment. Because of the good agreement with our previous, medium-purity data, the proposed equation covers the full range of medium and low-purity cane sugar conditions, from I/W = 2 to I/W = 4.8, for which no reliable data existed heretofore.

Velocidad de cristalización de la sacarosa de soluciones altamente impuras

Se midió en el laboratorio la cinética de cristalización de la sacarosa, en soluciones de azúcar de caña de baja pureza, en el rango entre 3.0 y 4.8 de impureza/agua (I/W) y a las temperaturas de 40° a 75°C en un cristalizador por enfriamiento. Se encontró que la ecuación de velocidad de crecimiento (µm/min)

$$R = 52.7\eta^{-4.74(W/I)}\sigma$$

estaba de acuerdo con los datos experimentales en forma bastante satisfactoria y se espera que sirva de base confiable para la optimización de los cristalizadores de bajo grado con respecto a

20 Keenliside & Stein: *Paper presented to the 17th Meeting ASSCT*, 1987.

composición óptima, velocidad de enfriamiento de la masa cocida y tamaño de equipo. Debido a que la ecuación está también de acuerdo con nuestros datos previos de pureza media, vemos que la ecuación propuesta cubre el rango completo de azúcar de caña de pureza media hasta baja, desde I/W = 2 hasta I/W = 4.8, para lo cual no había hasta ahora una información digna de confianza.

Vitesse de cristallisation du saccharose à une concentration élevée en impuretés

A l'aide d'un cristallisoir de laboratoire (à refroidissement) on a mesuré la cinétique de la cristallisation du saccharose dans les solutions de sucre de canne pour un rapport Impuretés/Eau (I/W) allant de 3.0 à 4.8 et à des températures entre 40 et 75°C. On a observé qu'une équation de vitesse de croissance (en µm par minute):

$$R = 52.7\eta^{-4.74\,(W/I)}\sigma$$

correspondait assez bien aux données expérimentales. Elle peut constituer une base fiable pour optimiser les cristallisoirs d'arrière-produits quant à la composition optimale, la vitesse de refroidissement dans le cristallisoir et les dimensions de l'équipement. Suite à la bonne correspondance avec nos données antérieures qui se rapportaient à une pureté moyenne, l'équation proposée couvre l'ensemble de la zône des conditions pour le sucre de canne à moyenne et basse pureté lorsque la valeur de I/W est comprise entre 2 et 4.8. Jusqu'à présent il n'y avait pas de données fiables pour ces conditions.

Kristallisationsgeschwindigkeit von Saccharose bei hohen Verunreinigungskonzentrationen

Gemessen wurde die Kristallisationskinetik von Saccharose in Rohrzuckerlösungen niederer Reinheit in einem Laborkühlungskristallisator bei Nichtzucker-Wasser-Verhältnissen (I/W) im Bereich von 3.0 bis zu 4.8 und bei Temperaturen von 40 bis zu 75°C. Eine Gleichung für Wachtstumsgeschwindigkeit (µm/Min)

$$R = 52.7\eta^{-4.74(W/I)}\sigma$$

erwies sich als ganz günstig in Beziehung zu den Versuchsdaten, und man erwartet, dass sie als zuverlässige Basis für Optimisierung von Nachproduktkristallisatoren dienen wird vom Standpunkt der Zusammensetzung, der Füllmassekühlungsgeschwindigkeit und des Apparateausmasses. Infolge der guten Übereinstimmung mit unseren früheren Daten für Lösungen von mittlerer Reinheit, eignet sich die vorgeschlagene Gleichung für den ganzen Bereich der Verhältnisse von Mittel- und Niederreinheitsrohrzucker mit I/W = 2.0 bis zu I/W = 4.8, wofür es zuverlässige Daten bis jetzt nicht gab.

