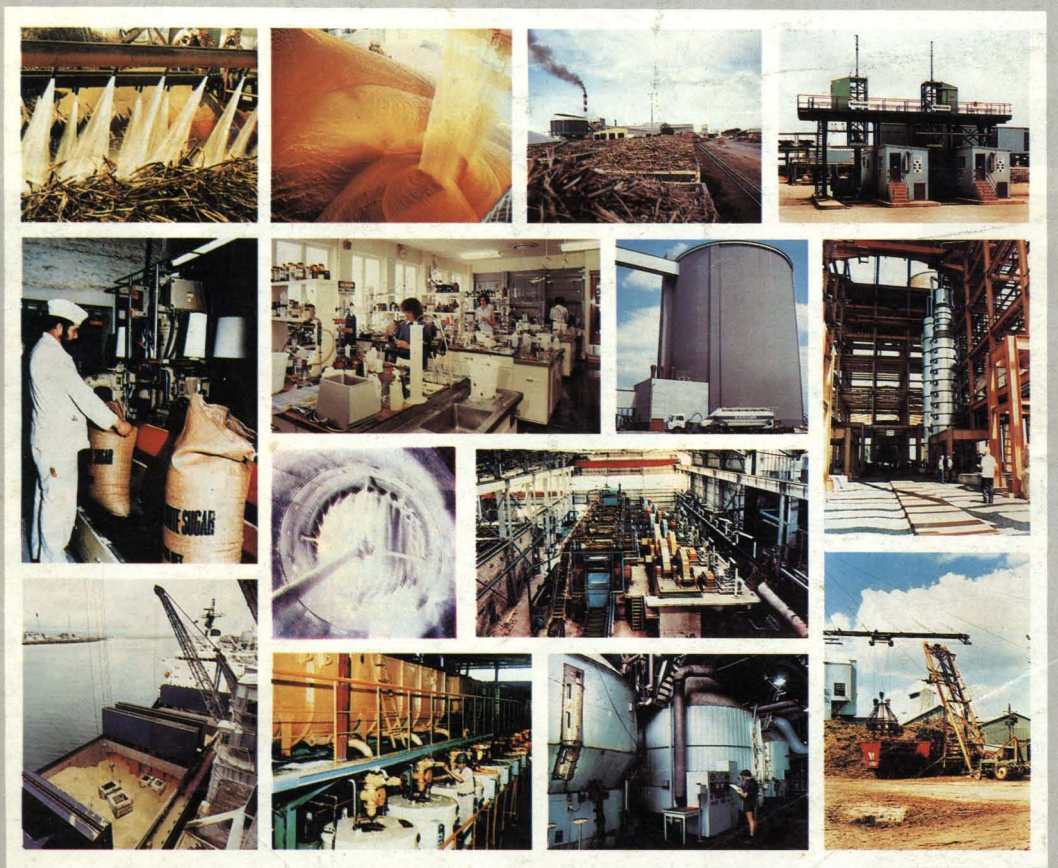
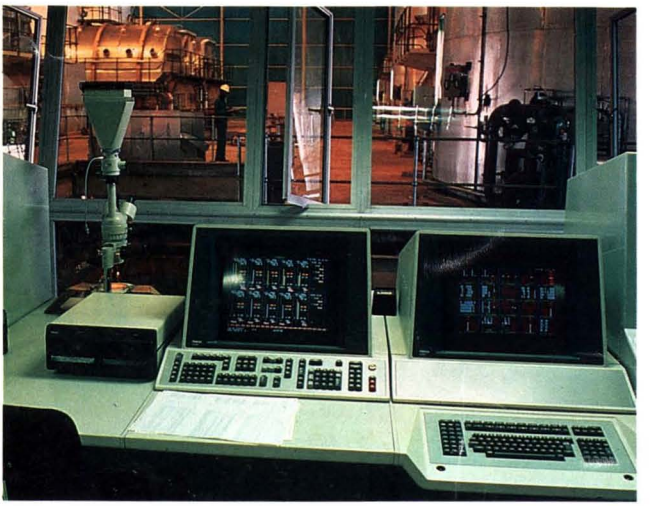
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXVIII/ISSUE No. 1054

OCTOBER 1986

FS Continuous Vacuum Pan



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Single Copies
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Airmail: £24 extra

Claims for missing issues will not be allowed if received more than two months from date of mailing, plus time normally required for postal delivery of journal and claim.

Published by
International Media Ltd.,
P.O. Box 26, Port Talbot,
West Glamorgan SA13 1NX, U.K.
Tel: 0639-887498 *Telex:* 21792 REF 869

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

INTERNATIONAL SUGAR JOURNAL

Volume 88
Issue No. 1054

CONTENTS October 1986

Published by

International Media Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.
Telephone: 0639-887498 *Telex:* 21792 REF 869
US Office: 2790 Foster Avenue, Corning, CA 96021
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News and views

ISSCT Congress, 1986

As planned, the 19th Congress of the International Society of Sugar Cane Technologists took place in Jakarta during August 21 - 31. By dint of an immense effort on the part of the Australian Editor, John Clayton, and the secretariat in Indonesia, the technical papers were available in printed form, bound in two volumes, for delegates attending the meetings. No press release is yet to hand with details of attendance from different countries, etc. but these will appear in due course as a third volume of *Proceedings*. The cost of the two volumes of papers is $85.00 and they should be sought from offices of the Organizing Committee at P.O. Box 86 JKWB, Jakarta 10270, Indonesia. An invitation to hold the next Congress in Brazil was accepted for 1989, that from Colombia having been withdrawn.

World sugar balance, 1985/86[1]

A fourth estimate of the world sugar balance for 1985/86 was recently released by F. O. Licht GmbH. Production is now set at 98,885,000 tonnes, raw value, against 100,127,000 tonnes in 1984/85, while consumption has increased to 100,313,300 tonnes in 1985/86 from 98,638,000. With a difference between imports and exports of 517,000 tonnes, against 1,488,000 tonnes a year earlier, the final stocks are reduced to 37,982,000 tonnes (37.86% of consumption) from 39,927,000 tonnes (40.48% of consumption).

Licht observes that, "although fundamentals have improved and are likely to improve further in 1986/87, the long-term outlook for sugar is dim. Exporters will have to adjust to lower demand growth, which has already fallen close to population growth. Unless exporters keep a tight rein on production, another period of low prices may soon be upon us, probably even before the recovery has developed to its full potentialities. This should be sufficient incentive to make a concerted effort to control production within the framework of a new ISA. However, this will need hard work and the ability to compromise, a virtue not spread widely among sugar exporters."

World sugar prices

From an initial level of $153.50 on August 1, the London Daily Price for raw sugar dipped slightly to $151 for two days but then improved to $156 at which it stayed until August 13, aided by the EEC's restrictive export policy, reports of drought in Cuba, higher oil prices (which led to speculation that more cane might be diverted to alcohol manufacture in Brazil and elsewhere) and reports of mixed prospects for the coming European beet sugar crop.

Rumours reached the market of a sale of sugar by the US to China; they were first denied but then confirmed in an announcement by the US Department of Agriculture. The sale was of 145,850 tonnes of raws and the price was 4.75 cents/lb, nearly 2 cents below the market price for January/March 1987 delivery.

The LDP started to fall immediately and by August 20 had reached only $126 per tonne. A number of other factors then influenced the market, among them reports of severe water shortages in Havana, heavy Soviet buying of sugar, Licht's first estimate of European sugar production, indicating a drop of about 4%, and the price rose to $133.50. However, sugar producers in Florida and California notified the USDA that they intended to forfeit some 256,000 short tons of sugar to the CCC and the fear that this might be dumped on the world market led to a further decline in values so that the LDP ended the month at only $129.

During the first half of the month, the London Daily price for white sugar had followed that for raw sugar fairly closely with the premium near to $40 per tonne. The collapse occurred in raw sugar prices, however, and was not so great in the LDP(W) so that the premium rose to about $50 during the second half of the month. As a consequence, the LDP(W) which started the month at $194.50 ended it $13 lower at $181.50 against a corresponding fall in the LDP of $24.50.

US sugar sale to China

The sale announced on August 12 amounted to 145,850 tonnes of CCC-owned surplus raw sugar which had been forfeited by Florida producers and was from the 1984/85 crop. As details became available the sale drew protests from countries whose economies depend on exporting sugar but was defended by the US authorities as being a replacement of sugar which could not be provided by Cuba and so would not displace Chinese purchases from its usual sources of supply. It was also claimed that the price was so low because allowance had to be made for the higher cost of shipping from the US as against from nearer suppliers; the inconsistency of these arguments is self-evident. The sale, for $15.3 million, involves the US in a loss of more than $40 million, and appears to have been more in the nature of a tolling operation since China subsequently sold 18 cargoes of white sugar for shipment up to June 1987.

The Australian government, already angered by subsidized sales of US grain to the USSR which displaced Australian exports, protested against the sugar deal, as did Thailand. The Thailand House of Representatives sent a message to the US Congress that more dumping of sugar by the US would force Thai cane planters into bankruptcy and would lead them to lobby for legalization of opium and marijuana cultivation as retaliation measures. Both countries have suffered not only from a loss of potential sales but also the consequent reduction of some $25 per tonne for the rest of their world market sales. The Thai planters are asking their government to seek compensation from the US for the damage caused.

The *Czarnikow Sugar Review* comments[2]: "If the alternatives within current US sugar policy are limited to either making further export sales of forfeited sugar to maintain the current very low import quota or to make further drastic cuts in the quota in order to match requirements, the outlook for all

1 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 413 - 420.
2 1986, (1752), 113 - 114.

those producers which have supplied the USA for the past 25 years or so appears bleak indeed. With third world countries accumulating serious debt problems it cannot help their situation to have the markets for the goods that they are able to produce cut back in volume and world prices undermined. Presumably the developed countries wish to continue exporting manufactured goods but common sense dictates that they can only do so to the less developed countries if the latter can earn the money to pay for them.....US government delegates at numerous international meetings have advocated that the best policy approach for primary commodities is one based on free market principles. While there remains such a gap between the rhetoric of the United States and its actions in practice, it is extremely difficult to see how less developed countries can achieve reasonable prices for their primary products."

New USSR-Cuba sugar trade terms[3]

The Soviet Union has imposed stiff terms on Cuba in the latest trade and economic agreement between the two countries. The agreement, signed in Moscow last May, provides for a drop in the price of Cuba's sugar exports to the USSR from 915 roubles per tonne last year to a fixed price of 850 roubles throughout the 1986/1990 period. The volume of Cuba's sugar shipments would also remain fixed at four million tonnes per year.

The oil price for 1986 would remain unchanged from last year's level of 26 roubles per tonne despite the steep fall in world oil prices since last November. Diplomatic sources said that the Kremlin had vetoed Cuba's demand for a higher sugar price and an annual revision of prices thereafter. Moscow had also refused to initiate any big new industrial projects in Cuba during the current five-year period, arguing that priority should be given to completing several large installations already under construction. The Russians continue to subsidize Cuba heavily, however, by paying preferential prices for Cuban exports and allowing Cuba to re-export Soviet oil for hard currency.

World Bank views on long-term sugar prices[4]

Ronald Duncan, head of the World Bank's commodity studies, told a commodities seminar that the Bank expects world sugar prices to continue rising from last year's lows. Preliminary figures for a report to be released in September suggest the International Sugar Agreement daily price (f.o.b. at greater Caribbean ports) will be US $154 per tonne this year against $90 last year (in current dollar values). The price is forecast to rise to $187 in calendar year 1987, to $235 in 1988, to $316 in 1989, to $450 in 1990, to $452 in 1995 and to $525 in the year 2000. Duncan said that the estimates assume US and European sugar market restrictions remain in force. In the medium term prices should increase steadily as surplus stocks are reduced but there will be strong fluctuations in prices and there could be another boom before the year 1997, he said.

Asian sugar consumption[5]

Sugar demand is rising in all Asian nations except Japan, although growth in world sugar consumption is tailing off, according to Wong Yi-Ting, chairman of the Taiwan Sugar Corporation. In an address to the 19th Congress of the ISSCT in Jakarta in August he said that world consumption is expected to have risen during the previous 12 months by little more than 1%, the lowest for more than 25 years. This rise contrasts with growth rages averaging 5.2% in the 1950's, 3.2% in the 1960's, 2.2% in the 1970's and 2% in the first half of the 1980's.

Asia is a bright spot, however, with a 5.9% average growth rate of raw sugar consumption in the first half of the 1980's. He estimated sugar use in Asia would have reached 30.5 million tonnes in 1985/86, accounting for 31% of world sugar consumption and up from 29.9 million tonnes in 1984/85 and 22.9 million tonnes in 1980/81. The highest growth rates are in India and Pakistan, where consumption rose by 10.6% and 11.5%, respectively, over the past five years.

Japan's raw sugar use decreased in the early 1980's following the introduction of high fructose syrup, with 1985/86 consumption estimated at 2.82 million tonnes against 2.88 million tonnes the year before. High fructose syrup is not widely used in Asian countries other than Japan, and therefore has no significant effect on Asian sugar consumption. In Japan it accounts for 20% of total sweetener consumption.

Europe beet sugar production, 1986/87[6]

An estimate of European beet sugar production before the campaign starts is necessarily a shot in the dark, but sometimes these shots have proven to be quite accurate and, if nothing unforeseen happens, European beet sugar production could fall 3.7% to 29.9 million tonnes in 1986/87 according to F. O. Licht GmbH, whose figure compares with the 1985/86 output of 31.1 million tonnes. The reduction is less than had been hoped for, as the area cutbacks did not come up to former expectations. Farmers have reacted to the current depression but too weakly to solve the current surplus problem.

The EEC area turned out to be not more than 1% below that of 1985 but the late spring, coupled with dry weather in some parts of the Community, lead to an expected 5.7% drop in production to 13.7 million tonnes. Sharp reductions are forecast for Austria and Yugoslavia, while a better crop is expected in Turkey, all as consequences of changes in the beet area.

Little information has come from East Europe but weather conditions so far suggest that most countries will have a reasonable crop. In the USSR, however, sowings were slow to start and lower than usual rainfall could reduce yields. Also, in Poland, the area sown to beet was smaller and plant density is

3 *The Times*, August 15, 1986.
4 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 404.
5 *Public Ledger's Commodity Week*, August 30, 1986.
6 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 453 - 456.

reported to be unsatisfactory; however, recent beet tests show a high root weight and sugar content. Details of these estimates appear below.

	1986/87	1985/86
	tonnes, raw value	
Belgium	915,000	1,025,000
Denmark	467,000	577,000
France	3,475,000	4,324,000
Germany,West	3,210,000	3,432,000
Greece	348,000	345,000
Holland	1,086,000	975,000
Ireland	206,000	189,000
Italy	1,685,000	1,352,000
Portugal	5,000	9,000
Spain	985,000	965,000
UK	1,304,000	1,316,000
EEC	*13,686,000*	*14,509,000*
Austria	293,000	468,000
Finland	141,000	104,000
Sweden	377,000	347,000
Switzerland	105,000	139,000
Turkey	1,720,000	1,398,000
Yugoslavia	855,000	949,000
West Europe	*17,177,000*	*17,914,000*
Albania	38,000	40,000
Bulgaria	125,000	89,000
Czechoslovakia	860,000	939,000
Germany East	710,000	805,000
Hungary	550,000	527,000
Poland	1,680,000	1,808,000
Rumania	625,000	585,000
USSR	8,150,000	8,350,000
East Europe	*12,738,000*	*13,143,000*
Total Europe	29,915,000	31,057,000

Indian measures to raise production[7]

Indian sugar production in the 1985/86 season is expected to reach about 7.0 million tonnes, white value, up nearly 900,000 tonnes from the season before. Another increase is now expected for the 1986/87 crop year. With the 1985/86 season virtually complete the Union government seems to be considering whether some aspects of the current sugar policy need revision to give a further boost to sugar production in the 1986/87 season. The Food and Civil Supplies Minister has indicated that revision of the policy is under the government's active consideration. He also said that the new policy will harmonize the interests of different sectors including consumers, cane growers and sugar producers.

The current season's sugar policy, which provides for a minimum statutory sugar cane price of 16.50 rupees per quintal, linked to a basic recovery of 8.5%, has yielded encouraging results. Since the government has already made advance announcements of a statutory cane price of 17 rupees per quintal, cane growers are expected to supply their cane to the centrifugal sugar sector. Thus, with a realistic sugar policy, along with normal monsoons, the industry is expected to exceed the production level of 8.0 million tonnes, white value, in the 1986/87 season.

Argentina crop plan[8]

Production in Argentina has fallen sharply in recent years, from more than 1.6 million tonnes, raw value in 1983/84 to below 1.2 million tonnes in 1985/86 when, as a consequence of frosts in Tucumán province, even the reduced target was not met. For 1986/87 the crop plan has been set at 1.05 million tonnes, tel quel, equivalent to about 1,135,000 tonnes, raw value. This will leave a surplus of cane available and millers are entitled to produce extra sugar in excess of quota, should they wish to do so, but this would have to be for their own account and would have to be exported to the world market. Production costs are in the region of 12 - 13 cents/lb, though marginal costs are no doubt considerably lower and millers might find this an attractive proposition for small quantities, especially if the world market price should rise. The production quota, incidentally, already includes 75,000 tonnes for export, most of which would be destined for the US market, leaving some 975,000 tonnes which should be adequate to fulfil domestic needs.

Stocks in Argentina are very high; at the end of June 1985, they amounted to 477,000 tonnes against 272,000 tonnes a year earlier. This resulted from the setting of a high production quota in 1984/85 which was well in excess of domestic needs, while provision of the substantial subsidies needed to export the balance was against government policy. There has been some pressure from millers, who have had to pledge their sugar with banks, for provision of subsidies to reduce the overhanging surplus, but under the Austral plan all prices are frozen and subsidies not available.

Facts and figures

GEPLACEA meeting, 1986

The 22nd Plenary Meeting of GEPLACEA (the Group of Latin American and Caribbean Sugar Exporting Countries) is to be held during October 12 - 16 in Maceió, Alagoas, Brazil, the organization of the event being coordinated by the I.A.A. and the Alagoas Cane Planters Association. Topics under discussion will include a work program and budget for 1987; the international markets for sugar, molasses and derivatives; prospects for an International Sugar Agreement; programs and cooperation in technology; and a project for the diversification of the sugar industry, developed with the United Nations Development Program.

Portugal sugar concession[9]

The Management Committee of the EEC Commission has agreed that Portugal should be allowed to import 94,000 tonnes white sugar equivalent of raw sugar in 1986/87, in addition to the reduced levy quota of 75,000 tonnes, according to *Agra Europe*. The 94,000 tonnes represents sugar which has already been imported since, at the time of accession to the EEC on March 1, Portuguese refiners had been uncertain how the arrangements being negotiated by their government would affect the supply of raw sugar and there was a tendency to stockpile. Without this special measure, the excess would havehad to be exported, which would make little sense for a country with a large deficit in the supply of sugar. The 94,000 tonnes additional concession should exactly clear the excess stock.

Pakistan beet sugar production, 1986

The 1986 beet campaign in Pakistan lasted only 32 days in May/June and only two of the four factories worked as the crop was small. Total slice was 134,061 tonnes, some 30% greater than the 103,137 tonnes sliced in 1985. White sugar outturn was 13,931 tonnes as against 10,430 tonnes last year; this brought total cane plus beet sugar production to 1,116,000 tonnes against 1,317,000 in 1985.

7 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 409.
8 *Czarnikow Sugar Review*, 1986, (1752), 119 - 120.
9 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 423.

Product news

Fabcon and Touchstone in major link-up

Fabcon Inc. of San Francisco and Touchstone Machinery Industrial Corporation of Taiwan have got together in a joint venture to provide a world-wide design and manufacturing capability. Spearheading their product range is the Fabcon-designed pressure fed Lotus cane mill, together with the Unigrator, Rapid crystallizer and other equipment. Using Touchstone's manufacturing capabilities, Fabcon offers to convert any cane mill to the pressure fed Lotus design. Higher extraction rates and greater throughput are the major advantages, coupled with reduced milling losses and bagasse moisture, with consequent increased boiler efficiency. Life-time maintenance costs are similar to those of a conventional top roller mill, and in operation the mill is less prone to choking. Lotus mills are already operating in Morocco and Pakistan. With machinery products in use in more than 30 countries, Fabcon/Touchstone offer a comprehensive international service.

Further details:
Fabcon Inc.,
Unice Machine Division,
2670 Leavenworth Street,
San Francisco, CA 94133,
U.S.A.

