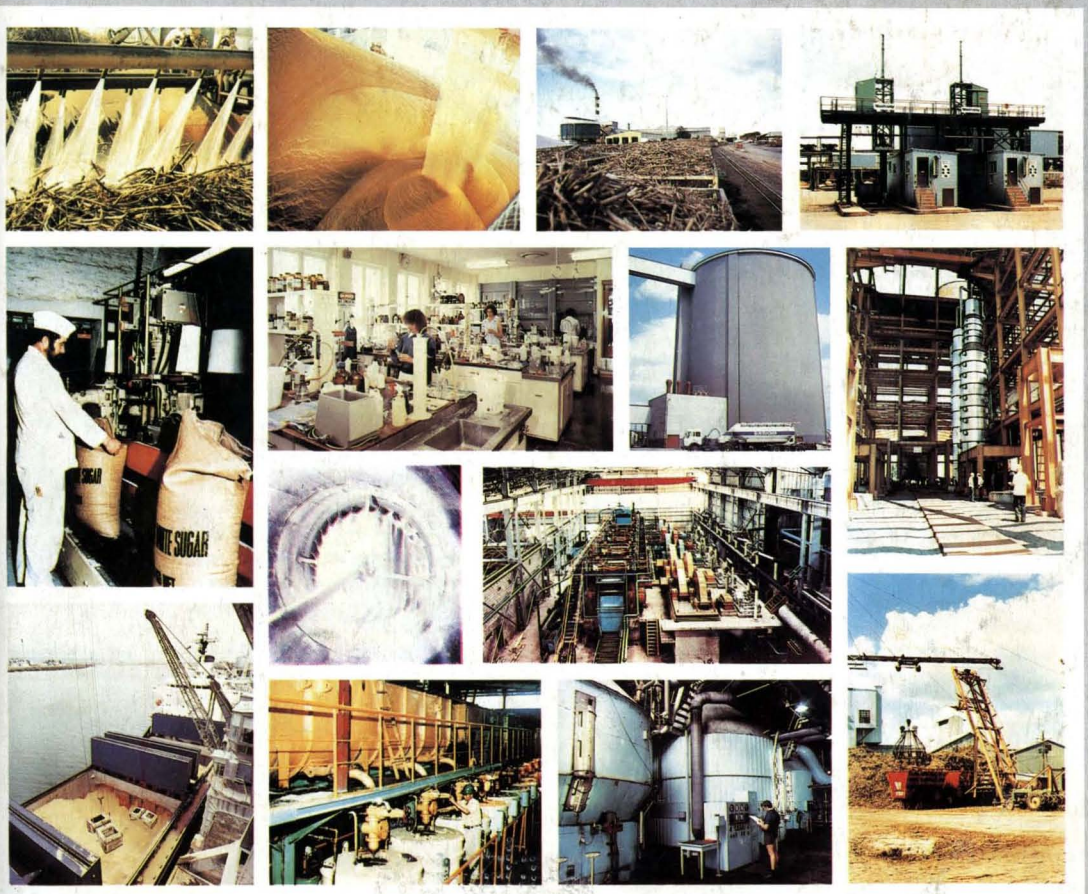
INTERNATIONAL SUGAR JOURNAL



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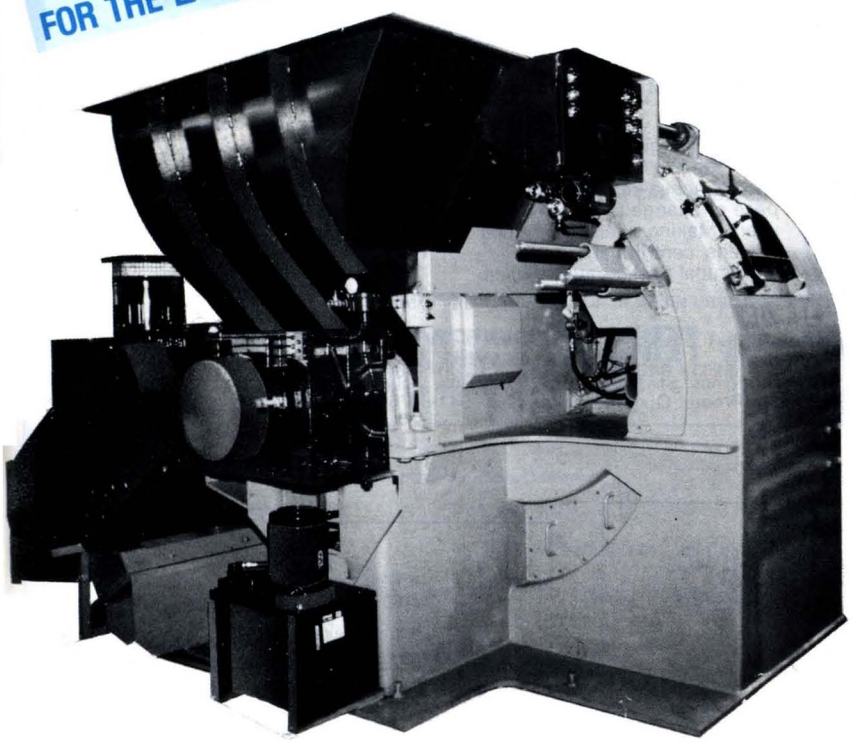

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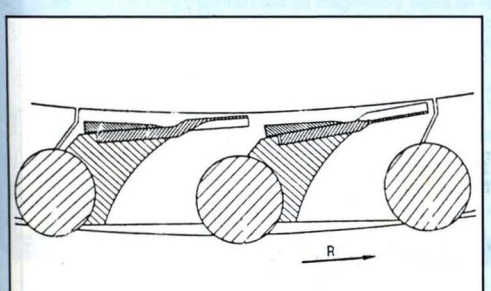

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News and views

Philippines sugar expansion plan[1]

Sugar production in the Philippines is to increase substantially over the next four years to 2.1 million tonnes per annum, according to the chairman of the Sugar Regulatory Administration. He expects production in 1988/89 to reach 1.55 million tonnes, tel quel, against 1,369,000 tonnes in 1987/88 and 1,337,000 tonnes in 1986/87. Domestic consumption is forecast at 1.7 million tonnes in 1991/92, which would leave about 300,000 tonnes for export. The Philippines was a net importer last year owing to a long drought on the back of a glut which had led farmers to take land out of production. Since then the area planted to cane has rebounded. Hitting the 2 million-tonnes target by 1991/92 would require an additional 120,000 acres sown to sugar cane against nearly 650,000 acres at present.

The SRA chairman urged growers to seek new sales outlets, especially in Asia, to reduce reliance on the United States, a disappearing market. Asian demand is running at about 6.5 million tonnes a year and rising, with only Thailand able to make significant export sales. He suggested that the Philippines could find buyers in China, Japan and Singapore.

Alcohol from cane molasses in India[2]

There is a sizeable industry in India producing alcohol using molasses as a feedstock. It includes 194 licensed distilleries with a combined capacity to produce some 1450 million litres of alcohol. There is serious under-utilization of plant, however, with production in 1987/88 reaching no more than 754 million litres, which was itself a sharp improvement over the 619 million litres in the previous season. It is planned to raise this further during the current season to 1100 million litres, with about 450 million litres going to potable liquor production and 250 million litres being channelled to industrial use.

There is some need of coordination, however, since some chemical plants have been importing cheaper alcohol at international prices whilst others have had to halt production temporarily following problems in obtaining alcohol from neighbouring states. In addition, many chemical plants have found that naphtha is a cheaper feedstock than domestic alcohol produced from molasses. The sugar industry has already been given authority to explore the possibility of exporting alcohol but, with international prices considerably below domestic prices, it has been difficult to make progress.