Nomenclature

C - concentration; kg/kg water
g - mass growth rate; kg/kg water/sec
G - mass growth rate; kg/m²/sec
L - characteristic length of the crystal; m
N - number of crystals; 1/kg water
Q_1, Q_2 - parameters of equation 4
Q - parameter of equation 13
R - linear crystal growth rate; m/sec
SC - solubility coefficient ($= C_{s,eq}/C^{o}_{s,eq}$)
t - time; sec
T - temperature; °C
X - concentration; kg/kg solution
X′ - concentration measured by refractometry; kg/kg solution
α - volume factor = 0.36
β - surface factor = 3.12
ρ - crystal density, kg/m³
η - solution viscosity, Pa.s
σ - supersaturation ($C_s/C_{s,eq} - 1$)

Subscripts

eq - equilibrium
imp - impurity (non-sucrose, non-water)
o - initial
s - sucrose
TDS - total dissolved solids
w - water

Superscripts

o - pure sucrose solution ($C^{o}_{imp} = 0$)

New books

continued from page 105

with thermoplastic materials. Perhaps the time has now come for the polysaccharides; mankind is now more aware of the need for biodegradability, harnessing the capabilities of organisms to produce required materials almost to order is being achieved, and modern methods of analysis are permitting better insight into the structure and properties of compounds. The markets for polysaccharides are still only small, apart from starch, but a knowledge of the materials may provide a basis for developing new markets in the future. The present book could be a useful tool in such development, as a comprehensive survey of the structure of the polymers, methods for their characterization and analysis, properties, synthesis, substitution and modification, whether chemical, enzymatic or electrochemical, structure/property relationships and biological activities. Comprehensive bibliographies are provided for each chapter and the volume concludes with an index.

* * *

Bagasse pulp and paper project in Iran[1]

A feasibility study has been made in Iran for the establishment of a pulp and paper plant using bagasse as raw material and having an annual capacity of 90,000 tonnes/year. The project is being promoted by Karun Agro Industries Inc. for incorporation in its sugar cane plantation and 20,000 t.c.d. factory complex.

Colombia sugar production, 1988[2]

Sugar production in Colombia last year totalled 1,364,000 tonnes, raw value, up 70,000 tonnes from the year before. Another increase of 55,000 tonnes to 1.42 million tonnes is expected for 1989.

1 *GEPLACEA Bull.*, 1989, **6**, (3), Sugar Inf. 3.
2 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 137.

ICUMSA News

Editor: R. Pieck

Message from the President

Review of methods

In an earlier issue[1] a brief report was given of the review of methods for conformity with IUPAC guidelines for collaborative testing. By now all Referees will have received from Mrs. Godshall a report listing in some detail the comments and recommendations of her Working Group on each of the methods reviewed.

I would now like to indicate what I believe should happen next. First, the report of the Working Group should be made available to all who wish to study it and any comments which people wish to make should be directed to the Referee affected and to Mrs. Godshall. When all such comments are taken aboard, Mrs. Godshall will be able to write her Subject 3 Referee's Report for presentation at the 20th Session next year. At the same time individual referees affected by this report can also consider what action is appropriate and include recommendations in their own Referees' Reports.

At the 20th Session in Colorado Springs we can expect to emerge with a comprehensive plan which addresses the issue of methods not meeting IUPAC standards. This is especially timely as we will be reviewing methods for publication in the Method Format new methods book.

Method Format

The Publication Committee is presently examining options for a method format to be used in the new book. It is a prerequisite that this format must meet the requirements for international recognition. It seems to me that, if we would be happy with a format that already has that recognition, this might be a convenient course to follow. For example, we could adopt the method format used by ISO. I would not like to see methods forced to conform to a specified degree of detail though I appreciate that there must be some irreducible minimum in order to satisfy all aspects of the format. Some methods, such as those for measuring pol of raw sugars, get their good repeatability and reproducibility from a high degree of method specification. This of course may not apply to all methods.

Any members with views on method format which they would like considered should discuss them with Mr. Dutton.

Referees' Reports for the 20th Session

In the past, Referees' Reports have often been received too late before the Session for National Committees to consider properly the recommendations put forward. A special effort should be made to have Reports in the General Secretary's hands by the end of 1989. It would be useful if Referees could at the same time send copies to each of the Chairmen of National Committees for distribution and discussion. While the General Secretary will also send complete sets of Reports to National Committees, this will not happen until February 1990 at the earliest, so valuable time is lost when others could be discussing the Referees' Reports.