Kent add to System 19

The R1200 series module, a microprocessor based, rack-mounted, digital display controller has been added to the System 19 range of instrumentation. It provides analogue PID control or motorized valve control with relay outputs, both with optional balanceless and bumpless auto-manual changeover, or relay, or open drain control in on/off and time-proportioning PID forms. The controller can accept a wide range of input signals from D.C. milliamp, millivolt and voltage sources such as pH electrodes, flow sensors, load cells, thermocouples and from resistance thermometers. The instrument has a basic overall accuracy of 0.25%.

The four-digit display is exhibited on a green fluorescent screen. The display can be set to show sequentially the measured value, the set point and high and low alarm settings, or any of these parameters may be locked on to the screen. The screen incorporates a number of "tell-tale" indicators to identify the status of the main four digit display. An additional 21-segment horizontal bar display shows the analogue control output set point relative to range or regulator position, depending on the most appropriate information for the particular application. A centre zero 9-segment vertical bar display shows deviation from the set point.

All input, output and display characteristics are set or altered by touch sensitive membrane switches situated on the front panel. Security against inadvertent changes is ensured by having to press two switches to alter any parameter. Internal switches give total security by locking in all the programmed information. A remote set-point facility is available on most models and up to two auxiliary alarm/control channels may be fitted.

Further details:
Kent Industrial Measurements Ltd.,
Eaton Socon, St. Neots,
Cambs. PE19 3EU, U.K.

Universal tank contents gauge

A new tank contents gauge from Coley Thermometers Ltd., suitable for all liquids used in industry and agriculture, is claimed to be the most reliable and accurate of its type. The gauge is operated by a stainless steel capsule in the tank which senses the pressure head caused by the liquid and transmits it by means of an inert gas in a capillary tube to the instrument head, where a mechanism moves a pointer. The gauge is accurate to 1%, and, unlike other types, provides a continuous reading without manual pumping or external power. The whole system is of stainless steel, so it can be used for any liquid, including oils, caustic solutions and acids, as well as juices and syrups with a high solids content.

The instrument head may be fitted in either interior or exterior locations up to 65 metres from the tank. The pressure capsule can be attached to an existing outlet or fitted from the top of the tank. A special capsule which is easily cleaned from inside the tank is availabble for the food industry, or for use with liquids with high solids contents.

Coley Thermometers will calibrate each instrument in any units and for any shape or size of tank, provided it is freely vented.

Further details:
Coley Thermometers Ltd.,
2 - 4 London Road,
Brentford,
Middx TW8 8JP, U.K.

NAF manufacture valves in Finland

Production of the NAF Uniball range of one-piece maintenance-free ball valves has recently been moved to NAF's new plant in Finland. A 20-page full colour technical brochure has been produced on the NAF Uniball which was originally designed for use in buried pipelines where its lack of body joints overcomes problems of external leakage and the smooth contours of the body make it easy to insulate. This valve range, widely used on process duties, hot water and chilled water lines, is made in carbon steel up to 500 mm (20 inch) and stainless steel up to 100 mm (4 inch) for pressure ratings up to PN 40 and the usual screwed, flanged and weld type end connections are available.

Further details: Naval Oy.,
Box 32,
SF–23801 Latila,
Finland.

Coal handling by Tower Silos

Tower Silo Systems will supply coal storage silos and extraction equipment as part of a major project at Tate and Lyle's Thames sugar refinery involving construction of new coal-fired steam raising plant. The scheme includes the installation of two 1100 tonnes capacity "Prestave" concrete silos, the largest stave silos to be built in the UK

for coal storage so far. Tower Silo Systems will also incorporate variable output Parcey extractors to provide an efficient 20/30 tonnes/hr feed of coal to a pneumatic transfer system.

The order of the contract has been placed by Tate and Lyle Sugars, a Division of Tate and Lyle Industries Ltd. The contract is being managed overall by M.E. Boilers Ltd. of Peterborough, who are undertaking the design and installation of a complete steam generating plant. The silos will feed four M.E. Coil boiler units incorporating integral atmospheric fluidized-bed combusters burning coal as the primary fuel, with heavy fuel oil providing 100% standby.

Further details:
Tower Silo Systems Ltd.,
Lysander Road, Bowerhill,
Melksham, Wiltshire, U.K.

Weighing control

Richard Simon & Sons have developed a new loss-in-weight controller. An extension of the company's range of continuous weighing products, this controller operates on the discontinous batch weighing method providing a constant rate feed of material, whether for powders, solids or liquids. Linking proven weighing techniques with state-of-the-art electronics, it is designed for easy opearation and will be availabe customized for individual applications.

Further details:
Richard Simon & Sons,
Park Lane,
Basford,
Nottingham, UK.

Electrodialysis of sugar and water

Portals Water Treatment Ltd., who have been involved in electrodialysis for over thirty years, are marketing a new range of electrodialysis equipment. It is employed not only for the treatment of water, but for many specialist applications including deashing of sugars and potable water production. The comprehensive range of standard packages are simply tailored to each clients's needs; from laboratory feasibility testing to large modular industrial systems.

The latest electrodialysis range is the 2/10 which provides a compact, self-contained method of treating saline waters. Supplied in five standard sizes, they will produce up to 300 m^3/day of controlled quality water from most supplies, to World Health Organization (WHO) standard.

Further details:
Portals Water Treatment Ltd.,
632-652 London Road,
Isleworth,
Middlesex, UK.

A sweet tooth for Girdlestone

One of the first Girdlestone 900 series centrifugal pumps is now operating at British Sugar's Kings Lynn sugar factory, which slices 600,000 tonnes of sugar beet per campaign. Handiling sugar in liquid form at 90°C, the 910 industrial pump has a 327 m^3/hr capacity, a differential head of 54.9 m and was supplied for its low NPSH handling ability.

Launched in 1985, the 900 series pump ranges were specifically designed with the maintenance engineer in mind. A unique design feature of the series is the provision for both rear removal of the complete rotating assembly and for front access to the impeller and seal by removal of the suction cover.

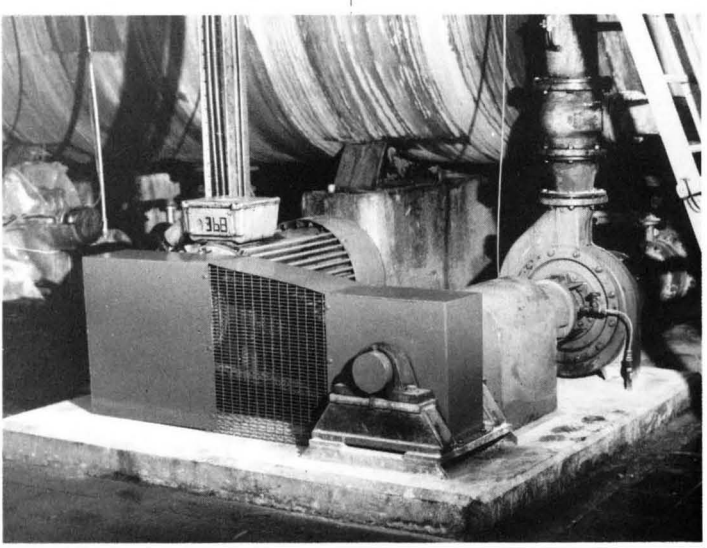
Materials specified for the 910 pump at British Sugar include a cast iron volute casing, stainless steel 316 impeller and a shaft of stainless steel type 329.

Further details:
Girdlestone Pumps Ltd.,
Melton, Woodbridge,
Suffolk, UK.

Expanded range from Accrafill

The well-established Accrafill sack filler and weigher is now available in a wider range of models. The latest version, "Mini-Accrafill", offers a simple and effective approach to filling containers in the 2 kg to 12.5 kg range. Installed as part of a bulk materials handling system, it can be supplied via a hopper, vibratory feeder or volumetric screw feeder. Design options are available to meet a wide variety of operating conditions.

Further details: A. T. Sack Fillers,
150 Hampstead Road,
Bristol BS4 3HR, UK.



British Sugar 28th Technical Conference

Technical staff from the Central and Regional headquarters and Research Laboratories of British Sugar plc, together with the managers and some senior staff from the company's 13 sugar factories and 44 guests from the UK and fourteen other countries, assembled at the Grand Hotel in Eastbourne for the 28th Technical Conference during June 9 - 12.

After a welcome from the Conference Chairman, Mr. R. W. Chappell, Executive Director of British Sugar, the first session began on the morning of June 10 under the chairmanship of Mr. N. W. Broughton, Head of the Research Laboratories, and included three papers on white sugar colour, the first by Mr. Broughton and his colleagues on the sources of white sugar colour, a second by Prof. G. Mantovani and colleagues of the Universities of Ferrara and Turin on industrial factors decreasing sugar crystal colour, and a third by Mr. P. W. van der Poel and colleagues of CSM Suiker B.V. on colour formation and elimination from crystals.

The afternoon session was chaired by Mr. R. J. Bass, Director of Engineering and included a review of agricultural prospects for the coming campaign, contributed by Mr. T. P. J. Dyke for British Sugar and by representatives of the other countries present. Mr. M. K. Faviell of Canada could not say what the condition of the crop was in his country because, when he had left home two weeks earlier, there had been 18 inches of snow in the fields around Calgary and nobody had bothered to dig down through it to check on germination.

Papers were then presented on extension and modernization of the Aarberg sugar factory and refinery in Switzerland, by Mr. H. R. Brunner and colleagues, after which Mr. J. S. Hogg and colleagues discussed factory generation and import of electrical power in synchronism with the public electricity supply. Papers were also presented on the utilization of low grade heat by Mr. D. G. Brown and Mr. D. C. Hogan of British Sugar, and on energy reduction and process integration by Mr. N. R. Twaite and Mr. J. J. Davenport of British Sugar in cooperation with Mr. E. K. Macdonald of the Energy and Process Integration Unit, Harwell.

On the following morning, Mr. P. Mottard of G.T.S. in France presented a paper on pulp pressing additives, after which Dr. K. E. Austmeyer of the Braunschweig Technical University discussed new ways of pulp drying. Finally, Mr. R. J. Parker and Mr. J. N. Smith described a pulp dryer outfall housing explosion and the investigation which it occasioned. The afternoon was then free for participants to play golf or take part in a number of excursions which had been ably organized by the Conference Administrator, Mr. Dennis Garside, and the Conference Secretary, Mrs. J. E. Foxon.

The last session of the Conference was held under the chairmanship of Mr. M. Shore, Director of Research, and included papers on crystal sizing by Mr. J. S. Hogg and colleagues of British Sugar and the University of Sheffield, on the new liquid sugar process at Vauciennes sugar factory by Mr. J. Foucart and Mr. J. Paleos, and finally a paper on developments in the drying and cooling of sugar by Mr. N. R. Twaite and Mr. A. J. Randall. Mr. Chappell then summarized the Conference and thanked all who had participated before closing the proceedings.

The papers will be either reproduced in full or abstracted in this Journal.

Electrodialytic de-ashing of cane juice for increased sugar production*

By Teh-An Hsu
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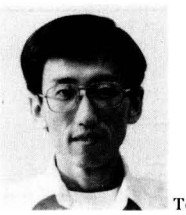
Introduction

Electrodialysis (ED) is a membrane process by which dissolved salts in an aqueous feed can be removed (Fig. 1). Since the appearance of ED techniques about 40 years ago[1], extensive work has been done in the field of water desalination[2-7], and the process has been commercialized for over 20 years.



Teh-An Hsu

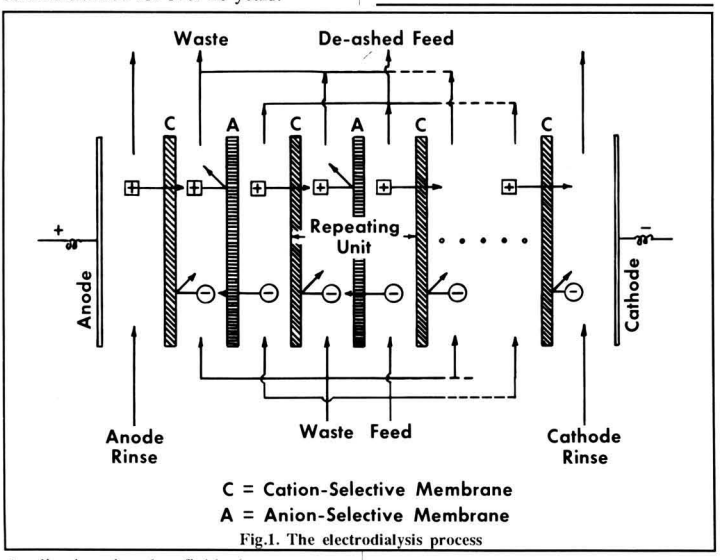


Fig.1. The electrodialysis process

Applications in other fields, however, have been limited.

Although the potential of applying ED to reduce ash in sugar juice to increase recovery in raw sugar processing has been well recognized[8-10], few data are available. The potential recovery increase, however, has been shown to be significant — sugar production can be increased by 1.9 kg for every kg of ash removed[11]. In the 1983 season, Hawaii's sugar industry produced 1,044,000 short tons (947,000 tonnes) of sugar, along with 303,000 tons (275,000 tonnes) of molasses which contained 107,000 tons (97,000 tonnes) of sucrose and 31,000 tons (28,000 tonnes) of ash[12]. If 40% of the ash had been removed prior to crystallization, sugar production would have been increased by 24,000 tons (21,000 tonnes), or a 22% reduction in sugar lost to molasses. At a return of $360/ton ($400/tonne), the value of this sugar is $8,500,000.

To determine the technical and economic feasibility of ED juice de-ashing, and to examine the necessity of feed juice prescreening, we conducted a study in which a small-scale ED apparatus was tested both in the laboratory and in a sugar factory. The results are presented in this paper.

Materials and methods

Materials

Feed juice: For the laboratory tests, feed juices were prepared by diluting a 60% refractometer solids syrup down to 5 - 25% solids. The syrup contained 2.5% carbonate ash, of which 34% was potassium and 31% chloride. For the factory tests, feed juices were prepared by diluting freshly collected syrups to 30 to 45% solids.

Electrode rinse solution: In the study, the two electrode rinse streams were drawn from a common source (Fig. 2). The solution used was either 0.1N KCl solution or 0.1N KCl solution adjusted with concentrated HCl to pH 1.5.

Waste stream: In some laboratory runs, feed and waste were drawn from, and returned to, a common pool of juice. For the remaining runs, either tap water or 0.1N KCl solution was used as the waste stream.

Analytical methods

Carbonate ash: Carbonate ash content was determined by either of two methods: (1) the standard procedure given in Sugar Cane Factory Analytical Control[13] or (2) the conductivity method. For the second method, curves relating ash and conductivity were first established, as in Figure 3, then used for estimating ash from conductivity measurements. This method is somewhat less precise; its precision is, however, acceptable (as shown by the limited scattering of data in Fig. 3) and it is much less time-consuming.

Potassium and chloride: K^+ and Cl^- contents were analysed using an Orion potassium electrode and a Buchler-Cotlove model 4-2008 Chloridometer, respectively.

Voltage and amperage: A digital multimeter and volt-ammeter were used to monitor, respectively, the voltage drop across, and the electric current flowing through, the electrodialyser. These two parameters were necessary for

* Published as Paper No. 614 in the journal series of the Experiment Station, Hawaiian Sugar Planters' Association

1 "Industrial processing with membranes", Part 1 Eds. Lacey & Loeb (R. E. Krieger Publishing Co., Huntington, N.Y.), 1979.
2 Calvit & Sloan: *Proc. 1st Int. Symp. on Water Desalination*, 1965, 11.
3 Harkare *et al.*: *Desalination*, 1982, **42**, 97.
4 Mattson: *ibid.*, 1979, **28**, 207.
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6 Matz: *Proc. 1st Int. Symp. on Water Desalination*, 1965, 251.
7 Tsunoda: *ibid.*, 1965, 325.
8 Beet Sugar Development Foundation & Amer. Crystal Sugar Co., Final Report for U.S.D.O.E. Contract No. AC03-79CS40213, 1981.
9 Sugiyama *et al.*: U.S. Pat. 3,718,560 (1973).
10 Vane: *Sucr. Belge*, 1977, **96**, 277.
11 Unpublished data, Hawaiian Sugar Planters' Assoc.
12 *Factory Report*, (Hawaiian Sugar Planters' Assoc.), 1984, (155), Table 2.
13 "Sugar cane factory analytical control" Ed. Payne (Elsevier, New York), 1968.

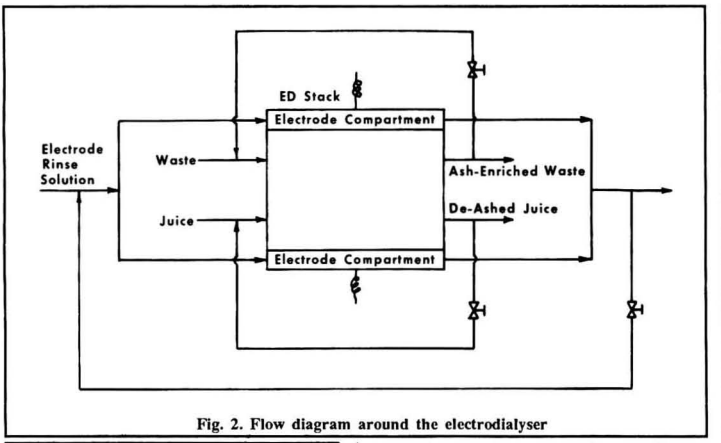

Fig. 2. Flow diagram around the electrodialyser

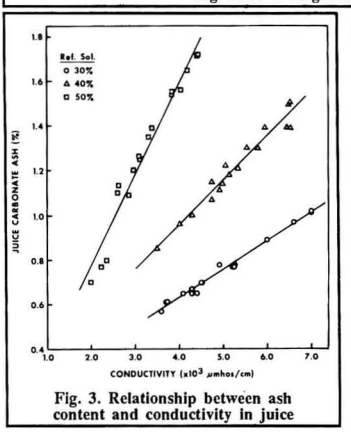

Fig. 3. Relationship between ash content and conductivity in juice

determining the energy requirements and the limiting current densities (to be defined later) for the ED process.

Experimental apparatus, operating conditions, and study procedure

Experimental apparatus

The heart of an ED system is the electrodialyser in which the feed is de-ashed. A typical commercial electrodialyser contains up to 200 "cell-pairs" (repeating units as illustrated in Fig. 1). The unit used in this study was a 9 inch × 10 inch (22.9 cm × 25.4 cm) laboratory electrodialyser manufactured by Ionics Inc. and was assembled to have 10 and 5 cell-pairs, respectively, for the laboratory and factory tests.

The membranes tested were all supplied by Ionics Inc. Only one type of cation selective membrane, 6I-CZL-386, was involved in the study, whereas two types of anion-selective membrane, 103-QZL-386 and 204-UZL-386, were tested, respectively, for the laboratory and for the factory tests. The 204-series membrane was a more recent product and was reported to be more resistant to fouling and to have a lower sucrose transport capacity[14].

Operating conditions

A number of operating conditions were maintained relatively constant throughout the study. First, the laboratory tests were all conducted at room temperatures of 25 to 30°C and the factory tests at ambient temperatures of 30 to 35°C. Second, juice flow rate was maintained at 30 cm/sec along the flow paths in the electrodialyser. (The manufacturer recommended the flow rate be between 20 and 40 cm/sec.) Third, the waste stream flow rate, a parameter of relatively less significance, was either held at 30 cm/sec or adjusted to give the same pressure drop as the juice side. Fourth, the flow rates of the two electrode rinse streams, also of less significance, were set either to be 90 cm/sec or to give pressure drops the same as the juice side.

Study procedure

Prescreening: The necessity of feed juice prescreening was studied by determining the pressure drops across the electrodialyser for juice samples of various concentrations with and without prescreening (325 mesh).

ED tests to determine limiting current densities, cell-pair resistances, and potassium and chloride removal factors: The ED process has certain limitations, one of which is the limiting current density (LCD), i.e., the maximum electric current per unit effective membrane area that could be applied under given feed and operating conditions. Conducting the process at a current density higher than the LCD will lead to intolerably high electrical resistance, resulting in high operating expenses, severe damage to membranes, and undesirable changes in product characteristics[1].

To determine the LCD, we first used a specific cell-pair electric resistance (SCR, cell-pair voltage drop/current density) method for lower juice, and hence lower ash, concentrations, and subsequently developed a pH method for higher juice concentrations. In the former method, SCR was plotted against current density and the LCD was determined as illustrated in Figure 4. In the latter method, the pH of the de-ashed juice was plotted and the LCD was determined as shown by the pH curve in Figure 5. (Also shown in Fig. 5 is that the SCR method in this case failed to yield the LCD.)