There are plans to allow the use of alcohol as an additive in fuel in a proportion of 10%. The proposal was put forward to a high-level official committee by the sugar industry which has given assurances that it is in a position to supply about 400 million litres of alcohol per year. The advantage with a scheme to blend alcohol in vehicle fuel would be the saving in foreign exchange, estimated at around 6000 million rupees, by reducing oil imports. Also, by using an existing surplus by-product, there would not be the disadvantage of depleting cane supplies for the traditional outlets.

UK sugar production, 1988/89[3]

Despite a difficult start at some factories, the 1988/89 campaign ended on a highly successful note with total sugar production of 1,306,000 tonnes and 732,000 tonnes of dried animal feed. Fuel and lime use was an all-time low and was achieved as a direct result of efficiency and good all-round performance. At Wissington a program of concentration on sugar boiling technique and better use of control systems achieved a significant improvement in final product grain size and uniformity which was maintained throughout the "juice run" which ended in February.

About £40 million has been allocated for capital work during the 1989 off-season, with the major share going to Ipswich factory, where a new boiler house complex is being installed, as well as a concrete flat pad beet storage area and some new beet handling equipment. York factory is to have a new white sugar centrifugal station and Bury a new central control room. New pulp presses are being installed at Cantley as well as an evaporator body. Allscott will have £4 million spent on upgrading the boilers and a new 11 MW generator and power distribution system, as well as a new continuous vacuum crystallizer.

World sugar prices

The bullish trend from February continued during the first three weeks of March and the London Daily Price for raw sugar rose from $291 on March 1 to $303 on March 21 with small dips at intervals between. The strength was provided by purchases by the USSR and Mexico and possible purchases by Venezuela. In the last week of the month, selling by some Brazilian producers brought a sharp decline to $276.40, but the underlying strength of the statistical position and new sale reports brought a quick return to $296.60 on March 30 but a new fall to $295.20 the next day. The white sugar premium widened from $23 per tonne to about $30 after the first week in March and stayed at more or less this level through the rest of the month, the London Daily Price for white sugar following that for raws quite closely; it started the month at $314 per tonne and after climbing to $331.50 on March 17 sank to $307.50 on March 28 but bounced back to $325 two days later, dropping to $323 on March 31.

Australian sugar crop, 1988

In its first Annual Report, the Australian Sugar Milling Council has released information on the recently concluded 1988/89 season. A total of 317,273 hectares of cane were harvested and the yield of 88.4 tonnes per hectare provided just over 28 million tonnes of cane. This was crushed in the 31 Austra-

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 34 - 35.
2 *Czarnikow Sugar Review*, 1989, (1781), 7 - 8.
3 *British Sugar News*, 1989, (88), 1.

lian sugar factories to give an outturn of 3,670,000 tonnes of 94 n.t. sugar, an increase of 119,000 tonnes over the previous record and representing a sugar yield of 11.6 tonnes/ha. The crop benefited from good weather conditions which favoured cane growth but not sugar content. Other features of the season were an increase in green cane harvesting and expansion of the "roaming" permitted since 1987 whereby a grower can cultivate cane on a total of 115% of his assigned area and then selectively harvest the most productive land, provided that the total harvested area does not exceed his assigned area.

Codex standard proposal for raw sugar

The Codex Alimentarius Commission has authorised the development of standards for raw cane sugar following a study by a committee for Latin America and the Caribbean which concluded that there was a need for a world-wide Codex standard. This seems to be a most peculiar idea since, with the exception of a small number of "natural food" fanatics, very few people in developed countries use raw sugar as food, most people involved in its production would prefer the refined product and it is basically an industrial raw material.

The proposed Codex standard specifies raw sugar but only from cane, quotes a minimum pol of 96°S, and limits on colour and loss on drying. Raw sugar is to be prepared in accordance with the Recommended International Code of Practice – General Principles of Food Hygiene; how this is to be achieved in a typical raw cane sugar factory, and how and by whom it would be monitored are unanswered questions. Raw sugar may be sold in bulk or packed in bags, labelled with details of net contents and country of origin.

All this would be harmless enough if it only applied to raw sugar intended for consumption as such, but application of legislated standards to the overwhelming amount of raw sugar sold for further processing would be at best an irritant and at worst an impossible burden. It is to be hoped that the project is dropped.