With the above timing in mind it would seem that collaborative testing should be largely completed by the middle of 1989 to allow adequate time for the working up of the data and the writing and discussion of results before the Referees' Reports can be produced.

Contributions to Referees' Reports

Since our Sessions take the form of a presentation of the Referees' Report and discussion of the material contained therein, anyone wishing to have some matter of interest discussed must endeavour to have it dealt with in a Referee's Report. This of course allows everyone to have prior knowledge of what is up for discussion and to have some time to consider carefully one's own views. Where National Committees wish to have their views considered by a Referee in his Report, such material must be in the hands of the Referee in sufficient time for him to deal with it properly. Given the deadline proposed for Referees' Reports, it would seem reasonable that Referees will need to have submissions no later than, say, September 1989 if they are to give them proper consideration.

Length of Referees' Reports

The Publications Department continually reminds us of the need to contain the size of our *Proceedings*. Not only does this mean that Reports should be concise but, also, that they should not be regarded as the main vehicle for publishing data for the first time. The results of collaborative tests should be submitted to refereed journals for publication as technical articles. In this way they get wider distribution and they are subject to the judgement of our peers. Even if it is not possible to have collaborative test results published before writing Referees Reports, it would be a good goal to aim to have papers submitted to technical journals. Such data can then be cited as "submitted for publication".

Portugal forms National Committee

Mr. Luis Bento of Refinerias de Açúcar Reunidas (RAR) has advised the Commission that a meeting has been held with representatives of Sociedade Industrial do Ultramar (SARL), Sociedade de Refinadores de Santa Iria (SORES), Sociedade de Indústrias Agrícolas Açoriana (SINAGA) as well as his own organization at which it was resolved to form a Portuguese National Committee of ICUMSA. The executive of that committee comprises Mrs. M. E. Moreira (SIDUL), Mrs. M. T. Sena Belo (SORES), Dr. A. Soares (SINAGA) and Mr. Bento (RAR). Members who attended the 19th Session at Cannes will remember Mrs. Moreira attending as an observer. A formal application by the National Committee for affiliation with our Commission is expected shortly.

Murray Player

Subject 6 – Spectroscopy

By Giorgio Mantovani,
University of Ferrara

1 *I.S.J.*, 1989, **91**, 36.

Spectroscopy as an ICUMSA subject is new even though the techniques involved have long been of great interest. Indeed, both organic and inorganic compounds are regularly measured by spectroscopy. Suggestions of new avenues which might be explored are sought from all members, not just the Subject's Associate Referees. For example, the emergence of Near Infrared Spectroscopy (NIR) in recent years suggests that there may be scope for future collaboration on methods based on this technique.

Following the reorganization of subjects after the Cannes meeting, three Recommendations were assigned to the new Subject 6. These were:

(1) A method for the standard preparation of sugar samples for trace metal determination by atomic absorption and emission spectroscopy should be chosen and submitted to a collaborative study.

(2) Methods for the determination of α-amino acid nitrogen should be further studied, for instance by the fluorometric determination method.

(3) Research work should be carried out to find methods for determining formaldehyde in white sugar.

A recent invitation to Subject 6 Associate Referees to participate in collaboratively testing methods envisaged in the above recommendations did not produce the required eight collaborators. Your Referee seeks an indication of willingness to participate in testing the above methods from any members with an interest in this work.

In preparing the Referee's Report for the 20th Session, suggestions and comments on possible methods on spectroscopy would be most welcome.

Starch-derived sweeteners

By Dr. Brian Whitehouse, General Referee

I have accepted Dr. Player's invitation to direct the work of the reactivated Subject G9, Starch-derived sweeteners, notwithstanding the difficulties one sometimes experiences in getting agreement on analytical methods within one's own company let alone between international bodies.

While I have already indicated to Associate Referees the directions I believe we should pursue, I would like to extend an invitation to readers to contribute as well (my fax-number is +32-2-2542675).