To avoid large numbers of ash analyses, the "ion removal factor," defined as the number of gram-equivalents of an ionic species removed from the feed per cell-pair per unit faraday of electricity that has passed through the electrodialyser, was used for determining ash removal from directly measured current. In this study, we extensively used two ion removal factors: the potassium (PRF) and the chloride (CRF) removal factors. To determine them, juice before and after de-ashing was sampled and analysed for K^+ and Cl^-; the respective factors were then calculated.

ED tests to determine relationships of potassium and chloride removal to ash removal: With PRF and CRF and the applied current known, we were able to calculate the removal of K^+ and of Cl^-

14 Literature provided by Ionics Inc., MA.

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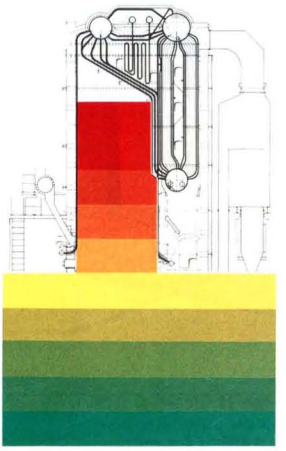

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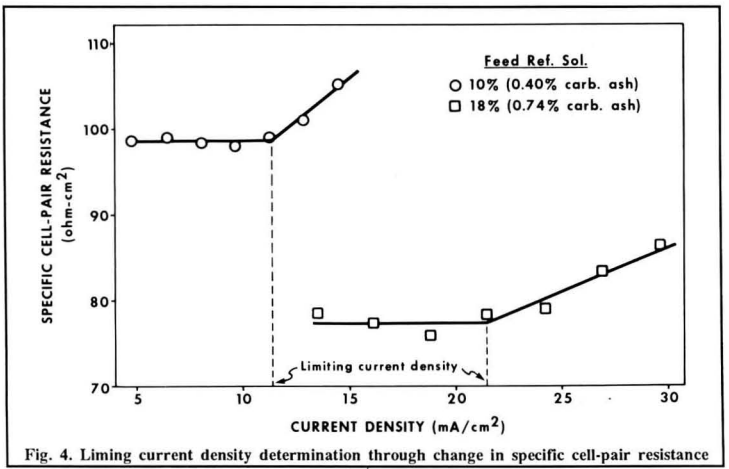


Fig. 4. Liming current density determination through change in specific cell-pair resistance

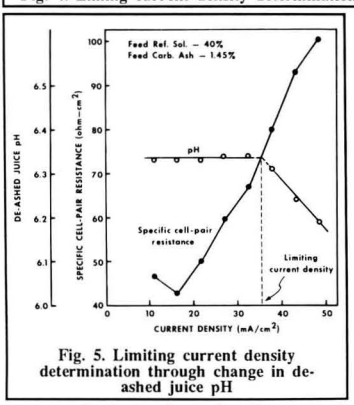


Fig. 5. Limiting current density determination through change in de-ashed juice pH

but not of ash. To determine the removal of ash, the relationship of K^+ or Cl^- removal to ash removal needed to be established. For this purpose, tests were conducted in which tap water was used as the waste, and both juice and waste were totally recycled. Low current densities were used so that at the end of each run (about 10 minutes allowed) the current density was still lower than the corresponding LCD. Ash, K^+, and Cl^- in initial and final juices were then analysed and relationships of interest established.

Economic analysis : The internal rate of return (IRR) method[15], also known as the after-tax rate of return on investment using the discounted cash flow method, was used to assess economic feasibility of the ED juice de-ashing process.

Results and discussion

Juice pretreatment

Figure 6 illustrates that the presence of suspended solids increased the pressure drop across the electrodialyser substantially, indicating the need for feed prescreening. As a result, we screened all syrup samples prior to diluting them for ED runs, and the electrodialyser was able to run several hours a day for several days without any serious increase in pressure drop.

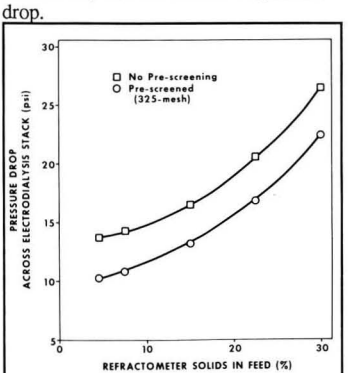


Fig. 6. Effect of pre-screening of juice feed

Limiting current density

As mentioned earlier, for higher juice concentrations, the SCR method failed to yield the LCD's. We consider this to be due primarily to the low Reynolds numbers in the tests.

The idealized ED model[1] assumes that the feed is well mixed in the electrodialyser. In our study, since the Reynolds numbers were estimated to be of the order of only a few hundred, the flows were apparently all laminar and thus the assumption regarding well-mixing did not apply. Consequently, it is reasonable to assume that "concentration polarization" (ash becomes depleted near the membrane surface so that ionization of water occurs[1]) started only from the end where the ash concentration was lowest. This caused the electric current to be unevenly distributed along the flow path, which, in turn, resulted in an SCR curve without a clear break point, as shown in Figure 5. The curve for the de-ashed juice pH (also shown in Figure 5), however, yielded a distinct break-point, allowing the LCD to be readily determined.

It is to be noted that the SCR is an averaged value over the entire flow path, whereas the de-ashed juice pH is a localized measurement which gives the pH of the juice leaving the area where concentration polarization begins. The pH method, therefore, is by nature a more sensitive method in determing LCD.

LCD values determined by the two methods are plotted in Figure 7. The levelling-off of the curve at high ash content was somewhat unexpected (an increasing LCD with increasing feed ash content had been expected). We believe

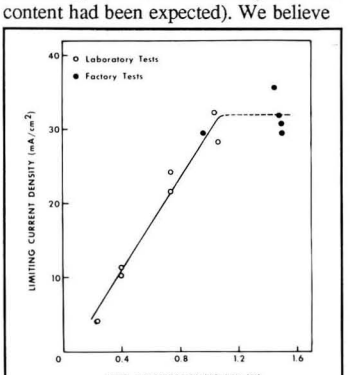


Fig. 7. Limiting current density as a function of ash in juice (the plateau portion is shown with broken line to reflect the high data scattering)

15 Weston & Brigham: "Managerial Finance", 7th edn., Chap. 13, (Dryden Press, Hinsdale, IL), 1981.

that this is related to the juice solids concentration, i.e., in the case of sugar juice which contains ash as well as other soluble components, LCD is a function of not only ash but also solids concentration. Unfortunately, the amount of data available did not suffice to pursue a three-dimensional correlation.

Cell-pair resistance

Figure 8 gives the values of SCR at various LCD levels obtained from tests conducted in the laboratory. These data were useful in the economic analysis for projecting energy requirements for the process. For solids concentrations higher than 25%, the SCR values were predicted by extrapolating the curve in Fig. 8 and making the extrapolated curve symmetrical to a vertical axis at 30% refractometer solids (an earlier study[11] showed the curve for the specific resistance of cane juice to be approximately symmetrical to an axis vertical to the x-axis at 30% refractometer solids).

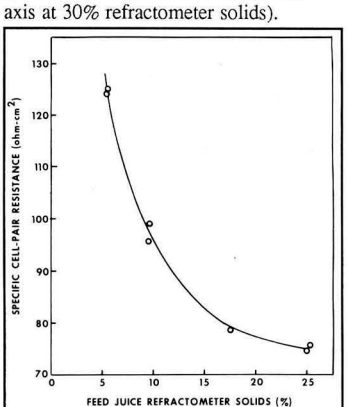


Fig. 8. Specific cell-pair resistance for electrodialytic juice de-ashing

It should be noted, however, that the SCR in ED is, in effect, a sum of several resistances: feed, waste, and two ion-exchange membrane sheets. Our SCR data were obtained in the tests in which juice from a common pool was fed to both the juice and the waste compartments. In practice, it might be feasible to lower the cell-pair resistance by using a waste of high salt concentration, provided that the concentration is not so high as to cause precipitation.

Coulomb efficiency and potassium and chloride removal factors

When KCl solutions were used as the feed and the operating current densities were kept below the LCD, we found the coulomb efficiencies to be very close to the theoretical value of 1.0. Thus, the coulomb loss of the ED apparatus was negligible as long as the LCD was not exceeded.

When juices were tested, the PRF and CRF averaged 0.60 and 0.94, respectively, (Fig. 9). Thus, Cl^- in juice was removed much more effectively than K^+, possibly owing to the fact that Cl^- was the most mobile of all anions in cane juice, whereas K^+ was not the most mobile cation. The high CRF suggests that there was almost no removal of any other anions until Cl^- was nearly all removed.

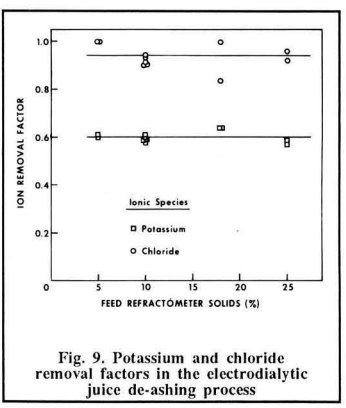


Fig. 9. Potassium and chloride removal factors in the electrodialytic juice de-ashing process

Potassium and chloride removal vs. *ash removal*

Since Cl^- was the most mobile anion in the ash, the percentage removal of Cl^- was much higher than that of ash, as shown in Fig. 10. In fact, Cl^- and K^+, the two most abundant ionic species in cane juice, were both removed faster than ash — the removals were, respectively, 63% and 3% higher as indicated by the slopes in Figure 10.

Other observations

When the LCD was exceeded for an extended length of time, precipitates formed, and the precipitation was heavier towards the outlets of the flow paths,

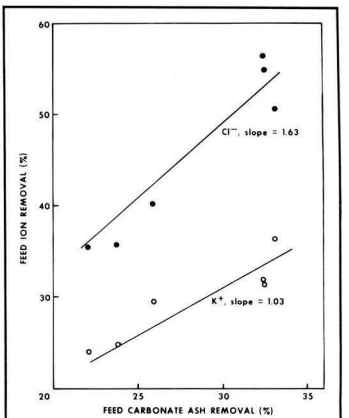


Fig. 10. Preferential removal of potassium and chloride over ash

possibly owing to the drastic changes in pH in those areas as discussed earlier.

During the factory tests, the pressure drop across the 5-cell-pair electrodialyser was about 40 psi (280 kPa) for 45% solids juice. As deposition of suspended solids or precipitation occured, it increased, at times by 5 to 10 psi (30 to 70 kPa), in a run. For even higher increases, we dismantled and cleaned the electrodialyser to remove precipitates, deposits and slimes. On all occasions, full restoration to the original performance was obtained.

Heavy juice stains formed permanently on every membrane sheet, covering the entire flow path. The membranes, however, appeared to be in good condition after a total of approximately 200 hours of operation. Following the conclusion of the testing program, several membranes were sent to the supplier for examination; they were verified to have had no appreciable chemical changes.

Economic analysis

Table I shows examples of the IRR values for the ED juice de-ashing process at sugar and molasses returns of $356 and $35/ton, respectively. Hawaiian sugar factories produce from 43,000 to 160,000 tons (39,000 to 145,000 tonnes) sugar/year[12]; thus the process might be attractive to some of the larger local factories.

ISJ Abstracts

Cane sugar manufacture

Handling of low-grade massecuites

K. N. Shukla, M. R. Jamkhandikar, A. R. Bhide and B.R. Math. *Maharashtra Sugar*, 1985, **10,** (4), 9, 11, 13, 15-16.

Aspects of low-grade massecuite treatment discussed include the boiling process, viscosity and its effect on crystallization, cooling in continuous vertical crystallizers and the use of continuous centrifugals, with their attendant advantages.

Prospects and possibilities of membrane separation processes in the Indian sugar industry

S. S. Mahajan. *Maharashtra Sugar*, 1985, **10,** (4), 29, 31, 33.

Possible applications of reverse osmosis and ultrafiltration to juice concentration and alcohol separation from impurities in place of distillation are discussed.

Pallet net solves sugar stacking problems

Anon. *S. African Sugar J.*, 1985, **69,** 397.

At Mount Edgecombe factory, brown sugar in 25-kg bags has to be stored in a warehouse since the factory only operates for 6 - 8 months in the year. Handling of the bags has been made less labour-intensive with a reduction in damage by stacking on pallets and enclosing the stacks in pallet net; a fork-lift truck can pile to a height of five stacks. The use of pallet net has also proved effective with 12.5 -kg plastic packs of brown sugar which caused unstable loading because of their slippery surfaces.

Enzymatic removal of starch from sugar cane juice during sugar cane processing

Y. K. Park, I. S. H. Martens and H. H. Sato. *Process Biochem.*, 1985, **20,** (2), 57 - 59; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (23), Abs. 23 R557.

The possibility of enzymatic removal of starch from cane juice was studied. Analysis of the starch removed showed that it had a particle size of 1 - 6 μm and a gelatinization temperature in the range 65 - 80°C. It was susceptible to the action of both bacteria and yeast α-amylase. When bacterial amylases were used at 80 - 90°C, oligosaccharides were formed having a degree of polymerization of 1 - 7. With yeast amylases, hydrolysis took place at 50 -55°C with the formation, mainly, of maltose and small quantities of glucose and maltotriose.

Massecuite reheating practices

S. J . Clarke and L. Serebrinsky. *Sugar Bull.*, 1985, **64,** (6), 8, 15.

The importance of the molasses saturation factor in regard to low-grade massecuite reheating is discussed. Normally, the molasses is supersaturated and the massecuite can be reheated to the saturation temperature or slightly above it without fear of crystal dissolution; but if the molasses is only just supersaturated on discharge from the crystallizers, reheating will cause under-saturation and risk of dissolution. However, experience has suggested that an appreciable degree of under-saturation is acceptable without significant redissolving providing reheating is rapid and carried out immediately before spinning. The massecuite retention time in the mixer or reheater at elevated temperatures can greatly affect purity rise in the final molasses, and experience with the Stevens coil is mentioned; the high ratio of massecuite volume to heating surface necessitates good mixing for regular temperature control, so that the dissolution rate is much greater if the temperature is too high, while the heat from the water may be sufficient to cause local dissolution where the massecuite is in contact with the coils. Although consistent pan operation should give a stable massecuite and molasses Brix and hence a fairly constant saturation temperature, this temperature must still be determined, although continuous monitoring of it at the entrance to the mixer or reheater, while desirable, is not practicable.

Ash in pan stage products

J. N. Ness. *BSES Bull.*, 1985, (12), 6 - 7.

The author briefly explains how some 12% of the ash in syrup enters sugar in boiling and makes up almost half of the sugar impurities. The major ash constituents in syrup, sugar and final molasses are shown by diagrams and then subdivided into cations and anions to indicate the major components in each group in the three products. De-ashing to remove K^+ and Ca^{++} is mentioned as well as the relative importance of Cl^- and SO_4^{--}.

BSES tests prove molasses cooler design

Anon. *BSES Bull.*, 1985, (12), 18 - 19.

Problems in the use of shell-and-tube heat exchangers for molasses cooling are discussed, and the application of a plate heat exchanger reported in which the overall heat transfer coefficient varied from 25 to 90 W/m²/°C depending on molasses flow in the range 72 - 360 kg/hr. The 26 plates of the unit were arranged to allow a single molasses pass from bottom to top in 13 parallel paths, with a 12-pass cooling water path. Under Australian regulations, molasses (normally leaving the centrifugals at 60 - 65°C) must be cooled to 38°C before bulk storage or shipment.

The water balance in sugar mills

M. Cheng and C. Y. Chiang. *Taiwan Sugar*, 1985, **32,** (5), 9 - 16.

Because of increased demands for water in industry generally, and because of the problem of water pollution caused by industrial effluent, there is need for more rational utilization of water in Taiwan sugar factories, and the authors show how to obtain the best results by making maximum use of vapour bleeding and of condensate as well as of recycled water.

Quantitative studies on the phenolics development in Egyptian raw sugar manufacture

A. Abou El-Ela and A. Abou Doh. *Taiwan Sugar*, 1985, **32,** (5), 23 - 26.

In analysis of samples from the individual process stations at Kom Ombo factory it was found that there was little difference between diffusion and mill juices in terms of the total phenolics content (TPC) and that the greatest concentration of TPC (the average of nine determinations) occurred in mixed juice (18,611 ppm on Brix). White sugar contained 200 ppm TPC and raw (*B*-) sugar 320 ppm, while final molasses contained 17,322 ppm. Hence processing failed to remove more than 35% of the TPC. The order of TPC removal efficiencies of clarification processes was: sulpho-phosphatation > sulphitation > phosphatation.

Improvements in exhaustion of final molasses

M. Saska. *Sugar Bull.*, 1985, **64,** (4), 11.

Fine grain (10 - 30 μm) often occurs in Louisiana *C*-sugar, and poor massecuite preheating and spinning may cancel out the effect of good crystallization, e.g. through melting of fines, increased molasses adhesion to fines, loss of fines through the centrifugal screen, and reduction in the rate of molasses drainage as a result of plugging of the passages with fines. The effects were quantified by assuming the specific surface area (SSA) of the crystals (cm^2/g) to be 5.5L where L = crystal size (cm), and assuming that: the SSA of *C*-sugar is the sum of the areas of the individual crystals, the dissolution rate of the crystals is proportional to their SSA, the thickness of the molasses layer adhering to the crystals is independent of crystal size, and the total amount of adhering molasses is proportional to the SSA. Calculations showed that, by comparison with a massecuite containing no fines, the presence of large quantities of fines raised molasses purity by 0.3 units and reduced sugar purity by 7.7. units, while the corresponding values with moderate amounts of fines were 0.2 and 2.5 units, respectively. Loss of fines through the centrifugal screen caused a 1.34 units rise in molasses purity, while the effect of drop in drainage rate depended on the amount of extra centrifugal capacity available.

Studies on ion exchange resins for cane syrup decolorization

W. F. Lin. *Rpt. Taiwan Sugar Research Inst.*, 1985, (108), 35 - 43 (*Chinese*).

Results of laboratory studies on cane syrup decolorization using strongly basic anion exchange resins showed that colour removal bore no direct relationship with the initial colour of the syrup but was closely related to the types and characteristics of the colorants and their precursors. A styrene resin was effective in treating a syrup which was still of high colour content after treatment with acrylic resin, and the colour content could be reduced from 50 - 180 units to < 20 units with an acrylic-styrene resin system. The colour of micro-crystal refined sugar was significantly correlated with that of the decolorized syrup from which it was obtained. Iron caused some of the colour in the sugar, which is why stainless steel equipment is recommended.

Plant trials on chemical cleaning of evaporator heating surfaces at Umfolozi mill

M. A. Getaz. *S. African Sugar J.*, 1985, **69,** 432, 434 - 435.

After successful trials at the SMRI, a full-scale two-stage evaporator cleaning process was introduced at Umfolozi which involves spraying a 25 - 30% w/v NaOH solution at 100 - 105°C over the tubes followed by a 2% w/v sulphamic acid solution at 70°C. While the pilot plant trials had shown that a 3-hour spraying period was sufficient, the full-scale factory trials indicated the need for 4 hours (possibly because of less effective spray coverage and lower application rates than used in the earlier tests), but extending treatment beyond this brought no further benefit. To minimize corrosion, the temperature at which the sulphamic acid is sprayed should be no higher than 80°C; however, no information has yet been obtained on corrosion by the NaOH and acid because of the limited time during which the procedure has been used. Mention is made of occasional excessive frothing during the NaOH treatment, but in all such cases scale removal was exceptionally good. It is considered necessary to screen the cleaning solutions so as to remove scale; while most of it in the the solutions (which could easily amount to 15%, it is thought) is removed by flushing after treatment, the scale is in circulation during spraying and can cause blockage of tubes and pipes. The economics of the cleaning technique are discussed; although these still favour mechanical cleaning, it is considered possible to reduce them by optimization, and the general dislike of mechanical cleaning by workers is regarded as an important factor in favour of chemical cleaning.

Use of ultrasound in pan control

O. Llompart, R. Consuegra and C. Salabarria. *Control Cibernetica y Automatización*, 1982, **16,** (1), 22 - 25; through *S.I.A.*, 1986, **48,** Abs. 86 - 170.