Trinidad sugar production freeze planned[4]

Just weeks after the start of the 1989 sugar crop, for which a target of 100,000 tonnes has been set, the government of Trinidad & Tobago has unveiled a rationalization plan which will freeze annual sugar production at 75,000 tonnes from 1993 onwards. The decision is indicative of the uncertainty currently felt throughout the Caribbean about the future for sugar sales to the EEC and the US. The 75,000 tonnes objective would be just sufficient to cater for the islands' own domestic requirements and quota sales to these two preferential markets. It also reflects the government's long delayed response to the constant losses suffered by Caroni (1975) Ltd., the state-owned production and refining company which controls the whole sugar sector. In all, 7200 sugar workers will lose their jobs but will be offered 8000 acres of company land to grow cane and other crops as independent farmers. The intention is to have farmers do almost all the cultivation of cane in the future with Caroni only a processor and marketer. One of its two sugar factories will be shut down, and a new company will be set up to oversee diversification of cane land to fruit and food crops. The government has approved a one-third rise in domestic prices of sugar in 1989, with a further 12.5% rise planned for 1991.

Ethiopia sugar complex[5]

A financing package for the Finchaa sugar complex, which includes a sugar cane estate, a sugar factory and a plant for producing anhydrous alcohol, has been approved, according to an AED report. Total cost of the scheme is now estimated at $255 million, including a foreign exchange element of $161 million, plus a $4 million barter deal. Most of this is to come from the African Development Bank.

The scheme is to be situated 330 km northwest of Addis Ababa, in an undeveloped valley on the Finchaa river. It comprises a net cultivated area of 6024 hectares of sprinkler-irrigated cane, plus a 4000 t.c.d. factory. Work could begin by July or August and during the first phase, expected to last five years, the aim is to produce 85,000 tonnes of sugar per year, with expansion to 127,000 tonnes in the second phase. Full production is expected in 7-8 years.

Indian sugar production and consumption

By the end of January, production of sugar from the current crop had reached 4,250,000 tonnes, white value, against 3,734,000 tonnes in the corresponding four months of 1987/88. A significant improvement is expected and C. Czarnikow Ltd. estimate that it will reach 10.95 million tonnes, raw value, against 9.9 million tonnes last season[6].

Consumption may prove to be much more difficult to predict: final figures for 1988 are set at 10,545,000 tonnes, raw value, and Czarnikow believe that the strong growth in sugar consumption is likely to continue, especially since supplies can now be assured from domestic production and, with an election in prospect this year the authorities would be likely to check any rise in prices by generous releases of sugar. Part of the 1.1 million tonnes expansion last year was, however, due to very much lower involvement of open-pan sugars. With improved cane quality this season such sugars are likely to gain ground. As a corollary, however, a higher level of khandsari could detract from internal needs for sugar. Even so, Czarnikow estimate consumption at just over 11 million tonnes. This increase of 484,000 tonnes over 1988 is one of the smallest of recent years.

There would seem to be little scope for exports; however, authority has been granted to sell up to 300,000 tonnes, with the object of earning much

4 *Public Ledger's Commodity Week*, February 18, 1989.
5 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 120.
6 *Czarnikow Sugar Review*, 1989, (1782), 19 - 23.

needed foreign exchange. Further sales might result in a need to import sugar later in the year. With such a large scale producer and consumer it only takes slight variations in the totals of both sides of the supply/demand balance to make a significant change in the impact on the world market.

Papua New Guinea sugar industry recovery

Ramu Sugar Ltd., Papua New Guinea's only sugar manufacturer, began production in 1982 but was devastated by a hitherto unknown cane disease, Ramu stunt, in 1986. Output fell from 34,000 tonnes to less than 10,000 tonnes. Booker Tate Ltd., the corporate managers, put into action a rehabilitation program which included replanting some 6000 hectares with new varieties in two years. The success of this program was seen when, in 1988, the industry produced at record levels of over 50,000 tonnes. Work continues on the exact identification of the causal organism of Ramu stunt and its mode of transmission. Meanwhile, PNG is again self-sufficient in sugar and has small quantities available for export.