My immediate objectives are:

– to identify problems being experienced with existing methods

– to agree on priorities for work leading to collaborative testing of new or existing methods.

At the November 1988 meeting of the Codex Alimentarius Committee on Methods of Analysis and Sampling, only temporary endorsement was given to most of the methods of sugar analysis proposed for revised Codex standards. The deficiency in most cases concerned the lack of collaborative testing and already plans have been made to rectify this for some "tried and trusted" ISO and ICUMSA methods.

In my view, the activities of Subject G9 should not dwell on old "grandfather methods" but those concerned with the determination of the sugars composition of products ranging from maltodextrines to high dextrose syrups. For many years now, HPLC methods have been taken for granted but standardization must be addressed. In doing so the interests of chemists as well as the market place must be considered. The measurement of the relative proportions of mono, di and oligosaccharides of many intermediate and finished products have a great bearing on their processability and is also being demanded by customers. I believe this is an important subject for study.

Codex aims to have single reference methods which can be used in settling disputes or to which simpler routine methods may be related. The vieing between international organizations like IFG, ISO, AOAC and ICUMSA for recognition of competing methods can be counter-productive and the Inter-Agency Committee was formed to promote collaboration between such organizations. I would hope that the activities of Subject G9 can contribute to the establishment of method uniformity between all international organizations with an interest in this subject. I look forward to participating and invite your assistance.

Facts and figures

Mauritius sugar exports, 1988[1]

	1988	1987
	tonnes, tel quel	
Belgium	1,953	1,640
Canada	60,077	89,400
China	48,350	0
Finland	25,050	0
France	12,137	70,955
Germany, West	54	628
Holland	2,442	4,613
Italy	4,316	2,744
Morocco	14,350	0
New Zealand	108	21,055
Portugal	18,000	18,000
Switzerland	797	562
UK	454,292	421,195
US	10,310	9,559
USSR	0	15,750
Other countries	216	216
	652,452	656,317

Philippines sugar deficit forecast[2]

A USDA report forecasts imports of sugar by the Philippines despite a local production surplus projection by industry authorities. The Philippine Sugar Regulatory Administration believes that production will rise to 1.7 million tonnes from 1.36 million tonnes in 1987/88, giving enough to meet local demand, the 180,500 tonnes US quota and possibly exports to other destinations. The US report estimates 1988/89 output at only 1,425,000 tonnes, up from 1,250,000 tonnes, however, and claims that imports of 106,000 tonnes will be necessary against 110,000 tonnes in 1987/88.

1 *Mauritius Sugar News Bull.*, 1988, (12).
2 *Public Ledger's Commodity Week*, March 18, 1989.

Facts and figures

USSR sugar imports and exports, 1988[1]

	1988	1987
	tonnes, raw value	
Imports		
Raw sugar		
Australia	0	181,575
Brazil	197,697	387,555
Colombia	12,000	12,000
Costa Rica	25,503	47,906
Cuba	3,003,865	3,750,333
Dominican Republic	203,170	144,934
Germany, West	16,271	0
Guatemala	167,596	61,340
Honduras	38,760	28,582
Mauritius	0	15,750
Mexico	372,724	181,194
Nicaragua	15,984	49,428
El Salvador	40,603	15,008
Swaziland	0	41,300
Thailand	0	103,964
Zimbabwe	0	14,000
	4,094,173	5,034,869
White sugar		
Australia	10,000	0
Cuba	86	0
Czechoslovakia	0	5,934
EEC	83,000	0
Hungary	32,004	11,692
Poland	2,030	2,075
	127,121	19,701
Exports		
Raw sugar		
Finland	0	29,993
White sugar		
Afghanistan	59,163	40,060
Bulgaria	17,027	13,856
Djibouti	1,980	0
Egypt	22,078	0
Guinea-Bissau	0	821
Mali	7,752	4,193
Mongolia	45,406	39,927
Vietnam	10,000	9,890
Yemen, South	49,504	48,413
	212,911	157,161

Australia sugar expansion plans[2]

The Central Sugar Cane Prices Board has given unanimous support for an expansion of the productive capacity of the Australian sugar industry. Growers can apply to the Board for permission to grow more cane as a result of the decision but the extra sugar is not expected to be harvested until 1990. Less than half of Queensland's cane growers have extra land available for growing more cane, but an increase of about 300,000 tonnes of sugar is expected, which would bring Australian output to 4 million tonnes.