Limitations of existing methods of measuring supersaturation and crystal content are noted and a method avoiding them is proposed. It was found that, for magmas made with a given liquor, the readings of an ultrasonic viscometer were independent of crystal content (0 - 40% tested), i.e. the viscosity V_L of mother liquor rather than V_M of the massecuite was being measured. The crystal content R (as a fraction, on massecuite) can be computed from $R = \ln (V_M/V_L)/2.84$. A material balance is developed for calculating supersaturation directly from R, footing parameters, liquor parameters and total weight of massecuite.

Beet sugar manufacture

Determination of the consumption of antifoam agent for the diffusion process

N. V. Kulinich, V. G. Yarmilko, B. N. Valovoi and V. V. Artemenko. *Sakhar. Prom.*, 1985, (12), 18 - 20 (*Russian*).

Investigations showed that it is unwise to follow official recommendations on the amount of antifoam agent to add to diffusion juice, as the quantity will depend on juice quality as well as temperature, so that only by conducting laboratory tests on the spot will the optimum be found. Comparison between a Dow Corning product, Briox SG-17 (from British Petroleum) (both at 0.005% on juice) and soap stock at 0.01% on juice confirmed the fall in performance with reduced temperature, although the Dow Corning product was still by far the most effective. In factory trials, it gave best results at 0.008% on juice at a juice purity of 83.9 and a temperature of 70°C.

Effect of processing factors on crystal conglomeration during massecuite boiling

N. I. Shtangeeva. *Sakhar. Prom.*, 1985, (12), 22 - 24 (*Russian*).

The effects on conglomeration of supersaturation at nucleation, of massecuite temperature, of the length of the boiling cycle, of surfactants, and of massecuite purity and crystal size fractions were investigated, from which it was concluded that optimum was a supersaturation of 1.15 - 1.20 at nucleation, a temperature of 65 - 80°C and use of a surfactant at 0.01% on massecuite.

Results of factory operation of a R3-PPZh-6 hydropneumatic beet lift

V. G. Yarmilko. *Sakhar. Prom.*, 1985, (12), 24 - 27 (*Russian*).

Details are given of the performance of an experimental beet lift capable of raising 7500 tonnes of beet per hour to a height of 28 metres.

Plant for unloading acetomonoglycerides from a container, preparing an emulsion and feeding it to vacuum pans

Yu. D. Golovnyak, L. G. Belostotskii, Ya. G. Ropotenko, A. I. Kovalenko and A. Ya. Ropotenko. *Sakhar. Prom.*, 1985, (12), 27 - 28 (*Russian*).

Details are given of a system for handling and processing fatty acid acetomonoglycerides to be used as surfactants in boiling.

A device for controlling raw juice dilution

Z. S. Voloshin, I. B. Margulis, V. A. Nikolaenko and N. A. Rudchenko. *Sakhar. Prom.*, 1985, (12), 28 - 30 (*Russian*).

A twin-float density meter system is described which is designed to monitor juice Brix before evaporation so as to determine changes in the value during carbonatation and filtration, when dilution occurs as a result of milk-of-lime addition and sweetening-off.

The aerodynamic resistance of muddy sugar beet

V. A. Knyazev. *Sakhar. Prom.*, 1985, (12), 32 - 36 (*Russian*).

The extent to which muddy beet reduce air flow in forced ventilation of storage piles has been investigated, and recommendations are given on the use of axial fans under such conditions.

An arrangement for mechanical cleaning of disc filter frames

M. Ya. Drai and I. I. Gametskii. *Sakhar. Prom.*, 1985, (12), 36 - 37 (*Russian*).

An electric rotary brush system for cleaning filter frames is described.

A double time switch for control of the beet level in a hopper

G. M. Nikitin. *Sakhar. Prom.*, 1985, (12), 38 (*Russian*).

A circuit diagram is given of the title control device.

Residence time of beet pieces in the beet washer

W. Uhlenbrock. *Zuckerind.*, 1985, **110,** 1072 - 1073 (*German*).

Determination of the residence time distribution of beet fragments in the washer is used as an example to demonstrate the advantage of red beet over stained sugar beet as an indicator.

Measurements of crystal sizes in white sugar massecuites using the Carl Zeiss Oberkochen Mikro-Videomat-2

M. Schneider and H. Schiweck. *Zuckerind.*, 1985, **110,** 1074 - 1080 (*German*).

Details are given of the three methods mainly used to determine crystal size distribution: sieve analysis, electrolytic analysis using e.g. a Coulter counter, and optico-electronic determination; their chief advantages and disadvantages are noted. A description is given of the Mikro-Videomat-2 with which a micro- or macroscopic image of the sample is projected onto a monitor screen with the aid of a television camera; the original picture is scanned for light intensities and converted into a bright-field/dark ground picture on a grid containing 480,000 points, thus permitting determination of the total number of points per crystal (measurement of surface area) or per crystal chord (measurement of length). Merits of the system are indicated, and information is given on the procedure used for sample preparation and on use of the equipment, together with results obtained.

Energy saving with speed-controlled A.C. drives in the sugar industry

J. Merkl. *Zuckerind.*, 1985, **110,** 1082 - 1089 (*German*).

Advantages of speed-adjustable A.C. motors, particularly as drives for pumps and fans, are briefly noted, especially

their energy-saving potential by comparison with conventional drives. The use of frequency for speed control is explained, with descriptions of types of convertor and their properties, and a guide is given to determination of the desirable load characteristics of a drive. Installation and running costs are discussed, and the potential energy reduction with static frequency convertors indicated in the case of a centrifugal pump drive. Examples of frequency convertor application in the sugar factory are described, and means of controlling the output of fans is discussed.

A new, efficient condensate extractor in the East German sugar industry

I. Friedemann. *Zuckerind.*, 1985, **110,** 1094 - 1095 (*German*).

See *I.S.J.*, 1986, **88,** 92A.

Chemical and microbiological stability of sugar syrups subjected to prolonged storage

G. Vaccari, G. Sgualdino, G. Mantovani, D. Matteuzzi and W. Scheda. *Ind. Sacc. Ital.*, 1985, **78,** 152 - 161 (*Italian*).

Storage of thick juice, of mixtures of syrups and of green syrup in 50-litre containers and industrial tanks was studied under the climatic conditions encountered in Italy. Results showed that low-purity syrups had good storage properties, but all syrups showed a significant increase in colour. Disinfection proved unnecessary provided the syrups were cooled before storage. Some problems occurred in thick juice storage, particularly in the south of Italy, and results were distorted by a precipitation of non-sugars on the bottom of the tanks which caused an apparent increase in pol and purity.

DDS vacuum pan automation at Szolnok sugar factory

G. Malatinszky and O. Krieger. *Cukoripar*, 1985, **38,** 129 - 136 (*Hungarian*).

Details are given of the layout and operation of the DDS 74-II conductivity-based pan automation system as installed at Szolnok for the six *A*-pans and one low-grade seed pan; the 74-I, which is very similar but simpler, was installed for the four *B*-pans and five *C*-pans. Boiling house performance was evaluated over two years when some pans were still being operated manually. Once certain teething troubles had been overcome, the automatic system permitted a reduction in the *A*-massecuite boiling cycle from an average of 4.93 to 4.16 hours and a decrease in energy consumption, while the mean grain size was comparable to the average for the Hungarian industry, with much less dust than previously. Although automation had been considered almost unnecessary for the intermediate strikes because of the ease of manual boiling, it did achieve the main target of reducing labour requirements; pan feeding was almost self-regulatory provided the conductivity was maintained at the recommended level. In other respects, the merits of the system were the same as with *A*-massecuite boiling. The conductivity of the syrup used as footing for *C*-massecuite was so stable with changes in beet quality (unlike the effects on the raw juice) that it was rare to need to make any changes in the control value. Seed preparation from *A*-massecuite green syrup was good. The only mechanical failure in the automatic system was rupture of the rubber diaphragm valve, while an apparent fault also occurred if the pan was not properly steamed out after dropping of the massecuite, since this led to sugar deposition on the bottom electrode with distortion of the conductivity measurement in the subsequent strike.

Sugar end purification

K. Bara. *Cukoripar*, 1985, **38,** 76 - 78, 145 - 147 (*Hungarian*).

Experimental carbonatation of a *C*-sugar melt of 60 - 65° maximum Brix with 3 - 4% lime on Brix reduced the lime salts content by 20 - 40%, invert sugar by an average of 44%, amino-N by 26%, the content of iron ions (which play a major role in colour formation) by 29% and colloids by approximately 25%. Viscosity fell by 8 - 10% and the crystallization rate rose by 9 - 11%. Although treatment had practically no effect on molasses yield (because of the quantity of non-sugars removed), there was a probable 0.04 - 0.06% (on beet) reduction in the melt sugar content, representing an approx. 2% fall in molasses sugar. Details are given of the distribution of large and small M.W. fractions in thick juice, *A* and *B* raw and wash syrups, *C*-sugar and molasses.

Sugar factory changes in the latter half of the century

P. Wertán. *Cukoripar*, 1985, **38,** 147 - 150 (*Hungarian*).

The author surveys the changes that have come about in factory processes and equipment to permit increased beet slicing while reducing both water and fuel consumption and at the same time providing for environmental protection.

Lime consumption in raw juice purification

K. P. Zakharov, V. Z. Semenenko, P. P. Zagorodnii and R. G. Zhizhina. *Sakhar. Prom.*, 1986, (1), 16 - 19 (*Russian*).

In a study of the effect of lime dosage (in the range 10 - 220% on raw juice non-sugars) on juice properties and carbonatation mud zeta-potential, addition of up to 85% CaO caused adsorption of negatively charged, finely dispersed colloids on the positively charged carbonate particles, which thus acquired a negative charge; there was linearity in changes in the colloid content and in improved filtration and settling properties with increased lime dosage. With lime rates above 85%, the mud particles regained their positive charge, but there was no further improvement in filtration, although juice quality continued to improve, e.g. through further separation of colouring matter which had both negative and positive charges (so that colorant

adsorption took place at below and above 85% lime). The experimental results are defined by a number of mathematical equations.

Phase residence time in DS (DDS) inclined, twin-scroll diffusers

E. V. Minenko *et al. Sakhar. Prom.*, 1986 (1), 20 - 23 (*Russian*).

Investigations of the residence times of the liquid and solid phases in DDS diffusers of 1400, 2000, 3000 and 4200 tonnes daily throughput involved pieces of carrot and aluminium sulphate as indicators. Gravimetric analysis and polarographic measurements of samples taken at points along the diffusers revealed peaks of concentration and a rather sizeable tail for both phases, demonstrating the occurrence of both ideal displacement (countercurrent diffusion) and negative conditions (bypass flow for the extractant and a dead zone for the cossettes). With increase in diffuser size, the proportion of dead zones increased, while the bypass streams decreased, resulting in greater residence times for both phases. Empirical equations are presented for calculation of the residence times for both phases.

Optimization of *A*-massecuite boiling using a computer

M. A. Karagodin, V. I. Tuzhilkin, A. R. Sapronov and A. I. Sorokin. *Sakhar. Prom*, 1986, (1), 23 - 26 (*Russian*).

Regression analysis of data obtained by mathematical modelling of *A*-massecuite boiling demonstrated the marked effect on the length of the cycle of feed syrup purity and massecuite crystal content. Sets of input and output data, where the massecuite Brix, crystal content and supersaturation were constant, are discussed, showing how specific parameters can be adjusted to provide optimum conditions.

Carbonatation of *A*-massecuite raw syrup

P. P. Zagorodnii *et al. Sakhar. Prom.*, 1986, (1), 26 - 28 (*Russian*).

Investigations of *A*-massecuite raw syrup carbonatation are reported and trials of a system developed on the basis of the findings discussed. The syrup was diluted to 72 - 74°Bx, heated to 85 - 90°C and an average of 2.7% CaO (by volume) added. After 30 minutes retention in the liming tanks, the syrup was gassed with CO_2 to pH_{20} 8.2 - 8.9 (at which no saccharates were formed between sugar and $CaCO_3$), reheated to 80 - 90°C and split into two portions, one of which was filtered and the other (after addition of an anti-foam agent) recycled for further gassing. Results showed a 11.2% purification efficiency, 14.7% decolorization and 33.8% reduction in lime salts; there was no need for supplementary evaporation because of a syrup Brix of 60 - 63° after carbonatation and filtration.

Technological reserves of tower diffusers and their utilization

G. K. Gorskii, A. G. Babak and N. S. Karpovich. *Sakhar. Prom.*, 1986, (1), 28 - 30 (*Russian*).

The design and operation of KDA tower diffusers do not allow creation of the right temperature conditions for a maximum sugar yield. However, installation of a supplementary circulation system to reheat the cossettes-juice mixture in a KDA-15 model, in the middle section of which the temperature was raised to 67°C (compared with 65°C without supplementary heating) and to higher levels at points further up the diffuser, reduced losses to 0.155% (compared with 0.294% without the new system). Sugar yield rose by 0.94 units with a beet pol rise of 0.55 units.

Experience at Meleuz sugar factory in processing syrups from beets stored for a prolonged period

A. A. Slavyanskii *et al. Sakhar. Prom.*, 1986, (1), 30 - 33 (*Russian*).

An account is given of work, started in 1973/74, on improving boiling house performance at Meleuz, including optimum handling of low-purity (84 - 85) syrup from beets stored from February to April. Problems created by melting low-quality affined sugar were overcome by treating the melt with 2nd carbonatation mud, which reduced colour by 12 - 30% (depending on the quantity involved) and raised its pH by 0.7 - 1.0 units and purity by 0.4 - 0.5%. Boiling *A*-massecuite on a crystal footing also provided a rise in purity when the syrup purity was below 83.

Experience in the use of VDF disc water separators

V. D. Petrunyak and N. D. Khomenko. *Sakhar. Prom.*, 1986, (1), 33 - 34 (*Russian*).

Inefficient and unreliable operation of disc separators for removal of flume water and light impurities from beet at some factories has been attributed to defective installation, poor adjustment and inadequate maintenance. Advice is given on achieving maximum results.

A new balanced protective system for S, DDS and DS diffusers

E. A. Tyutyunnikov and A. M. Tyutyunnikova. *Sakhar. Prom.*, 1986, (1), 35 - 37 (*Russian*).

Flaws in the balanced protective system for the electrical drives and components of diffusers, particularly DDS types, are discussed and details given of a simple mechanical system with electrical blocking which has proved reliable in use on scroll drives at various factories.

Air permeability of protective structures for beet piles

V. A. Knyazev. *Sakhar. Prom.*, 1986, (1), 41 - 44 (*Russian*).

While protective matting, screen or panels are intended to shut out currents of warm air from the stored beet, they must also be sufficiently permeable to air to allow adequate ventilation. The subject is discussed mathematically and on the basis of experience.

Laboratory studies

Application of HPLC in the Australian raw sugar industry

P. C. Ivin. *Sugar y Azúcar*, 1985, **80,** (10), 21, 24, 26, 29, 41.

A survey is presented of the use of HPLC in Australia, with a description of the system used for sucrose analysis at Pleystowe[1]. It is mentioned, however, that polarimetry remains the main technique for sugar measurement. Details are given of an automatic scheme involving a Waters modular system which proved excellent as a means of determining sucrose in various process materials throughout the 1984 season at the Victoria mill of CSR Ltd. Future prospects for HPLC are discussed. The failure of HPLC to resolve monosaccharides effectively is mentioned, but it is stressed that there is usually sufficient resolution to indicate the approximate glucose:fructose ratio and hence the degree of sucrose degradation during boiling.

Uses of HPLC at U.S. Sugar Corporation

R. P. DeStefano. *Sugar y Azúcar*, 1985, **80,** (10), 41.

The use of HPLC to measure sucrose, glucose and fructose in molasses and to determine "false pol" (caused by the presence of optically-active components such as dextran, fructose and glucose) in cane juice[2] is described, and mention made of its application to e.g. monitoring of the quality of juice held in clarifiers during shutdowns and determination of inversion losses in clarification. Future developments include the use of HPLC for automatic cane juice analysis for payment purposes.

Determination of dextran in raw sugar

D. F. Day and D. Sarkar. *Sugar J.*, 1985, **48,** (5), 8 - 9.

See *I.S.J.*, 1985, **87,** 123 - 126.

Use of a differential pulse dissolving voltameter to determine the lead content in sugar. I

A. Prugarova and M. Kovac. *Bull. Potravin. Vysk.*, 1985, **24,** (1), 11 - 17; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (22), Abs. 22 R483.

Application of differential pulse polarography using a dissolving voltameter to determine the Pb content in white sugar was investigated. It was found that the method is of high accuracy and requires less time than other polarographic methods. The Pb content could be determined in white sugar samples from a number of factories and was found to be lower than the appropriate norm.

Investigation of devices for obtaining beet brei in lines for determining beet sugar content

V. N. Mardal', A. A. Lyashenko and A. L. Shoikhet. *Sakhar. Prom.*, 1985, (12), 30 - 32 (*Russian*).

The comparative performance of saw devices for preparation of beet brei are discussed. Where an ultra-fine brei was prepared, it took only 60 seconds for the sugar to dissolve during digestion; this compared with 80 sec for a fine brei and 150 sec for a coarse preparation. Pressing of the ultra-fine and fine brei gave a compact mass from which a sample could easily be taken, as opposed to the coarse brei.

Sucrose crystallization at low supersaturation in impure beet syrups and pure solutions

V. Maurandi, G. Mantovani and G. Vaccari. *Zuckerind.*, 1985, **110,** 1096 - 1101.

Sucrose crystallization kinetics were studied at 15°C (at which diffusion has no significant effect on crystal growth), non-sugars:water (NS:W) ratios of 0, 0.6, 0.9 and 1.1, and an agitator speed of 10 rpm. The ultimate weight of the single crystals was approx. 100 g. Linearity in the growth rate/supersaturation relationship was found at NS:W values of 0 and 0.6, whereas at 0.9 there was a 2nd order decrease in the growth rate (for which the Burton-Cabrera-Frank equation is valid); at NS:W = 1.1 the fall in growth rate was of a much higher order, indicating an exponential decrease, for which the Kossel-Stranskii two-dimensional nucleation equation is valid. Increase in non-sugars concentration had no effect on transport, as demonstrated by crystallization at higher agitator speeds. The findings are also applicable to cane syrups, as shown by the data of Smythe[3]. The progressive fall in growth rate noted was apparently not caused by change in the mechanism of kink integration from a spiral growth system to two-dimensional nucleation.

Behaviour of non-sugars during raw juice purification. II

A. Stechová, F. Frantisek, J. Copiková and P. Kadlec. *Listy Cukr.*, 1985, **101,** 278 - 284 (*Czech*).

Liquid and gas-liquid chromatography and isotachophoresis were applied to determination of organic acids in model samples prepared from raw juice and in raw, prelimed, limed, 1st carbonatation and thin juices from three sugar factories. The procedures used with each method are described, and results are tabulated for a total of 14 acids in the case of GLC, a maximum of 12 found by liquid chromatography and for a total of 17 found by isotachophoresis. The values obtained by the chromatographic methods were in very close agreement, with GLC giving slightly higher concentrations, but the methods had the disadvantages of requiring time-consuming pre-isolation of the acids and the possibility of error even with careful sample preparation; the isolation technique used restricted determination to the non-volatile acids. Isotachophoresis has the advantages of being less time-consuming, involving only simple preparation of samples and required no prior removal of sucrose or other

1 Ivin *et al.*: *I.S.J.*, 1983, **85,** 348.
2 *ibid.*, 1985, **87,** 131A.
3 *Australian J. Chem.*, 1967, **20,** 1084.

interfering components; it was possible to determine both volatile and non-volatile acids by this method, which in many cases gave much higher values than the chromatographic methods.

On the statistical mechanics of crystal growth

V. Maurandi. *Ind. Sacc. Ital.*, 1985, **78,** 147 - 151 (*Italian, English*).

Burton, Cabrera & Frank showed[1] by statistical analysis that a critical temperature exists below which crystal faces are flat because of the free energy requirement to build a step; on the other hand, where the temperature exceeds this critical value, the energy requirement falls to zero and a roughening transition occurs whereby most of the surface integration is random. The use of suitable models of the mechanics of the changes taking place at the solid-fluid interface has permitted expansion of the work of Burton *et al.* on the spiral growth of crystals. The results and views of a number of authors are reviewed, and mathematical expressions presented which define the transition from flat to rough faces. The value of solid-on-solid models and the application of Monte Carlo type computer simulations to them, as in the case of an Ising model of a Kossel crystal (without dislocations) and of a Frank crystal (having a screw dislocation), are discussed.

Hardness of sucrose crystals

J. Gebler and J. Bauer. *Sugar Tech. Rev.*, 1986, **13,** 1 - 20.

See *I.S.J.*, 1985, **87,** 74A.

Reactions of monosaccharides in aqueous alkaline solutions

J. M. de Bruijn, A. P. G. Kieboom and H. van Bekkum. *Sugar Tech Rev.*, 1986, **13,** 21 - 52.

A survey is presented of the literature (with 119 references) on monosaccharide reactions in aqueous alkaline solutions. The reactions are divided into two categories: (1) initial reversible transformations without skeletal rearrangement of the sugar moiety, including ionization, mutarotation, enolization and isomerization, and (2) irreversible alkaline degradation reactions involving the rupturing and formation of C–O and C– C bonds and resulting in three groups of products: (1) carboxylic acids of low M.W., e.g. lactic, saccharinic, formic and acetic acid, into which most of the monosaccharides are converted and which have the same number of (or fewer) carbon atoms as the sugars, (ii) carboxylic acids having more than six carbon atoms, a M.W. in the range 300 - 5000 and containing conjugated enol carbonyl moieties and carboxylate groups, and (iii) miscellaneous neutral products formed in trace quantities. The effects of various reaction parameters on degradation are discussed, including variation in the hydroxyl ion concentration (which substantially alters the composition and relative quantities of the carboxylic acids) and valency of the cations involved (divalent cations such as Ca^{++} and Ba^{++} favouring lactic acid formation in contrast to monovalent cations like Na^{+} and K^{+}).

Adaptation of a method for determining the formalin content in sugar factory products

B. Gawrych and S. Rydel. *Gaz. Cukr.*, 1985, **93,** 149 - 151 (*Polish*).

A method is described for determination of formaldehyde, in which the sample (20 g fresh pulp, 2.5 g dried pulp, 5 g molasses or 25 g white sugar) is dissolved in 50 cm^3 distilled water, the pH adjusted to 3 with 10% sulphuric acid, and steam distillation then carried out; 10 cm^3 of the distillate is heated for 3 min on a water bath with 2 cm^3 acetyl acetone reagent. After cooling, the contents are made up to 15 cm^3 and the absorbance measured at 412 nm; the reading is compared with a calibration curve. Tabulated values are given for the different products.

Spectrophotometric assay of reducing sugars in molasses and sugar cane juice by 3,5-dinitrosalicylic acid reagent

A. D. Sawant, H. P. Vanza and S. J. Jadhav. *Maharashtra Sugar*, 1985, **10,** (8), 23, 25 - 26, 29.

Results obtained using dinitrosalicylic acid and spectrophotometry at 540 nm to determine reducing sugars in cane molasses and juice[2] (to which known quantities of glucose were added) are discussed with the aid of tabulated data.

High-performance liquid chromatographic separation of glucose 1-phosphate, fructose, sucrose and inorganic orthophosphate

R. M. Stikkelman, T. T. Tjioe, J. P. van der Wiel and F. van Rantwijk. *J. Chromatogr.*, 1985, **322,** (1), 220 - 222; through *Anal. Abs.*, 1986, **48,** Abs. 2C11.

In the course of studies on the enzymic phosphorylysis of sucrose, a method was developed for separation of the cited compounds, which involved HPLC on a column (20 cm × 9 mm) of Aminex A-7 resin. To avoid corrosion of the stainless steel column, aqueous trifluoroacetic acid (0.06M) was used as the mobile phase (0.3 ml/min) in preference to H_2SO_4 (0.03M); there was no hydrolysis of glucose 1-phosphate. The compounds, monitored by refractive index detection, were well separated, and clearly defined peaks were obtained.

Determination of reducing sugars in the nanomole range with tetrazolium blue

C. K. Jue and P. N. Lipke. *J. Biochem. Biophys. Methods*, 1985, **11,** (2/3), 109 - 115; through *Anal. Abs.*, 1986, **48,** Abs. 2D132.

The addition of potassium sodium tartrate to a basic solution of tetrazolium blue enhanced the sensitivity and decreased the reaction time required for the determination of reducing sugars. The detection limit was 1 nmole for neutral sugars and 2-amino- and acetamido-sugars.

1 *Phil. Trans. Royal Soc.* (London), 1951, **A243,** 299.
2 Miller: *Anal Chem.*, 1959, **31,** 426.

By-products

Increase in ethanol productivity in alcoholic fermentation of sugar factory products (molasses and raw syrups)

M. Nonus and M. de Miniac. *Ind. Alim. Agric.*, 1985, **102**, 971 - 985 (*French*).

The stages in the conventional molasses alcohol fermentation process with and without yeast recycling are described and the Alfa-Laval Biostil process outlined. Comparison of the performances of the three processes demonstrates the benefits of yeast recycling in regard to fermentation of products of high non-sugar dry solids content. Tests on yeast recycling showed that, for the same must, the quantity of yeast may be increased without sacrificing ethanol production; the essential need is for maintenance of the biomass quantity, which is governed by the rate of mortality of the yeast cells and rate of their development. Beyond the 4th fermentation cycle, the biomass and productivity remain constant, the dead cells acting as nutrient for the growth of new cells. It was found that there is no need for pre-washing or acid treatment of yeast; at the sake of permitting a small degree of bacterial contamination, elimination of pre-washing is of considerable technological benefit, not least because of removal of the problems created by recycling the water separated from the yeast after it has been centrifuged for a second time. A laboratory-scale continuous fermenter is described and results obtained with it discussed. Continuous yeast recycling raised the molasses fermentation productivity to more than 13g/litre/hr by the 5th fermentation stage, after which it remained constant until the 13th and final stage; this compares with 3 - 6 g/litre/hr in classical processes and provided 66.4 g/litre of ethanol within 5 hours. By using a selected strain of yeast, it would be possible to achieve this rate within 24 hours on a substrate of 20% non-sugar dry matter content (40% purity). An essential feature of the process is instant contact between all the substrate and all the recycled biomass rather than progressively as in current processes, while maintenance of a constant amount of biomass depends on a low level of oxygenation during fermentation. Means of maintaining sterile conditions include making use of the heat from the recycled vinasse (which has a temperature of 100°C) that is added to the must, maintenance of tanks for storage of supply water and additives at pH 1, very rapid dilution of the must to give a temperature of about 70°C, etc.

Utilization of products from sugar cane in Hawaii and investigation of alternative uses

H. W. Hilton and C. M. Hoskins. *Hawaiian Planters' Record*, 1985, **59**, 315 - 368.

A survey is presented of the literature (394 references) on cane by-products utilization and its research in Hawaii from 1916, covering (i) molasses, including fermentation products (alcohol, yeast, citric and lactic acids, acetone and glycerine, and penicillin), recovery of levulinic and aconitic acids, and other early uses for molasses; (ii) bagasse, including paper, board and dissolving pulp manufacture; xylan, xylose, xylitol and furfural; lignin; activated carbon preparation; microbial degradation of bagasse or leaf trash; and miscellaneous bagasse products; (iii) cane wax, fats and sterols; and (iv) industrial utilization of sugar.

Enhanced ethanol production in multiple batch fermentation with an auto-flocculating yeast strain

N. Hawgood, S. Evans and P. F. Greenfield. *Biomass*, 1985, **7**, (4), 261 - 278; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (22), Abs. 22 R397.

Recent data on intensification of fermentation by increasing the yeast concentration are reviewed. The effect of mixing rate and concentration of dissolved oxygen on the rate of alcohol fermentation was studied in the laboratory using auto-flocculating yeast strain *S. cerevisiae* ATCC 26603 and a system of multiple batch fermentation of the substrate in one and the same fermenter; glucose, sucrose and cane juice were used as substrate. Mixing the seed yeast with wort of 15% sugar concentration and 5% (of saturation) dissolved oxygen content until a yeast concentration of 20 - 30 g/litre was followed by settling of the yeast, decanting of the liquid phase and introduction of fresh substrate, which was fermented without addition of further seed yeast and without oxygenation. Under these conditions, 99% sugar conversion was achieved with formation of 9 - 10% alcohol during 4 hours at a rate of 0.44 g/g sugar and a settling rate after cessation of mixing of 2 - 4 cm/min. Acceleration of the mixing rate reduced the size of the yeast floc and increased fermenter capacity, while reduction in the dissolved oxygen concentration accelerated alcohol formation with negligible fall in yield.

The tasks regarding ethanol production in East Germany

B. Kretschmer. *Lebensmittelind.*, 1985, **32**, 245 - 247 (*German*).

The potential for alcohol production by fermentation in East Germany, the problems involved and the major fields of application of the product are discussed. Sugar beets are among the various raw materials discussed as substrate.

Technology for producing alcohol through fermentation

A. C. Sturion. *GEPLACEA Bull.*, 1985, **2**, (07), 18 pp.

The basic stages in alcohol fermentation and distillation are outlined, with an indication of factors that are of major importance (particularly sterilization), and descriptions with diagrams of a number of processes. Vinasse treatment and by-products that may be obtained from it are discussed.

Energy balance of fermentation ethanol production from various substrates

S. Tourlière. *Ind. Alim. Agric.*, 1985, **102,** 1197 - 1200 (*French*).

The energy consumed in growing sugar beet, processing it and fermenting the molasses to yield fuel alcohol is calculated, and the total process energy requirement of 268 therms per hectolitre of alcohol (allowing for energy recovered from incinerated vinasse) compared with 431 therms/hl for alcohol production from wheat (although this could be reduced by e.g. recovery of energy in the form of biogas from vinasse and utilization of the straw). On the basis of the balances, it is calculated that 1 litre of energy consumed in processing would permit the replacement of 2.85 litres of high-octane gasoline with alcohol from beet molasses and of 1.75 litres (possibly 2.3 litres with vinasse utilization) of alcohol from wheat.

The problems of pollution from distillery wastes and a techno-economic solution

Anon. *Maharashtra Sugar*, 1985, **10,** (7), 7 - 8.

It is calculated that vinasse concentration and incineration would generate more steam than burning of methane gas produced anaerobically from the same quantity of vinasse and would simultaneously provide energy and solve the pollution problem, unlike anaerobic lagooning and digestion as currently practised by Indian distilleries.

Production and nutritive value of single-cell protein from *Fusarium oxysporum* var. *lini* grown in vinasse

M. E. S. T. Silva and J. R. Nicoli. *J. Ferment Technol.*, 1985, **63,** (1), 91 - 94; through *S.I.A.*, 1985, **47,** Abs. 85 - 1668.

F. oxysporum var. *lini* was grown on a medium based on cane vinasse in a semi-continuous process. In each 24-hour period, about 15.8 g biomass dry solids/litre was produced, containing almost 50% crude protein. Tests with rats showed that the protein efficiency ratio was positive but lower than that for casein; the apparent digestibility was also lower than that of casein. Methionine, cysteine and isoleucine were the limiting amino-acids.

Improvement of the nutritional value of sugar cane bagasse by simple solid-state fermentation

F. A. Hamissa, A. J. El-Diwany, H. M. Shaker and A. M. H. El-Refai. *Microbios Letters*, 1984, **26,** (103/104), 129 - 133; through *S.I.A.*, 1985, **47,** Abs. 85-1673.

Tests were carried out on single-cell protein production by *Trichoderma viride* 253 M-16 using bagasse as the carbon source. 50 g NaOH-treated bagasse in a nylon bag was mixed with 60 ml of nutrient solution and the fungal inoculum, and incubated for up to 30 days. The protein content increased from 2.2% to 22% and the lignin content decreased from 21.8% to 10.5%. This would greatly increase the nutritional value of the bagasse.

Solid-state cultivation of *Talaromyces emersonii* on beet pulp

P. J. Considine, A. O'Rorke, A. P. Moloney *et al. Biochem. Soc. Trans.*, 1985, **13,** (2), 456; through *S.I.A.*, 1985, **47,** Abs. 85-1674.

Solid-state cultures of this fungus on beet pulp were prepared. Cellulase-containing extracts of the cultures gave greater saccharification of beet pulp than did filtrates of liquid fermentations at the same cellulase activity. The solid-state process increased the protein content of the solid material from 10% to 27%, thus increasing its value for animal feeding; the carbohydrate content decreased only slightly, from 36% to 29%, and the material would still be a suitable carrier for molasses.

Productivity of *Trichoderma viride* 253-cellulase in relation to the composition of the fermentation medium

M. A. Farid, H. M. Shaker and A. M. H. El-Refai. *Chem. Mikrobiologie Technol. der Lebensmittel*, 1984, **8,** (6), 161 - 163; through *S.I.A.*, 1985, **47,** Abs. 85-1677.

Media based on bagasse as carbon source were used for the cultivation of *T. viride* 253, with the aim of finding the optimal conditions for cellulase production. In general, crude bagasse led to higher cellulase activity than water-boiled or NaOH-treated bagasse, and the optimal bagasse concentration was 20 - 40 g/litre. Inclusion of peptone in the medium was essential for cellulase preparation.

Cellulolytic activity of moulds. IV. Evaluation of the utility of cellulosic wastes for biosynthesis of cellulases and xylanase by *Aspergillus terreus* F-413

J. Szczodrak, J. Rogalski and Z. Ilczuk. *Acta Microbiol. Polonica*, 1984, **33,** (3/4), 217 - 225; through *S.I.A.*, 1985, **47,** Abs. 85-1678.

A medium containing beet pulp as carbon source for culture of *A. terreus* F-413 gave higher activities of all enzymes of the cellulolytic complex and of xylanase than did media containing straw or sawdust from various sources.

Methanol and ammonia from biomass

E. G. Baker, L. K. Mudge and M. D. Brown. *Chem. Eng. Progress*, 1984, **80,** (12), 43 - 46; through *S.I.A.*, 1985, **47,** Abs. 85-1703.

Laboratory and pilot-plant tests were carried out with the aim of developing a one-stage process to generate specific gases from biomass by gasifying with steam in the presence of a catalyst. Ni catalyst on an alumina support gave the highest yield of gases (hydrogen, carbon monoxide and carbon dioxide) and a low yield of (unwanted) char, but when the biomass was bagasse, deactivation of the catalyst was rapid, probably owing to the high S content in the bagasse (300 - 600 ppm). It may be preferable to use potassium carbonate as catalyst.

Patents

UNITED KINGDOM

Sugar crystals separation

Fabcon Inc., of San Francisco, CA, USA, **2,137,522**. October 20, 1980; October 10, 1984; May 30, 1985.

See US Patent Application 4,256,582[1].

Process for the treatment and conversion of iso-glucose syrup

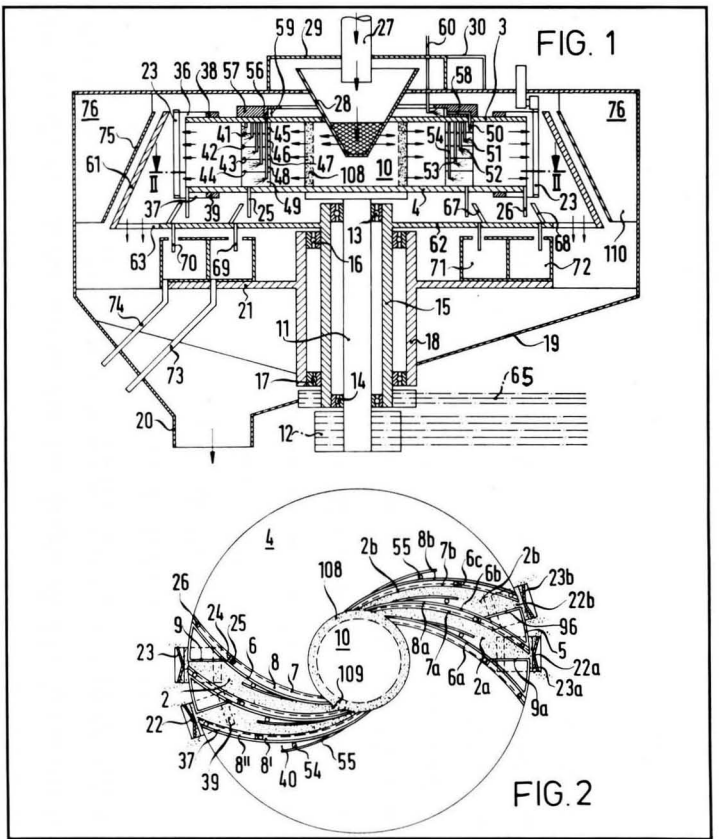
Starcosa GmbH, of Braunschweig, Germany. **2,143,825**. June 8, 1984; February 20, 1985; February 2, 1986.

High fructose syrup containing approx. 42% (42 - 45%) fructose by weight is evaporated to approx. 70 - 77% (75%) dry solids and crystallized by cooling from 30 to 18°C to yield a predominantly glucose-containing mass which is then filtered. The mother liquor is then aged for about 5 hr (1/2 - 7 hr) (1/2 - 13 hr) with stirring whereby an after-crystallization takes place. The mass is then comminuted or milled to provide a fraction of 5 - 50 μm (10 - 250 μm) particle size. The mother liquor is evaporated to 90% dry solids, seeded with a fine fraction of approx. 20 μm (obtained by sifting the finished product) and added to the crystal powder in predetermined doses. The mixture is stirred under vacuum whereby it is dried and cooled. The end-product has a fructose content of 42% by weight and a moisture content of 5% by weight.

Continuous sugar centrifugal

Krupp Industrietechnik GmbH, of Grevenbroich, Germany. **2,145,007.** August 15, 1984; March 20, 1985.

The basket 5 of a continuous vane-type centrifugal comprises uniformly spaced curved chambers 21 radiating from the axis of rotation of the basket and separated from one another by walls 6; each chamber contains an arcuate screen 7 which defines a liquid chamber divided by partition 24 into two separate compartments from which the mother liquor and wash liquid are discharged by drainage pipes 69, 70 into annular



collecting chambers 71, 72 and thence out of the centrifugal via pipes 73, 74. Nozzles 50 - 54 supply wash liquid at different levels, and the washed and dried crystals are guided by partition 9 in each chamber towards outlet 22 in front of which is a slide 23 that is pulsated to control discharge of the sugar which builds up behind the outlet. The slides are surrounded by a frusto-conical collecting ring 61 which rotates at half the speed of the basket. Arranged within the ring on the surface facing the chambers 2 are curved ribs 66 which act as a brake on the sugar being discharged. Sloping annular collecting flanges 67 and 68 on the upper surface of bottom plate 62 collect the liquids being discharged from pipes 25, 26 and transfer them to drainage pipes 69, 70. From the ring, the sugar passes to outlets 63 in bottom plate 62 and is thrown by centrifugal action against the wall of the housing and thence via base 19 to outlet 20. The high speed of rotation of the basket causes the air inside the housing to swirl above cover plate 3 and to travel to the outer region of the housing where it reaches the zone of fixed curved guide vanes located between cone 75 (surrounding ring 61) and the outer wall. The vanes deflect the air stream in a direction opposite to that of the basket, so that the air acts as a further means of decelerating the discharge rate of the sugar crystals and substantially reducing their impact against the wall. One or more pairs of ducts may be used instead of or in addition to the guide vanes to

1 *I.S.J.*, 1983, **85**, 154.

decelerate the discharge velocity of the sugar by providing a countercurrent of air.

Bagasse hydrolysis

Krupp Industrietechnik GmbH, of Grevenbroich, Germany. **2,145,090.** August 9, 1984; March 20, 1985.

Bagasse is mashed with water to 15 - 45% dry solids content and high pressure steam injected while the mash is being fed into a dispersing vessel where prehydrolysis takes place at 100 - 200°C (40 - 120°C) and 1 - 16 (1 - 10) bar for a period between 1 second and 10 minutes (1 - 5 sec) to reduce the hemicelluloses to pentoses which are separated by addition of a liquid detergent. The lignin is then separated by high-pressure extraction with a solvent such as aqueous alcohol of 20 - 80% concentration at 100 - 300 bar and 50 -200°C for 30 minutes - 3 hours. The residual organic matter, of 15 - 45% dry solids content and consisting mainly of cellulose, is hydrolysed (in a vessel identical to that used for prehydrolysis) for between 1 sec and 10 min at 210 -350°C and up to 190 bar (20 - 150 bar). Compression and decomposition waves plus tangential edge-impact forces in the stationary and rotary ducts of tunnels of the dispersing vessel significantly accelerate the chemical reactions, and the design permits hydrolysis with simultaneous application of pressure and heat.

A thermostable glucoamylase

CPC International Inc., of Englewood Cliffs, NJ, USA. **2,145,094.** August 16, 1984; March 20, 1985.