US sugar imports, 1988[3]

	1988	1987
	tonnes, raw value	
Argentina	23,500	34,925
Australia	74,692	67,756
Barbados	7,409	21,424
Belgium	3,270	18
Belize	25,833	13,624
Bolivia	12,883	6,127
Brazil	131,078	127,021
Canada	13,659	10,593
Colombia	77,456	40,742
Congo	7,502	0
Costa Rica	19,986	37,376
Dominican Republic	198,013	238,307
Ecuador	7,214	0
Fiji	8,523	22,666
Gabon	7,503	6,986
Germany, West	2,245	251
Guatemala	71,132	57,237
Guyana	0	9,906
Haiti	7,297	6,831
Honduras	13,663	8,302
India	7,308	6,694
Ivory Coast	7,464	6,779
Jamaica	10,638	9,538
Madagascar	5,278	6,836
Mauritius	10,557	274
Malawi	9,112	0
Mexico	163,528	206,867
Mozambique	11,625	18,987
Panama	4,708	11,342
Papua-New Guinea	7,511	6,728
Paraguay	12,778	0
Peru	43,692	26,964
Philippines	135,636	132,604
St. Kitts	6,597	0
El Salvador	38,913	598
Swaziland	14,824	25,230
Taiwan	10,813	9,939
Thailand	8,890	11,557
Trinidad	7,791	6,935
Uruguay	5,114	6,691
Zimbabwe	10,974	9,907
Other countries	52,733	61,434
	1,299,342	1,275,996

Barbados sugar exports, 1988[4]

In 1988 Barbados exported 67,813 tonnes, raw value, of sugar, a drop of 11% from the 76,428 tonnes of 1987. The principal destination, as before, was the EEC with 54,663 tonnes *vs.* 50,912 tonnes in 1987, and exports to Canada were little changed at 4298 *vs.* 4587 tonnes. Shipments to the US were markedly reduced, from 20,929 tonnes to 8852 tonnes in 1988.

Australian Sugar Research Council 1987/88 report

The Sugar Research Council was established in November 1987 with the objectives of increasing the commercial returns to the industry and the community in Australia, to make more effective use of resources and skills and to improve acountability for spending on research and development. The Council has to develop each year a R&D program, to approve payments from the Sugar Research Trust Fund and monitor work funded. The Council, under the Chairmanship of Roy Deicke of Bundaberg Sugar Co. Ltd., includes representatives of the industry, government and individuals. Its first report, for the period to June 30,1988, has just been published; funds come largely from the industry by levy, with a small government contribution. No R&D expediture is reported for the period of the report but a program has been drawn up for 1988/89 and details of this are given. Most of the research funds are allocated to the Bureau of Sugar Experiment Stations ($Aus 1,100,000 out of $Aus 1,950,000) and most are for agricultural research ($Aus 1,569,000). Projects include studies on the effect of far-red radiation on flowering of *Saccharum* spp. hybrids, long-term storage of *Saccharum* pollen, regeneration of sugar cane plants from protoplasts, alternative selection strategies for the Burdekin sugar cane improvement program, seasonal distribution of growth and sugar accumulation in sugar cane, selection of superior crosses, improving the yields of ratoon crops, enhancement of *Saccharum* spp.