A glucoamylase suitable for starch hydrolysis to glucose by simultaneous liquefaction and saccharification is derived anaerobically from *Clostridium thermoamylolyticum*; the enzyme has a M.W. of approx. 75,000, a half-life greater than 3 hours at pH 6 and 70°C and a maximum activity at 70 - 75°C and a pH of approx. 5.

Cane shredder

Walchandnagar Industries Ltd., of Bombay, India. **2,146,917.** September 23, 1983; May 1, 1985.

The shredder comprises casing 1 and a rotor 14 having a row of hubs with offset holders 15 which carry sets of hammers or knives 16, 17 in a variety of combinations; these face adjustable anvils 3A and 7 formed by adjustable plates 3, 41 of the casing each having indentations or serrations on its inside face. Plate 3 at the entry to the shredder may or may not have detachable indentations, while the entry throat formed by the plate is provided with means for adjustment of the gap. Anvil 7 is suspended from a floating pivot 9 and is supported by an adjustable means 12 through shear pins 13 or other suitable arrangement that will allow the anvil to yield and swing back on pivot 9 in the event of excessive loading caused by tramp iron or other foreign bodies. Various stationary deflectors such as plate 29 and plate 18 (with a profiled extension and curved entry lip 2) prevent bridging of cane and choking of the entrance. The shredder consumes some 30% less energy per tonne of fiberized cane than comparable existing equipment.

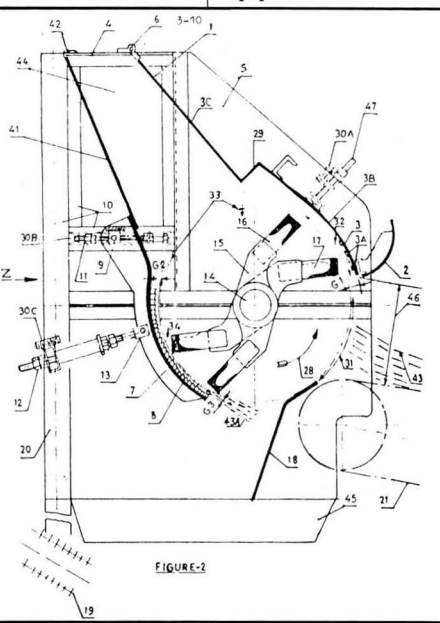


FIGURE-2

Details of the economic analysis and results of a process economics sensitivity analysis will be covered later.

Conclusions

1. To apply ED in sugar processing, the juice must be prescreened to remove suspended solids. It appears that 325 mesh screening is sufficient. (A coarser mesh may be adequate but will need to be tested.)
2. The ED juice de-ashing process preferentially removes K^+ and Cl^-, especially the latter. The percentage removals of K^+ and Cl^- are 3% and 63%, respectively, higher than the percentage removal of ash.
3. Technically, there are no major difficulties in applying ED in sugar processing with currently available ED equipment.
4. The profitability of applying the ED juice de-ashing process in sugar processing varies with factory size and juice characteristics. For Hawaiian factories with an industry-average ash level of 0.89% carbonate ash in 30% refractometer solids juice, the IRR for 40% de-ashing (the optimum de-ashing level) would fall between 20 and 30%.

Table I. Internal rate of return for 40% de-ashing of juice by ED

Factory size:	A[a]			B[b]		
Refractometer solids in feed juice, %	30	40	50	30	40	50
Feed juice ash level	Internal rate of return, %					
Industry average[c]	14	20	20	21	26	27
10% higher than industry average	14	19	19	23	29	28
20% higher than industry average	17	21	21	25	30	29

a Factory producing 63,000 tons (57,000 tonnes) 96 DA sugar/year.
b Factory producing 153,000 tons (139,000 tonnes) 96 DA sugar/year.
c Equivalent to 0.89% carbonate ash in 30% refractometer solids feed juice.

Summary

A study was made of the electrodialytic desalting of sugar cane juice. A laboratory-scale electrodialyser was tested both in the laboratory and in a sugar factory to obtain process operating parameters and to demonstrate its technical feasibility. No major technical difficulties were encountered except that prescreening to remove suspended solids was found necessary. An economic analysis shows that the process might be profitable for some Hawaiian sugar factories. This paper discusses the experimental data obtained in the course of the study. Also discussed, but only briefly, are results of the economic analysis of the process.

Acknowledgments

The author wishes to thank Mr. W. K. Hashimoto for his help in the laboratory test work and in the development of the computer program for the economic analysis. He also wishes to thank Mr. C. L. Chew for his help in conducting the factory runs and to acknowledge the Oahu Sugar Company personnel for permitting the tests to be conducted in their factory.

ENERGY MANAGEMENT

Sugar and energy losses in burned cane

By John H. Payne

One line of demarcation in the cane sugar industry separates the cane burners from the green harvesters. That the distinction is not trivial is attested by the presence in some regions of a penalty imposed on deliveries of burnt cane. Recent studies, experience and developments confirm that such a penalty has a basis in fact. This, plus the value of conserving the total biomass of the cane crop, may dictate that the cane fire is going out.

When an organism dies it starts to decay immediately. There is no time lag. A burnt cane stalk is a decaying organism. The enzymatic system which controls the flux of sucrose, glucose and fructose in and out of the storage cells is destroyed. No longer is it possible for sucrose to exist without inversion at the pH of 5.6. No longer is even the pH of 5.6 maintained; it begins to decrease.

Important developments in the knowledge of transport processes in plants have been made in the past few years. These have been summarized in a paper by Uribe & Lüttge[1]. It has been demonstrated that transport through the cell wall is controlled by a proton pump located in the plasma membrane. The pump has been identified as enzyme - adenosine triphosphatase (ATPase).

The mechanism of the transport and storage in sugar cane cells has been under study for several years by researchers Thom, Maretzki & Komor[2-6]. Sucrose, translocated from the leaves to the stalk, is broken down into glucose and fructose by the enzyme invertase before it can pass through the

1 *American Scientist*, 1984, **72**, 567 - 573.
2 *Ann. Rpt. Expt. Sta., Hawaiian Sugar Planters' Assoc.*, 1979, 41 - 42.
3 *ibid.*, 1980, 35 - 36.
4 *ibid.*, 1982, 28 - 29.
5 *ibid.*, 1983, 36 - 37.
6 *Eur. J. Biochem.*, 1984, **138**, 93.

cell wall. Within the cell the glucose and fructose are converted again into sucrose. Sucrose, as well as glucose and fructose, can then enter the vacuole which is the storage compartment where it can remain or be released in case of metabolic demand.

The transport through the vacuolar membrane, against the high concentration pressure within the vacuole, has been confirmed as controlled by an ATPase enzyme pump located in the membrane wall. The transmitter is an ion, probably H^+. Cells, in culture, exude H^+ ions in order to adjust the pH of the surrounding medium for optimum growth. Under normal conditions the pH is 5.6.

Thus, the hydrogen ion, H^+, is an essential element in the transport of sucrose in and out of storage. This process, and that of maintaining the integrity of sucrose at a pH of 5.6, thus involve enzyme systems. When the plant dies there is a breakdown of this mechanism and sucrose is left unprotected in a hostile environment of hydrogen ions. Of course, the decay process is complex but, as organic compounds decompose, acids are major products and a ten-fold increase in hydrogen ion concentration can occur in a relatively short period of time. The sucrose held in high concentration in the vacuoles, now uncontrolled, is free to flow through the membrane and into the high acidity surroundings. Very rapidly also, the plant structure, no longer protected, is invaded by micro-organisms and sucrose is rapidly destroyed.

This evidence is important to the sugar producer because it shows that sucrose stored in the cane plant is in a dynamic state in which the hydrogen ion plays an important role. Life is necessary to preservation of the system. Dead cane, therefore, is an extremely perishable commodity. Any delay in processing diminishes the quantity of sugar available for recovery. The rate of sugar loss depends upon temperature, humidity, cane variety and method of harvesting. The many studies of losses show "shotgun patterns" but appear to average higher than 1% per 24 hours.

Measuring losses is a difficult exercise at best. An approach to measuring deterioration from the quantity of ethanol appearing in cane juice was made by Blake & McNeil[7]. They found an 8-fold increase in the alcohol content of first expressed juice in burnt cane standing overnight. This corresponds to a calculated loss of 0.4% of the sucrose which of course does not include the quantity of sucrose converted to other compounds. To avoid having to deal with these losses it would appear prudent to deliver live cane to the factory.

Cane is burned because the removal of dry leaves makes it easier to harvest, whether manually or mechanically. Also, burning helps to control pests. Less energy is required in harvesting but a high percentage of the biomass energy stored by the cane is lost.

Information on the quantity of biomass produced by the cane plant in its life cycle is sparse. Early studies were made in Hawaii by Stewart[8] and Borden[9]. Estimates based on their data and those of Birkett[10] in the Caribbean and of Silva & Silva[11] in Brazil were used by Payne[12] to estimate the biomass yield of a high energy cane variety in Puerto Rico.

More complete figures on the two-year Hawaiian crop have been reported by Kinoshita & Gibson[13] and are summarized in the following table. The figures do not include detached material lying on the ground.

Table I. Composition of unburned field cane

	Component		Fibre		Pol	
	tonnes/ha	%	tonnes/ha	%	tonnes/ha	%
Net cane	268.1	78.6	32.5	9.5	39.2	11.5
Dead cane	25.8	7.6	3.8	1.1	1.4	0.4
Tops and green leaves	16.8	4.9	3.4	1.0	0.2	0.1
Dry leaves	30.5	8.9	20.2	5.9	0.2	0.1
Total	341.2	100.0	59.9	17.5	41.0	12.0

These results show that in the two-year crop about 40% of the fibre is in the tops and leaves. If the detached leaves were included, the order of magnitude figures would be half in the stalk and half in the tops and leaves. Thus, the cane fire consumes half of the energy potential fibre produced by the crop.

For this reason the direction of the Hawaiian sugar industry, where all cane is mechanically harvested, is tending toward unburned cane. Traditional suppliers of electrical power to the community grids, factories are geared to handling trash cane. Oil consumption is reduced. In 1983, 10.6% of electrical generation in the State of Hawaii was produced by the sugar industry.

The factory extraction plants have adequate capacity to handle the additional load of fibre. If the same pol in bagasse is obtained, which can be achieved, then the increased loss is proportional to the increase in the quantity of bagasse. If the pol in bagasse is low, as in a good diffusion plant, the increased quantity of bagasse does not cause a large loss of pol. Using figures from the earlier table and reasonable figures of 0.8 pol in bagasse for a diffuser and 2.0 for a mill, the calculated increase in pol loss for the net cane and trash cane would be as follows:

Diffuser (0.8 pol in bagasse)

	Net Cane	Unburned Cane
Weight	100.0	125.0
Fibre	13.5	22.5
Bagasse	27.0	45.0
Bagasse pol	0.22	0.36
Difference	0.41	

The loss of 0.14 is close to the indicated pol in the tops and leaves of 0.12, so there is little loss of pol in bagasse with the unburned cane.

7 *Proc. Queensland Soc. Sugar Cane Tech.*, 1978, **44**, 127 - 132.
8 *Proc. Assoc. Hawaiian Sugar Tech.*, 1929, 221 - 230.
9 *Hawaiian Planters' Record*, 1942, **46**, 191 - 238.
10 *Proc. 12th Congr. ISSCT*, 1965, 1636 - 1642.
11 *Proc. 17th Congr. ISSCT*, 1980, 288 - 295.
12 *Paper presented to 2nd Symposium on Fuels and Feedstocks from Tropical Biomass* (Center for Energy and Eironment Research, Puerto Rico),
13 *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1981, 49 - 50.

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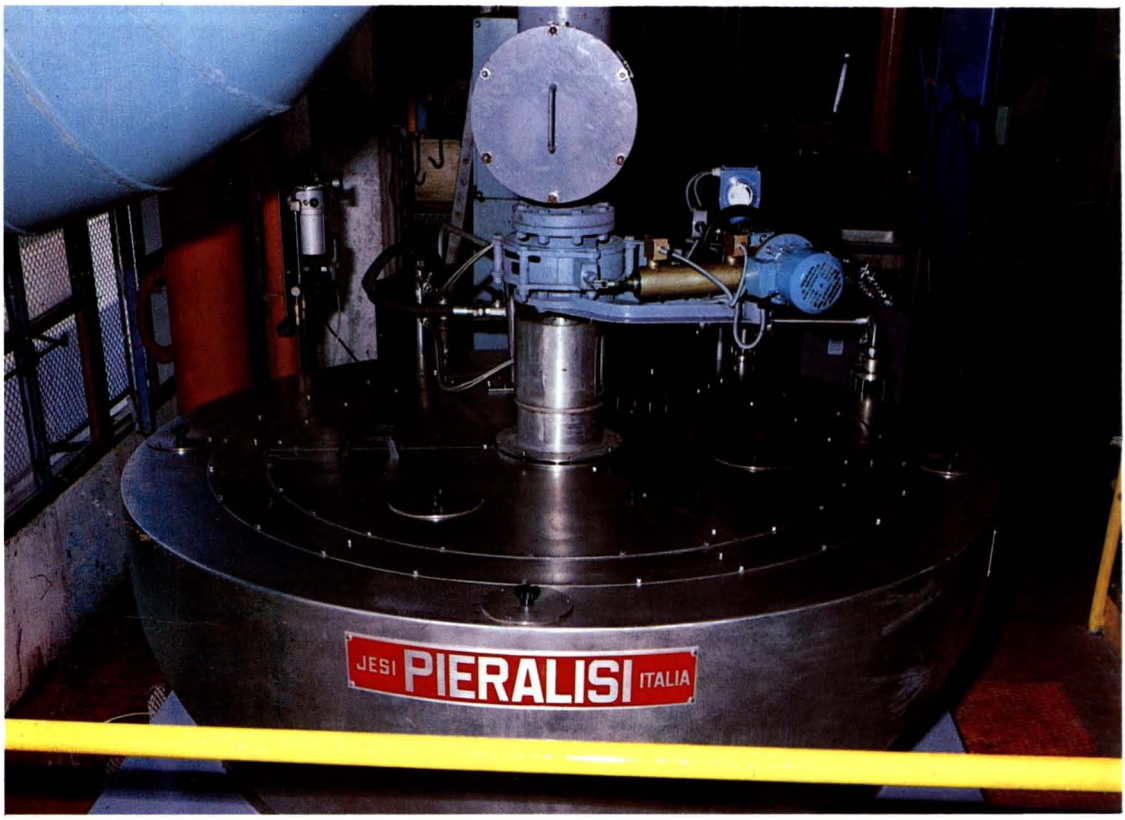

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Mill (2.0 pol in bagasse)

	Net Cane	Unburned Cane
Weight	100.0	125.0
Fibre	13.5	22.5
Bagasse	27.0	45.0
Bagasse pol	0.54	0.90
Difference	0.36	

In this case there is a significant loss of pol in bagasse. However, from the energy standpoint, where there is a market for electricity, the value of the increase of 9 units of fibre more than covers the loss of 0.36 units of pol. The real value of the fibre depends upon the value of power it can produce for the operating utility. In Hawaii this is close to the value of the fuel oil it replaces. Dry bagasse fibre has a gross calorific value of about 19.4 MJ/kg and fuel oil 43.5 MJ/kg, so the 9 units of fibre are equivalent to 4 units of fuel oil. At current US prices of $0.45/kg for sugar and $26 per barrel for fuel oil, the value of the lost pol approximates to $0.15 and the fuel oil value of the fibre gained to $0.64.

Of course, there are additional costs in harvesting and transporting the unburned cane which must be considered, but the combined effects of escaping sugar losses between burning and processing, and the energy value of the added fibre add up to a substantial value. It appears that much of this can be recovered.

In conclusion, much of the mechanism of sucrose storage in sugar cane is now known. On this basis it can be conjectured what happens when the plant dies, accounting for the losses in sucrose from burning to processing. By harvesting unburned cane these losses are minimized. Then, from the energy standpoint, the loss by the cane fire can be eliminated, making available a source of biomass for fossil fuel replacement.

Summary

The physiological changes in cane after death on burning for harvest are described and the loss of energy as combustible biomass is discussed. By harvesting unburned cane sucrose losses are minimized and an opportunity provided for increasing the commercial value of the crop by generation and sale of electricity or substitution of other fuels.

Pertes en sucre et en énergie dans la canne brûlée

On décrit les modifications physiologiques dans la canne aprés l'avoir tuée en la brûlant en vue de la récolte et on discute la perte en énergie subie sous forme de biomasse combustible. En récoltant de la canne à sucre non-brûlée, on réduit les pertes en sucre au minimum et on crée une opportunité pour augmenter la valeur commerciale de la récolte via la génération et la vente d'electricité ou la substitution d'autres combustibles.

Zucker- und Energieverlust in gebranntem Rohr

Die physiologischen Veränderungen im Rohr nach Absterben durch Abbrennen für die Ernte werden beschrieben, und der Energieverlust in form von verbrennbar Biomasse diskutiert. Bei Ernte von grünem Rohr werden die Sacchaose-verlust minimiert und es wird Gelegenheit gegeben, den kommerziellen Wert der Ernte durch Erzeugung von Elektrizität oder Substitution anderer Brennstoffe zu erhöhen.

Pérdidas en azúcar y energia en caña quemada

Se describen los cambios fisiológicos en caña después de su muerte por quemadura como preparación para el corte, y se discute la pérdida de energía en la forma de biomasa combustible. Por cosecha de la caña sin quemarla, se minimizan las pérdidas de sacarosa y se ofrece una oportunidad para aumentar el valor comercial de la cosecha por generación y venta de electricidad o por substitución de otros combustibles.

FACTORY ENGINEERING

Crystal sizing*

By J S. Hogg†, S. C. H. McCarey†, J. D. F. Wilkie†, D. Brown‡ and E. J. Weatherby ‡

Introduction

For many years British Sugar has been working with the automatic control of pan boiling[1,2,3]. In the course of that work many measuring techniques have been devised and developed for the various parameters within the boiling system. However, there is one area of measurement that has not received much attention. This is the direct measurement of crystal size during the boiling cycle.

Temperature has been widely used as a measurement of the degree of supersaturation before seeding and also consistency as an indication of the condition of the massecuite during crystal growth.

In an attempt to give some indication to pan boilers of the situation within the massecuite, most vacuum pans have been fitted with microscopes to enable the operator to obtain a visual impression of the crystal sizes and size range in the massecuite.

In the past few years the microscopes have been equipped with closed circuit television enabling the

* *Paper presented to the 28th Tech. Conf. British Sugar plc*, 1986, *here slightly condensed*

† British Sugar plc

‡ University of Sheffield

1 Withers & Bass: *I.S.J.*, 1967, **69**, 117.

2 Bass *et al.: Paper presented to 22nd Tech. Conf. British Sugar Corp.*, 1974.

3 McCarey & Fearnside: *I.S.J.*, 1985, **87**, 208 - 213, 223 - 227.

pictures to be brought into a centralized control area to give the operators an easy and quick view of the conditions within the vacuum pans at all times. However, these devices do not provide any numerical values for the crystal sizes.

A laser diffraction sizer invented at Sheffield University has been developed and marketed by Malvern Instruments. One of these Malvern sizers was used in the laboratory at Sheffield to study crystal growth from 1979 onwards. The technique appeared to be such that it could, with suitable adaptation, be used on process plant. After a joint application by British Sugar and Sheffield University to the Science and Engineering Research Council (S.E.R.C.), a research studentship was provided in 1982 under the Co-operative Award in Science and Engineering (CASE) Scheme.

The work program envisaged was a combination of laboratory and factory trials to develop the techniques of on-line measurement of crystal size and concentration, and the transfer of the experience gained to the plant environment.

It was also expected that, during the course of the work, further information would be obtained on the growth rates of sugar crystals.