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S111.
2 *Australian Canegrower*, 1989, **11**, (1), 8.
3 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S63, S112.
4 *I.S.O. Stat. Bull.*, 1989, **48**, (2), 3.

hybrids by introgression with *Erianthus arundinaceus* germplasm, crop improvement from genetic diversity, molecular tagging of economically important genes and promoters in sugar cane, breeding of clones with high early sugar content, production and evaluation of gene probes for diagnosis of mosaic and Fiji disease virus, population dynamics of *Inopus rubriceps* (soldier fly) in cane fields with emphasis on bionomic factors assisting pest management, development of models for drainage of perched water tables in the Isis irrigation area, nitrogen dynamics of soil growing cane under minimum tillage and trash conservation conditions, the effect of zinc deficiency as a factor limiting cane growth, genotype × environment interaction for clones and crosses in southern Queensland and northern New South Wales, development of early warning systems for potential damage due to rodents, assessment of the potential of sex pheromones for control of cane grubs, development of the fungus *Metarhizium anisopliae* as a biocontrol agent for soldier fly, production of genetic constructs for expression of cane mosaic virus coat protein in sugar cane protoplasts, varietal control of ratoon stunting disease, assessment of surge-irrigation in the Burdekin, new cover crops for cane fallows, assessment of cane harvester performance, optimization of cultural practices for efficient mechanical harvesting, development of a high-capacity haul-out bin, development of a real-time interactive scheduler/rescheduler for road and rail transport of cane, energy use in sugar factories, and phenolic colorants in sugar. Other activities will include production of instructional video tapes and technical manuals for cane growers, contribution to the publication of the *Australian Journal of Experimental Agriculture*, an experimental evaluation of land use options for the sugar industry, and assessment of the productivity and profitability of management options for the Australian sugar industry, as well as funding of a workshop visit and a study tour for two technologists.

Cuba sugar exports, 1988[5]

	1988	1987
	tonnes, raw value	
Albania	33,906	23,501
Algeria	162,458	33,677
Angola	43,984	32,421
Bulgaria	295,656	304,699
Canada	111,890	87,011
China	1,399,439	611,827
Colombia	132	113
Cyprus	542	0
Czechoslovakia	170,712	128,509
Dominican Republic	1,172	0
EEC	39,192	0
Egypt	50,375	76,922
Finland	12,529	56,689
Germany, East	338,676	283,510
Ghana	17,734	13,032
India	0	122,799
Indonesia	13,663	26,434
Iraq	66,845	26,322
Japan	372,469	222,931
Kampuchea	1,085	0
Korea, North	30,361	36,762
Laos	517	0
Libya	12,533	23,232
Malaysia	55,641	0
Nicaragua	15,572	0
Pakistan	39,016	0
Peru	0	12,354
Poland	0	54,029
Rumania	200,412	228,009
Sweden	0	25,130
Switzerland	2,975	3,023
Syria	26,733	76,740
Tunisia	24,458	37,833
Uganda	8,675	23,628
USSR	3,307,504	3,863,158
Venezuela	103,623	17,817
Vietnam	8,856	27,069
Other countries	2,739	2,954
	6,972,074	6,482,135

Cuba-Cambodia trade agreement[6]

Under a trade protocol signed recently, Cuba will deliver 2000 tonnes of raw sugar and 1000 tonnes of white sugar to Cambodia in exhange for rubber and other goods to a total value of 100,000 roubles.

USSR 1989 sugar import program completed[7]

Official Soviet sources said recently that the USSR has completed its 1989 sugar import program with purchases of 15 cargoes of raw and white sugar, each of around 12,000 tonnes. Traders estimate that the Soviet Union bought around 750,000 tonnes of sugar during the past few weeks out of an expected total requirement of about 5 million tonnes. They believe the USSR may be hoping that Cuba will supply the balance since a bumper crop is expected which could reach 8.5 million tonnes. However, they are of the opinion that Cuba may prefer to sell on the free market rather than supply so much sugar to the USSR. It is also reported[8] that the USSR has bought 500,000 tonnes of Cuban sugar in a swap deal with the French trade house Sucres et Denrées; the Cubans are reclaiming sugar bought by SD last year and will replace it with a similar amount in 1990.

Fiji sugar exports, 1988[9]

	1988	1987
	tonnes, raw value	
China	51,682	64,017
EEC	192,343	174,769
Japan	32,560	16,263
Malaysia	68,868	117,306
New Zealand	60,417	42,768
US	8,434	23,154
	414,304	438,277

Bagasse paper plant in Argentina[10]

Papel de Tucumán has introduced a new facility for production of 17,000 tonnes/year of glossy paper, to use a blend of 92% bagasse pulp and 8% Kraft pulp. The investment cost was $5 million but may save up to $16 million annually in foreign exchange by import substitution.