Theory of laser crystal sizing

The Malvern instrument uses a parallel beam of monochromatic coherent light produced from a He/Ne laser (= 0.6328 μm) to illuminate particles in an optical cell [Figure 1 (A)]. The particles produce a Fraunhofer diffraction pattern of rings which is focused on the photo-detector by a Fourier Transform lens. The detector

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comprises a set of concentric semi-circular light sensitive diodes radially displaced a distance of s_x from the central diode, as shown in Figure 1 (B). The undiffracted light is also focused on the detector, which is positioned a distance from the lens equivalent to the focal length (f) of the lens. The relative and absolute weight distributions of the suspension of particles can be found as follows:–

The diffraction pattern for field of monodisperse spherical particles of radius *a* is shown in Figure 2. The *light intensity* is maximum at the centre of

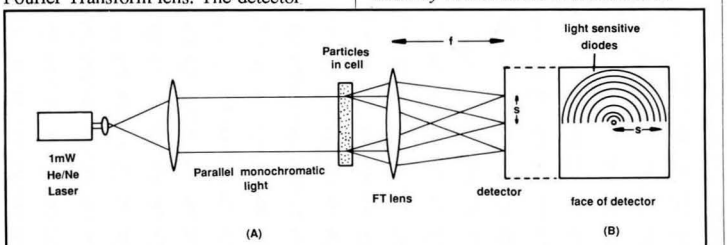

Fig. 1. (A) Schematic diagram of particle size analyser, (B) Photo-sensitive detector

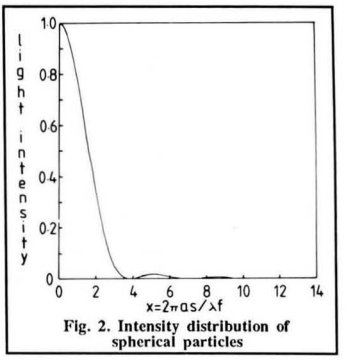

Fig. 2. Intensity distribution of spherical particles

the diffraction pattern and oscillates with decreasing amplitude as the radius increases. Since it is difficult to infer size distributions from light intensity measurements[4], the light energy distribution has been used in developing the theory[5]. The corresponding *light energy* distribution for a field of monodisperse spherical particles is shown in Figure 3. The radial distance corresponding to the first maximum is inversely proportional to the particle radius. Also, the individual size range covered by each light sensitive strip, and hence the total size range covered by the detector, may be varied by simply changing the focal length of the lens (see Appendix 1).

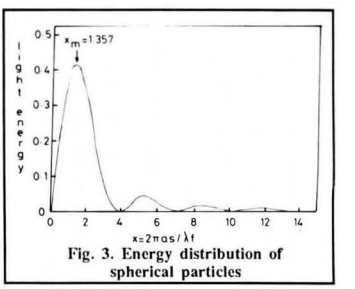

Fig. 3. Energy distribution of spherical particles

The total light energy distribution for a suspension containing a collection of particles of different sizes may be expressed in matrix form as:

$L(j) = W(i).T(i,j)$.....(1)

where L(j) is the light energy falling in ring j, W(i) is the weight fraction in the

4 Dobbins *et al.: AIAA Journal*, 1963, **1**, 1882 - 1886.
5 Swithenbank *et al.: Paper no. 76 - 79 presented to AIAA 14th Aerospace Sciences Meeting*, 1976.

size range i, and T(i,j) contains the coefficients which define the light energy distribution, similar to Figure 3, for each particle size range.

Equation 1 is solved by assuming a value for W(i) and calculating a theoretical value for L(j) using the appropriate T(i,j) matrix for a given set of experimental parameters. This theoretical L(j) is compared to the experimentally measured L(j) and the weight distribution is then iteratively adjusted until the sum of the squared errors in L(j), i.e. $\Sigma[L(j) - W(i,j)]^2$ is a minimum. Thus the relative weight distribution can be obtained from the light energy distribution.

By measuring the light energy focused on the central diode before and after the sample is placed in the optical cell, the fraction of light obscured by the particles can be found. This obscuration can then be used to calculate the absolute weight distribution and concentration through the Beer-Lambert Law[6].

Laboratory tests

A schematic diagram of the laboratory set-up is shown in Figures 4 and 5, with a photograph of the system in Figure 6. The design of the evaporative (vacuum) crystallizer was based on that used at the British Sugar Research plc Laboratories at Norwich[7], and it was run as far as possible under the same conditions as the plant process. The crystallizer was a well-stirred 5-litre glass flask, heated by an electric isomantle and maintained at a constant vacuum by a mercury vacuum regulator. The sugar solution in the crystallizer was concentrated to supersaturation 1.3 by boiling off water.

The solution was then fully seeded through a funnel with a prepared seed slurry of milled sugar in iso-propanol. A size analysis of the seed crystals is shown in Table I.

The experimental temperature (75°C) was measured by iron-constantan thermocouples accurate to 0.2°C and the pressure (200 mm Hg) by a mercury manometer accurate to 1 mm Hg.

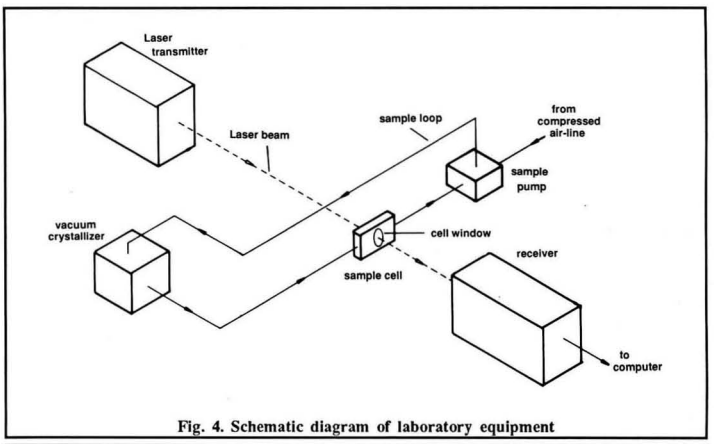

Fig. 4. Schematic diagram of laboratory equipment

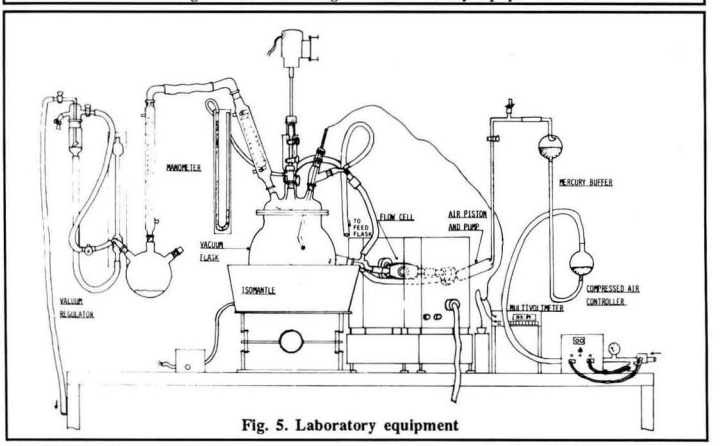

Fig. 5. Laboratory equipment

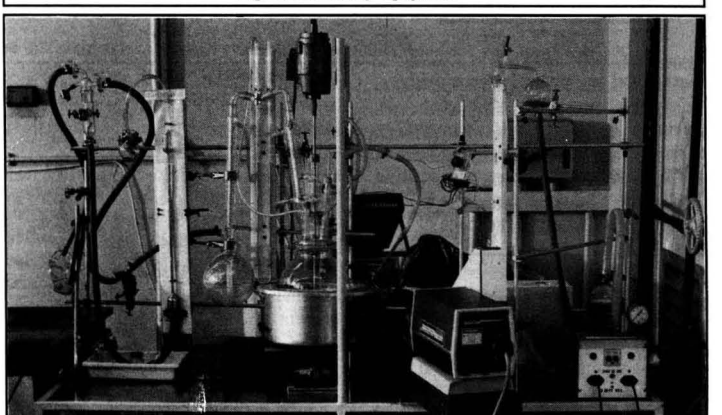

Fig. 6. Photograph of laboratory equipment

6 Brown & Felton: *Chem. Eng. Res. Des.*, 1985, **63,** 125 -132.

7 Weatherby & Brown: "Growth of sugar crystals from aqueous solution" in *Proc. 9th Symp. Ind. Cryst*, 1984.

MALVERN 2600/3600 PARTICLE SIZER VA.6
MALVERN INSTRUMENTS LTD,SPRING LANE,MALVERN,ENGLAND.

RESULTS FROM BLOCK 9
RUN NUMBER= 46 TIME=00-24-50 LOG DIFFERENCE= 4.30
SAMPLE % VOLUME CONCENTRATION= 0.0199 BEAM OBSCURATION= 0.11

SIZE MICRONS	WEIGHT % UNDER	WEIGHT IN BAND MICRONS		%	LIGHT ENERGY CALCULATED	MEASURED
564.0	100.0					
261.6	100.0	564.0-	261.6	0.0	121	0
160.4	95.0	261.6-	160.4	5.0	202	285
112.8	91.9	160.4-	112.8	3.1	299	298
84.3	87.2	112.8-	84.3	4.7	429	432
64.6	82.4	84.3-	64.6	4.8	633	624
50.2	74.5	64.6-	50.2	7.9	928	911
39.0	56.5	50.2-	39.0	18.0	1388	1285
30.3	30.9	39.0-	30.3	25.6	1715	1730
23.7	14.1	30.3-	23.7	16.7	2015	1966
18.5	4.1	23.7-	18.5	10.0	2047	2047
14.5	1.5	18.5-	14.5	2.6	1777	1762
11.4	1.0	14.5-	11.4	0.6	1475	1458
9.1	0.6	11.4-	9.1	0.3	1306	1247
7.2	0.3	9.1-	7.2	0.3	1208	1298
5.8	0.2	7.2-	5.8	0.1	1382	1365

D(50%) (UM)= 36.81 | V M D (UM)= 51.66 | S M D (UM)= 34.56
D(10%) (UM)= 21.58 | D(90%)(UM)= 101.24 | SPAN = 2.17

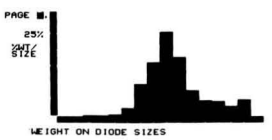

Fig. 7. Crystal sizer computer results at 25 minutes

MALVERN 2600/3600 PARTICLE SIZER VA.6
MALVERN INSTRUMENTS LTD,SPRING LANE,MALVERN,ENGLAND.

RESULTS FROM BLOCK 10
RUN NUMBER= 66 TIME=00-35-00 LOG DIFFERENCE= 4.56
SAMPLE % VOLUME CONCENTRATION= 0.0888 BEAM OBSCURATION= 0.27

SIZE MICRONS	WEIGHT % UNDER	WEIGHT IN BAND MICRONS		%	LIGHT ENERGY CALCULATED	MEASURED
564.0	100.0					
261.6	100.0	564.0-	261.6	0.0	344	197
160.4	97.7	261.6-	160.4	2.3	582	581
112.8	87.8	160.4-	112.8	9.9	857	850
84.3	68.8	112.8-	84.3	19.1	1168	1179
64.6	49.4	84.3-	64.6	19.3	1528	1517
50.2	25.3	64.6-	50.2	24.1	1843	1851
39.0	8.6	50.2-	39.0	16.7	2047	2047
30.3	5.4	39.0-	30.3	3.2	1979	1982
23.7	3.8	30.3-	23.7	1.5	1664	1619
18.5	0.7	23.7-	18.5	3.1	1298	1332
14.5	0.1	18.5-	14.5	0.7	1171	1159
11.4	0.1	14.5-	11.4	0.0	1171	1097
9.1	0.0	11.4-	9.1	0.0	1075	1004
7.2	0.0	9.1-	7.2	0.0	1051	1008
5.8	0.0	7.2-	5.8	0.0	1243	1229

D(50%) (UM)= 65.23 | V M D (UM)= 75.16 | S M D (UM)= 59.22
D(10%) (UM)= 39.93 | D(90%)(UM)= 123.30 | SPAN = 1.28

Fig. 8. Crystal sizer computer results at 35 minutes

MALVERN 2600/3600 PARTICLE SIZER VA.6
MALVERN INSTRUMENTS LTD,SPRING LANE,MALVERN,ENGLAND.

RESULTS FROM BLOCK 11
RUN NUMBER= 85 TIME=00-45-10 LOG DIFFERENCE= 3.84
SAMPLE % VOLUME CONCENTRATION= 0.3149 BEAM OBSCURATION= 0.51

SIZE MICRONS	WEIGHT % UNDER	WEIGHT IN BAND MICRONS		%	LIGHT ENERGY CALCULATED	MEASURED
564.0	100.0					
261.6	98.7	564.0-	261.6	1.3	911	867
160.4	81.2	261.6-	160.4	17.5	1373	1385
112.8	56.2	160.4-	112.8	25.0	1724	1711
84.3	25.1	112.8-	84.3	31.0	1938	1945
64.6	11.9	84.3-	64.6	13.3	2047	2047
50.2	6.2	64.6-	50.2	5.7	1907	1895
39.0	3.5	50.2-	39.0	2.7	1588	1604
30.3	0.6	39.0-	30.3	2.8	1283	1293
23.7	0.2	30.3-	23.7	0.4	1189	1132
18.5	0.2	23.7-	18.5	0.0	1088	1128
14.5	0.1	18.5-	14.5	0.0	1018	982
11.4	0.1	14.5-	11.4	0.0	945	935
9.1	0.1	11.4-	9.1	0.0	885	912
7.2	0.1	9.1-	7.2	0.0	1048	1068
5.8	0.0	7.2-	5.8	0.0	1318	1321

D(50%) (UM)= 107.13 | V M D (UM)= 122.43 | S M D (UM)= 93.16
D(10%) (UM)= 59.98 | D(90%)(UM)= 211.31 | SPAN = 1.41

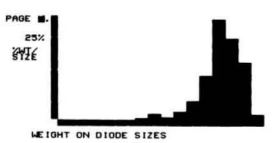

Fig. 9. Crystal sizer computer results at 45 minutes

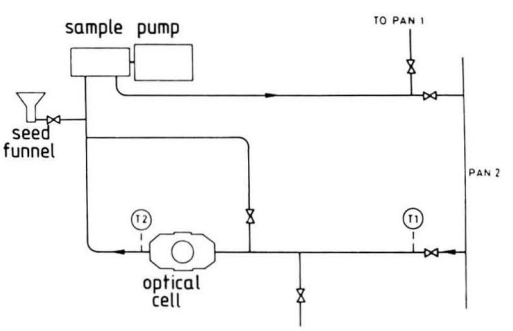

Fig. 10. Schematic diagram of plant sampling loop

Throughout any particular experiment, the sugar suspension was extracted continuously from the flask, pumped through the optical flow cell and returned to the crystallizer by means of a positive displacement pump. The pump was designed so as to avoid breakage of the crystals.

Laboratory results

A number of sugar boiling runs was undertaken in the laboratory and sets of data were gathered over a period up to 45 or 50 minutes from seeding. These sets of data comprised the standard output from the Malvern particle sizing apparatus. Part of typical set of data is shown as Figures 7, 8 and 9 which are copies of the output from the Malvern equipment computer.

The data comprises: in the first two lines, information to enable the record to be identified. Next is a figure showing the concentration of particles in the suspension as the % solids present by volume. With this figure is a number showing the % obscuration of the light beam.

The particle size data are presented in two ways; first, numerically, as a table showing the size of particles detected by each diode band and the weight of particles in each band, together with some details of the light energy measurements. Second, the data are presented in the form of a histogram showing the distribution of particle weights in each size band.

Figures 7, 8 and 9 show the results obtained at 25, 35 and 45 minutes from seeding for a run seeded with milled sugar produced at Newark factory having an original size distribution as shown in Table I. The laboratory pan was run with a relative supersaturation of 1.25, a temperature of 75.3°C and with absolute pressure 200 mm Hg. These sets of data are just three from approximately 90 sets

Table I. Size analysis for the seed crystals

Size band, μm	% Weight in band
118.4 - 54.9	0
54.9 - 33.7	0.1
33.7 - 23.7	0.3
23.7 - 17.7	1.2
17.7 - 13.6	3.3
13.6 - 10.5	5.2
10.5 - 8.2	9.5
8.2 - 6.4	14.2
6.4 - 5.0	18.1
5.0 - 3.9	17.8
3.9 - 3.0	12.8
3.0 - 2.4	9.5
2.4 - 1.9	4.9
1.9 - 1.5	1.5
1.5 - 1.2	0.6

measured during this particular run.

It is very easy to see from the histogram on each set of results just how the sugar crystals are growing with time and also how the distribution within each set of results changes with time.

The laser diffraction method of particle sizing does have limitations in that accurate measurements can only be taken within a range of concentrations that is dependent on crystal size. In low concentration suspensions, the number of particles is too low for accurate measurements to be obtained. Then there is a long range of particle concentration when the sizer operates well. As the concentration grows there comes a point when the obscuration of the beam is so high that the measurement is no longer possible. The results obtained from the various trials reflected this limitation. In the very early stages after seeding, concentrations of less than 0.0001% exist and the concentration has to rise to about 0.001% by volume before reliable results can be obtained. Readings cannot be taken after 85% obscuration which corresponds to a concentration between 0.2% and 0.8% by volume depending on the crystal sizes.

Following the success of these laboratory trials, it was decided that plant trials on a full-sized vacuum pan would be carried out at Newark factory. Some rough calculations were carried out to see how the measuring range of the equipment would fit in with real pan operations. At seeding, the concentration would be approximately 6×10^{-5}% by volume. Using video film recorded from pan microscopes it was estimated that crystal concentration would rise to 0.001% by volume after 5 minutes from seeding. The concentration after 25 minutes would have risen to approximately 0.8% by volume and thus the beam would be more than 85% obscured.

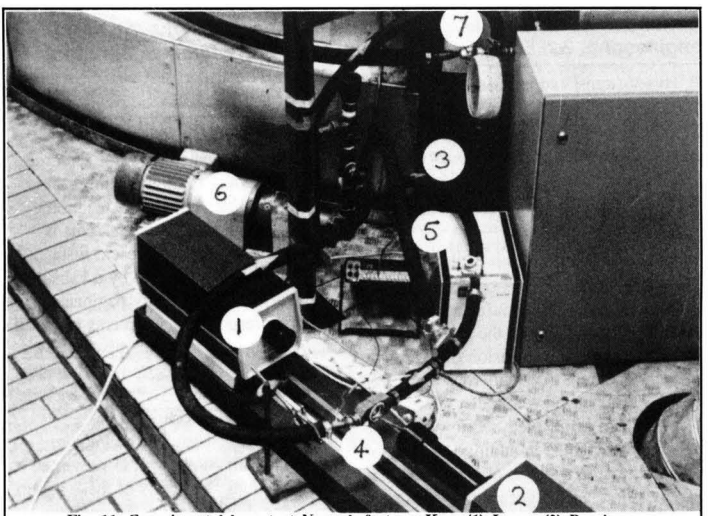

Fig. 11. Experimental layout at Newark factory. Key: (1) Laser, (2) Receiver, (3) Sample inlet, (4) Flow cell, (5) By-pass, (6) Pump, (7) Sample return

Factory tests

A schematic diagram of the plant set-up is shown in Figure 10, together with a photograph in Figure 11. The operating conditions for the crystallization vessel (Pan 2) were approximately the same as in the laboratory trials. A sample of the sugar suspension was pumped continuously out of Pan 2 and through the flow cell before being discharged into Pan 1. The sample was not returned to Pan 2, so as to avoid any adverse effects on the crystal growth there. In order to increase the measurement time as much as possible, the path length in the flow cell was set at 2 mm (as opposed to 6 mm in the laboratory experiments.) The Malvern equipment allows measurement of the crystal size at approximately one-minute intervals. This allows time for: (a) sufficient particles to be counted in any one measurement, and (b) the data to be analysed and shown on the screen of the micro-computer for inspection. All the data accumulated is stored in the computer memory bank to be either printed, stored on a disk or both at the end of the experiment.

When the laser beam is more than 50% obscured, which occurs after about 25 minutes, the data analysis becomes complicated owing to multiple scattering, i.e. the beam being diffracted by a number of particles before reaching the detector. Efforts are being made at Sheffield University to develop the theory to account for multiple scattering; however, the results reported here only apply to obscurations below 0.50.

(to be continued)

Turkey sugar factory construction[1]

Construction due to have started in Turkey includes three new sugar factory projects at Konya-Ereglisi, Cankiri-Corum and Van-Ercis, modernization ofthe tablet sugar and small packaging station at the Ankara – Etimesgut factory and a tablet sugar plant at the new factory at Mus.

1 *Zuckerindustrie*, 1986, **111**, 804.

New books

Handbook of cane sugar engineering. 3rd Edition

E. Hugot (translated by G. H. Jenkins). 1166 pp; 16.5 × 24.1 cm (Elsevier Science Publishers, P.O. Box 330, 1000 AH Amsterdam, Holland; P.O. Box 1663, Grand Central Station, New York, NY 10163, U.S.A.) 1986. Price: 725 Dutch florins; $268.50.

Since the 2nd edition of this renowned handbook was published, the technology of sugar manufacture has evolved remarkably and the author has carried out complete revision of his work to such an extent that numerous entirely new sections have been added while a few outdated or obsolete sections have been deleted. Thus, in addition to the updated text on subjects covered in the 1972 edition Mr. Hugot's throughness and expertise have been applied to descriptions and discussions on such plant as modern shredders, pressure feeders, mill rollers including the Lotus roller, the FS-van Hengel cane diffuser, saccharate liming, rapid clarifiers, falling-film and other modern evaporators, continuous vacuum pans, vertical crystallizers, continuous centrifugals, sugar dryers, liquid ring pumps, forced-draft cooling towers, modern condensers and bagasse drying and pelleting equipment. He has extended the range of calculations and formulae to cover the maximal speed of mills, mill capacity, power requirements, reduced extraction and material balances in milling, heat transfer in heaters and factory heat balance, steam flow and consumption in pans, and factory steam balance. A completely new chapter has also been added on automation and data processing, contributed by MM. G. Windal and J. C. Giorgi of the French Sugar Industry Research Institute who are well-known experts in the field. The book is dedicated to the translator, George Jenkins, who died when it was in the final stages of production, and it is a fine tribute to his contribution to the success of this cane sugar engineer's "bible". The price is remarkable — but so is the huge quantity of information which this latest edition contains.

Proceedings of the 3rd Annual Conference, Barbados Sugar Technologists Association, 1985

Such works as this volume of B.S.T.A. Proceedings are not acquired for the fineness of their bindings and similar qualities but for the technology included within their covers. This is perhaps as well in the present instance, since the work is formed by a substantial collection of individually paginated papers, preceded by a contents page, all stapled together and accompanied by a separate set of reports on the Barbados sugar crop of 1985. The papers include 13 for the Field Section of the Association and ten for the Factory Section, with another paper presented to both Sections. Abstracts of these papers will be published in this Journal and *Sugar Cane* in due course and readers will be able to judge whether, as in the case of previous Proceedings, they wish to acquire the complete volume, which is available at a price of US $10 from the B.S.T.A., c/o Sugar Technology Research Unit, Edgehill, St. Thomas, Barbados.

Crystal Jubilee

41 pp; 20.9 × 29.6 cm. (British Sugar plc, Oundle Road, Peterborough, Cambs., England.) 1986.

This year sees the 50th anniversary of the founding of the single company which unified the United Kingdom's beet sugar industry. The first beet sugar factory in England had been established at Cantley in 1921 and a number of sugar companies came into existence in the 1920's. An Act of Parliament brought the British Sugar Corporation into existence in 1936 to take over these companies and contributed greatly to provision of sugar for the British people during World War II. In the post-war period the country's output of sugar has increased greatly and output per factory even more so as a consequence of rationalization and closures and constantly increasing efficiency. Some of the changes are illustrated in this book, sub-titled "A celebration of 50 years achievement", and it provides an account of the modern British beet sugar industry in photographs and story, as well as providing information on sugar itself, on the sugar beet, etc. An attractive, well-produced work, it is a fitting tribute to the many people who have built up British Sugar over the past 50 years.

Monosaccharides in alkaline medium: isomerization, degradation, oligomerization

J. M. de Bruijin. 163 pp; 16.4 × 24 cm. (CSM Suiker B.V., Breda, Holland.) 1986.

This thesis for a doctorate in technical sciences granted to the author for work conducted at Delft Technical University deals with the isomerization and degradation reactions involving monosaccharides in aqueous alkaline solutions. It is divided into nine chapters: Introduction; Reactions of monosaccharides in aqueous alkaline solutions (including initial trans-formation, alkaline degradation reactions and the effect of reaction variables on product formation); Influence of reaction parameters on the composition of the final product from alkaline degrad-ation of monosaccharides; Characterization of oligomeric products formed during alkaline degradation; Kinetics of alkaline isomerization and degradation of mono-saccharides; Mechanistic picture of alkaline degradation; A note on alkaline degradation of D-fructose in the presence of formaldehyde; ^{13}C nuclear magnetic resonance spectroscopy of alkaline degradation products of monosaccharides; and Analysis of carboxylic acids formed by alkaline degradation of invert sugar: comparison between liquid and gas chromatography. Summaries in English and Dutch are appended. Knowledge of alkaline transformation of monosaccharides is of importance for sugar manufacture because of the degradation of invert sugar during raw juice purification, and this work makes a significant contribution to an understanding of the subject.

Facts and figures

China sugar imports 1985[1]

	1985	1984
	tonnes, raw value	
Australia	452,000	261,697
Cuba	680,000	705,054
EEC	13,000	0
Fiji	58,000	20,537
Hong Kong	5,000	0
Philippines	95,000	67,991
Poland	0	14,777
Thailand	911,000	277,920
	2,214,000	1,347,976

Egypt sugar production, 1985/86[2]

The area under sugar cane covered 198,000 acres in 1986 against 192,000 acres in 1985 and the quantity of cane delivered to the Egyptian sugar company rose by 500,000 tonnes. Sugar production in the 1985/86 crop is estimated at 775,000 tonnes, white value, or 75,000 above targetted output. In addition, Egypt's beet sugar production is estimated at some 80,000 tonnes, white value.

China sugar factory-refinery project[3]

Mitsui & Co. have said that it and Taito Co. Ltd., along with China Everbright Holding Co. Ltd. of Hong Kong, have agreed to study setting up of a joint sugar factory-refinery in Zhuhai, in southern China. The consortium aims to start operation in 1988, with initial investment at $20 million, according to a Mitsui spokesman. Plans are to produce 25,000 tonnes of refined sugar a year from 1988 for domestic consumption, processing 2000 tonnes of cane per day. The project also calls for refining of 50,000 - 60,000 tonnes of raw sugar supplied by Mitsui to sell to third parties.

Peru sugar statistics, 1985[4]

Peru's sugar crop is harvested and processed throughout the year. Output in the calandar year 1985 totalled 756,745 tonnes, against 619,879 tonnes in 1984. Consumption during the year rose from 632,907 tonnes to 688,900 tonnes, so that final stocks rose from 83,475 tonnes to 91,480 tonnes.

Corrigendum

The new dry fructose product Crystar, referred to earlier[5] as 80 times as sweet as sucrose in dry form and 15 times as sweet when used as a 10% solution, is, in fact, 80% and 15% sweeter, respectively[6].

Typhoon damage in China[7]

The southern Chinese province of Guangdong was hit by a typhoon in July and serious crop damage has been reported. Nearly 400,000 hectares of farm land were reported to have been affected. The Tungjiang river, a main tributary of the Pearl river, overflowed after heavy rain brought by the typhoon, affecting vast ares of rice and sugar cane along its banks. In Zhangzhou county alone 10,000 hectares of cane were destroyed, according to Hong Kong newspaper reports. Guangdong is China's biggest cane-growing province, accounting for nearly one-third of the country's total sugar production.

Egypt sugar imports 1985[8]

	1985	1984
	tonnes, raw value	
Brazil	212,000	315,119
Cuba	182,000	137,911
Czechoslovakia	0	39,130
EEC	217,000	289,507
India	0	39,130
Poland	45,000	12,945
Portugal	0	11,000
Thailand	0	5,943
US	0	39,218
USSR	13,000	0
	711,000	902,094

EEC rejection of subsidy on alcohol from beet[9]

The European Parliament has rejected with a very clear majority the idea of using surpluses of wheat, sugar beet, etc. for the production of alcohol. The Parliament followed the recommendations of its energy committee which said that the recent fall in the petroleum price would make uneconomical alcohol produced from such sources and this would thus have to be produced with the help of considerable Community subsidies. In an energy committee's report it was calculated that production of 3.4 million tonnes of alcohol would cost the EEC $1300 million more than the import of the petroleum. French members of the Parliament argued in vain that the price of petroleum could rise unexpectedly. On the other hand, the Parliament has approved a commission draft seeking to propose new source of energy.

Marketing of alcohol from cane juice process[10]

Queensland Science & Technology Ltd., formed to promote the "Sucrotech" and "Bio-Wastech" processes for alcohol and animal feed manufacture from cane juice and wastes[11], has announced that Cie. Commerciale Sucres et Denrées of France has agreed to provide assistance and marketing service worldwide. The principal market for the processes will be the USA, where Archer Daniels Midland Corp. Inc. is currently conducting trials on the Sucrotech process for alcohol manufacture. This technology is also being installed at the Ethanol Co. Ltd's distillery in Malawi and, with the aid of Sucres & Denrées, provision is being made with a leading Brazilian ethanol producer to begin operational trials this autumn.

Pakistan 1985/86 cane sugar production[12]

The 1985/86 season in Pakistan, which ended in May, was shorter than in previous years owing to a smaller cane crop available. It totalled 26.91 million tonnes, compared with 32.14 million tonnes in 1984/85, or a reduction of some 16%. The average cane yield per hectare was 34.26 tonnes, compared with 35.67 tonnes in the previous season. Of the total cane harvest 12,063,000 tonnes were crushed in the centrifugal sugar industry, compared with 14,692,000 tonnes, while cane sugar production reached 1.10 million tonnes white value (1,196,000 tonnes, raw value) compared with 1.30 million tonnes white value, (1,413,000 tonnes, raw value) produced in 1984/85. Sugar recovery amounted to 9.14%, up from 8.89% in the previous season. As the crop was poor, only 7.8 million tonnes of cane were used to produce 650,000 tonnes of gur and khandsari, compared with 8,559,000 and 761,576 tonnes, respectively, in 1984/85.

Morocco sugar imports[13]

	1985	1984
	tonnes, raw value	
Austria	13,043	13,044
Brazil	130,435	109,783
Colombia	13,435	109,783
Dominican Republic	0	45,652
EEC	15,217	28,261
Germany, East	0	41,087
India	0	41,087
Mexico	28,261	0
Thailand	0	52,174
Vietnam	13,043	0
Zimbabwe	30,435	16,304
	243,477	319,349

Cuba-Vietnam agreement on sugar technology aid[14]

Cuba is to help Vietnam develop its sugar industry; a recently signed economic and technical cooperation agreement provides for Cuba to help modernize and expand several existing sugar factories in Vietnam, assist in building new ones and train Vietnamese personnel in sugar industry technology.

Australian sugar factory closure stopped[15]

CSR Ltd. planned to sell its Goondi mill to the owners of the nearby Mourilyan mill, who planned to close the Goondi mill and re-zone all Goondi cane growers to supply the Mourilyan factory. However, the Queensland State government then proposed a rationalization of milling arrangements in the north of the state. Consequently, plans were altered and CSR proposed to close the Goondi mill, with the growers re-zoned between Mourilyan and the Babinda and South Johnstone mills, increasing the capacity of each to 950,000 tonnes. The proposals were

1 *I.S.O. Stat. Bull.*, 1986, **45,** (7), iv.
2 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 389.
3 *Reuter Sugar Newsletter*, June 16, 1986.
4 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** S299-S300.
5 *I.S.J.*, 1986, **88,** 142.
6 *Dyergram*, 1986, (16-86), 4.
7 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 389.
8 *I. S. O. Stat. Bull.*, 1986, **45,** (7), viii.
9 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 404.
10 *Amerop-Westway Newsletter*, 1986, (152), 9.
11 *I.S.J.*, 1985, **87,** 105.
12 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 410 - 411.
13 *I. S. O. Stat. Bull.*, 1986, **45,** (7), xvi.
14 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 411.
15 *Australian Canegrower*, 1986, **8,** (6), 9 -11.

put before the Central Sugar Cane Prices Board who also received submissions from local cane growers and other interested parties. Eventually the Board decided that the proposals could not be allowed and that CSR was not to be exempted from its obligation to crush cane at Goondi during the 1986 season. What will happen in the future is tied up with the prospects of Babinda mill which is heavily indebted and has a question mark over its future.

Proposals for joint Brazil – Cuba sugar commercialization[16]

Brazil, which has normalized diplomatic relations with Cuba after 22-year break, is reported to be proposing the formation of a joint sugar commercialization program aimed at raising the price of sugar on the world market. The I.A.A. President said that Brazil could not propose the plan earlier because of the broken relations between the two countries; they together account for 40% of international sugar trade with combined annual exports of about 8 million tonnes. He confirmed that exports by Brazil during the period May 1986/April 1987 were to be limited to roughly 2 million tonnes and that this sugar had already been sold. With an export provision of 2.7 million tonnes out of the 8.56 million tonnes production figure set in the 1986/87 Brazillian sugar plan, 700,000 tonnes are temporarily withheld and, with current market prices below 6 cents/pound, could be held indefinitely.

Poland sugar exports, 1984[17]

	1985	1984
	tonnes, raw value	
Chile	0	11,313
China	0	14,777
Egypt	44,711	13,100
India	93,591	24,430
Iran	0	14,344
Jordan	0	25,550
Kuwait	1,355	944
Libya	46,549	48,165
Switzerland	0	36,159
Syria	0	53,480
Yugoslavia	0	44,558
Other countries and unknown	101	14,052
	186,307	300,872

Jamaica sugar imports increase likely[18]

Following floods on the island, it is thought Jamaica's raw sugar production will not reach the 210,000 tonnes target because of cane crop damage. Jamaica needs 100,000 tonnes for domestic consumption and a further 140,000 tonnes to meet its US and EEC quotas. Imports had previously been estimated at 45,000 tonnes but this figure is now likely to be too low.

Argentina limitations on beet sugar and HFS output[19]

The Argentine government has decreed a limit on production of corn sweeteners and beet sugar at existing production capacity for a period of five years, in response to strong pressure from cane sugar interests. Corn sweeteners cannot exceed 85,000 tonnes, dry weight, and beet sugar 10,000 tonnes per annum.

Mexico sugar production, 1985/86[20]

Production in Mexico in the 1985/86 season totalled 3,696,000 tonnes, giving a surplus of 270,000 tonnes which may be exported. A surplus of 100,000 tonnes was achieved also in the previous crop after a balanced situation in the crop before and deficit in 1982/83. An estimated 500,000 tonnes of cane was left unharvested in the fields. Export of the 1985/86 surplus will depend on whether there is an improvement in market prices, or if better deals in exchange for fertilizers, for example, can be arranged as in 1985. If not, the sugar could be held in stock in case of an increase in domestic consumption.

Ghana sugar rehabilitation project[21]

A project now under study covers the rehabilitation of plantations, supply of equipment to the existing sugar factories and technical and management training. Four companies have shown interest up to now: one British, one Pakistani, one Italian and one American.

Spanish sugar production, 1985/86[22]

Sugar production in Spain in the 1985/86 season (July/June) totalled 902,815 tonnes, white value, of which 888,168 tonnes were beet sugar and 14,647 tonnes were cane sugar. These figures compare with 1,074,259 tonnes (comprising 1,064,942 tonnes of beet sugar and 9317 tonnes of cane sugar) produced in 1984/85.

Mexico sugar losses study[23]

A study was made recently by the Mexican Institute for the Improvement of Sugar Production (IMPA) on losses in cane fields and during transport to the sugar factories. The areas examined were harvested both by machine and manually and losses due to poor cutting and cane wastage were found to reach 11.8 tonnes per hectare with manual cutting in the area supplying Ingenio Belisario Domínguez and up to 20 tonnes/hectare with mechanical harvesting. Losses were evaluated for transportation over short and longer distances (6 - 30 km) and the cane falling from the trucks was found to vary from 2.5 to 22 kg per km. Other studies, carried out in the area supplying a factory in Juchitan, Oaxaca, showed much lower field losses resulting from poor cutting and much higher loss of cane on the roads.

Dominican Republic sugar production, 1985/86[24]

The 1985/86 season in the Dominican Republic ended with a production of 765,000 tonnes, raw value, 26% down from the officially reported 1,041,000 tonnes of 1984/85. The factories of the State Sugar Council (CEA) were stopped abruptly on July 5 owing to a lack of financial resources, while Central Romana Corporation's output was also the lowest for several years. The reduced production was due to the drought which affected the country in mid-1985 and excessive rains at harvest time. The CEA is reported[25] to be near bankruptcy, with debts exceeding $200 million. It may not be able to process the 1986/87 cane harvest and, according to a Vice President of the Council, it is possible that at least four of the twelve CEA factories would have to be closed if the books are to be balanced.

Portugal sugar imports 1985[26]

	1985	1984
	tonnes, raw value	
Argentina	0	13,007
Brazil	52,000	91,041
Colombia	12,000	0
Cuba	0	40,364
EEC	231,000	71,192
Fiji	29,000	0
Guyana	11,000	0
Malawi	24,000	0
South Africa	30,000	0
Swaziland	109,000	34,519
Zimbabwe	64,000	33,885
Other countries and unknown	13,000	3,906
	575,000	287,914

Panama sugar factory sale to Guatemala[27]

The Government of Panama has unofficially indicated that it has sold an antiquated but currently operational sugar factory to a Guatemalan company to produce alcohol for export to the US. The distillery for the Azuero plant is expected to be provided by either Brazilian or Spanish manufacturers.

Brazil sugar crop reduction by drought[28]

Brazil has postponed shipment of 500,000 tonnes of sugar exports from 1986/87 to 1987/88. The effect of drought on the 1986/87 cane crop, particularly in the state of São Paulo, has meant that planned outputs of sugar and alcohol will not be achieved, according to the President of the Sugar and Alcohol Institute (IAA). In addition, domestic consumption of sugar and alcohol has risen 10% above expected levels because of the government's economic stabilization plan announced in February. Sugar production is expected to fall 6.2% short of the planned 8.56 million tonnes, and alcohol production by 8.3% less than the planned 11,730 million litres. It is now envisaged that stocks will be used up by the end of the next harvest rather than over the next three as previously expected.

16 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 372.
17 *I.S.O. Stat. Bull.*, 1986, **45**, (7), xx.
18 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 370.
19 *World Commodity J.*, 1986, **9**, (1), 13.
20 *GEPLACEA Bull.*, 1986, **3**, (7), Inf-2.
21 *Amerop-Westway Newsletter*, 1986, (153), 10.
22 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 425.
23 *GEPLACEA Bull.*, 1986, **3**, (7), Inf-2.
24 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 429.
25 *ibid.*, 481.
26 *I.S.O. Stat. Bull.*, 1986, **45**, (7), xxi.
27 *Amerop-Westway Newsletter*, 1986, (153), 12.
28 *Financial Times*, August 8, 1986.

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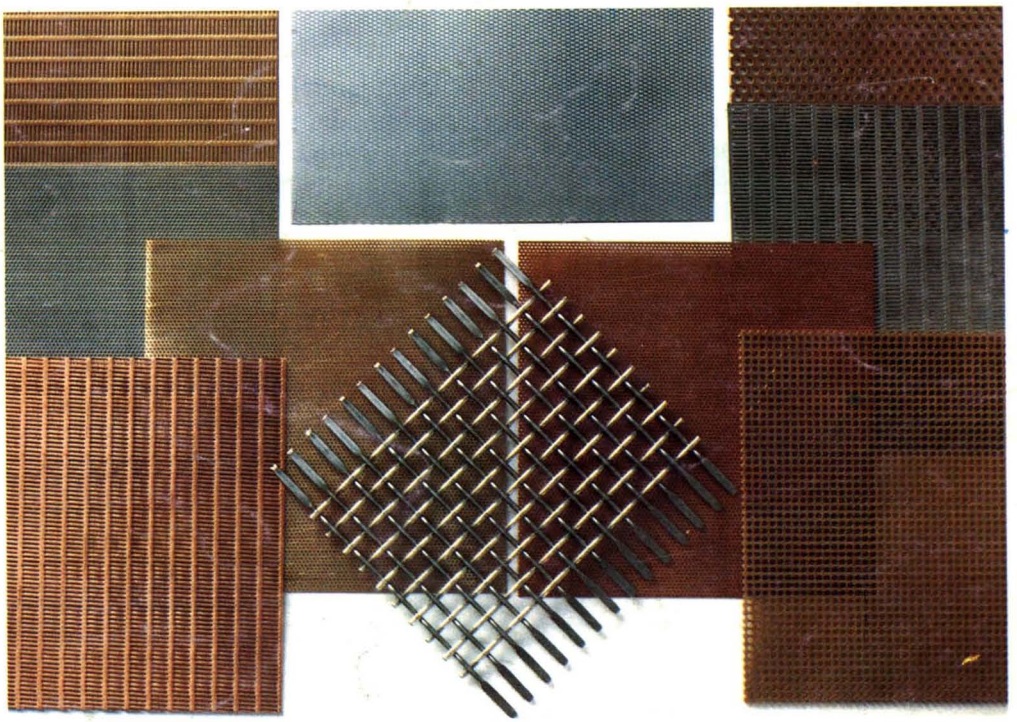

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