Ecuador sugar imports[11]

Sugar production in Ecuador in 1988/89 was badly hit by adverse weather and the government has therefore authorized imports of 60,000 tonnes of white sugar to meet domestic demand.

5 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S113; *I.S.J.*, 1988, **90**, 132.
6 *Czarnikow Sugar Review*, 1989, (1783), 45.
7 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 151.
8 *Public Ledger's Commodity Week*, April 1, 1989.
9 *I.S.O. Stat. Bull.*, 1989, **48**, (2), 16 - 17.
10 *GEPLACEA Bull.*, 1989, **6**, (3), Sugar Inf. 1.
11 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 172.

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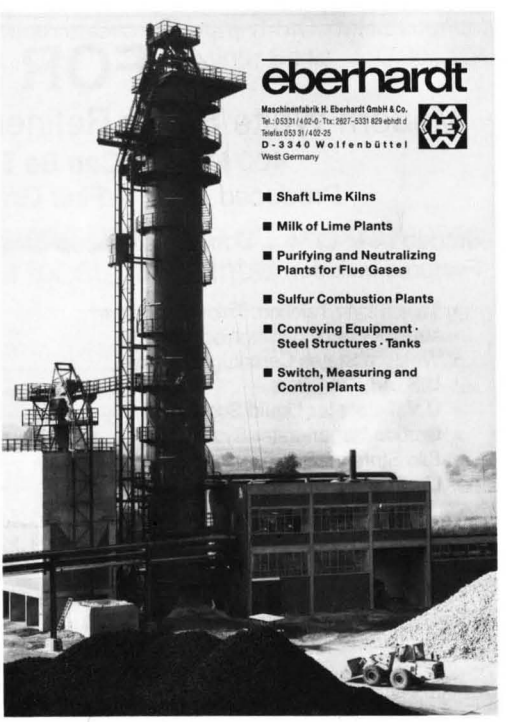

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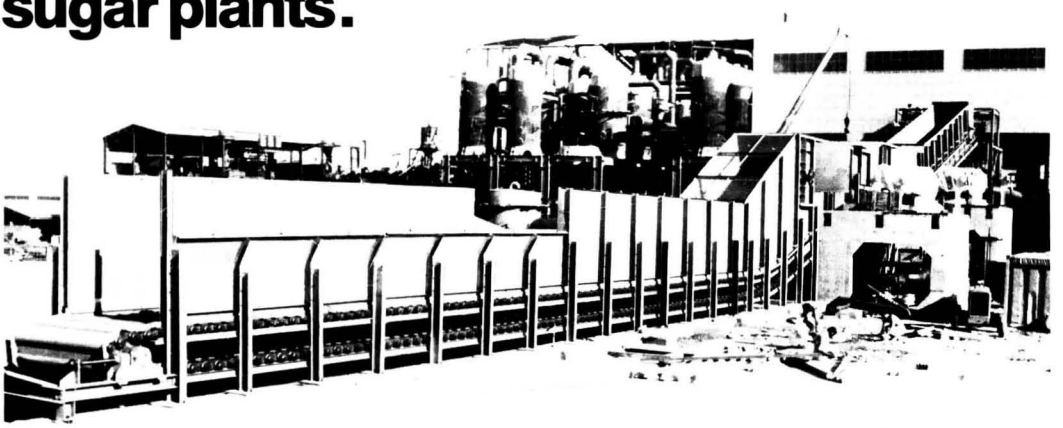

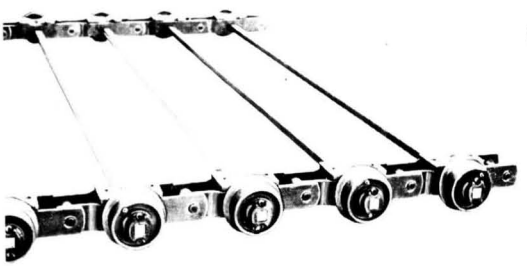

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