Texas cane sugar harvest, 1988/89

Texas's 16th and third best cane sugar campaign began on October 11, 1988 and ended on February 25, 1989. The Field Department of the Rio Grande Valley Sugar Growers Inc. was blessed with an exceptionally dry harvest season, with only 4.6 days lost owing to wet field conditions. The 138-day harvest period was the shortest on record for the tonnage involved. The 81.3 gross tonnes cane per hectare, 9.17 yield % cane, and 7.45 tonnes sugar per hectare all ranked third best in the cooperative's history. Eighteen Claas 1400 harvesters cut the 1,044,175 gross tonnes from 12,841 hectares at a rate of 0.42 hectare per hour. Each harvester averaged 58,010 tonnes for the season and one cut just under 62,700 tonnes for the season. In Texas harvesting is conducted 24 hours per day. The average cut speed was 2.75 km/hr. Harvesting crews averaged 4.75 tonnes/man-hour. With an average one-way haul from transload pad to the mill of 37 kilometres, the transportation department averaged 7.28 tonnes/man-hour.

The factory also accumulated some impressive statistics. The average of 7566 tonnes crushed per day for the elapsed harvest period established a new record. Performance records were also set in the boiling house where sugar colour averaged 1452 MAU for the season (The 1987/88 value was 1600), sugar ash was 0.43%, and clarified juice colour at 116 was less than half the 336 of 1987/88. This latter result was accomplished through better filtration, more on-line clarifiers and conversion of three clarifiers to the Australian system.

Europe beet area, 1989[7]

Proposed price cuts for EEC sugar beet, only partly compensated by changes in "green" currency rates, are surely in farmers' minds and explain why planting intentions in the EEC show little change from 1988. In Austria, Turkey and Yugoslavia the area planted is likely to be higher this year than 1988 but for the last two countries this is not a true increase as poor weather cut the area last year below what was originally planned, and both countries need more sugar to cover domestic requirements and export obligations. Austria too needs to expand production to replace depleted stocks. The beet area in other West European countries is likely to be unchanged. In Eastern Europe the forecast is for a 2.6% rise but the areas are targets set by the authorities and may be adjusted later in the year.

Based on average yields, EEC sugar production could decline by 6% but, considering the constant rise in yields, output may not fall by as much. However, higher production than last year seems achieveable only if the weather is better than normal. With normal weather, Yugoslavia's output should increase markedly and Austrian production should increase in line with the greater beet area. With expansions in Czechoslovakia and East Germany, sugar production in East Europe could rise by 700,000 tonnes. In total, the assumption of no great change in European beet sugar production seems to be a good working hypothesis at least for the time being. F. O. Licht's area estimates are as follows:

	1989	1988
	hectares	
Belgium	114,000	114,000
Denmark	69,000	69,000
France	425,000	421,000
Germany, West	389,000	396,000
Greece	44,000	35,000
Holland	125,000	123,000
Ireland	33,000	33,000
Italy	280,000	265,000
Portugal	1,000	1,000
Spain	174,000	194,000
UK	197,000	197,000
EEC	1,851,000	1,838,000
Austria	50,000	38,000
Finland	30,000	30,000
Sweden	50,000	51,000
Switzerland	15,000	15,000
Turkey	350,000	317,000
Yugoslavia	165,000	125,000
W. Europe	2,511,000	2,414,000
Albania	10,000	10,000
Bulgaria	53,000	50,000
Czechoslavakia	204,000	159,000
Germany, East	216,000	199,000
Hungary	110,000	107,000
Poland	426,000	420,000
Rumania	273,000	265,000
USSR	3,400,000	3,364,000
E. Europe	4,692,000	4,574,000
Total Europe	7,203,000	6,988,000

Poor demand for crystalline fructose in the US

US demand for crystalline fructose, which was projected to grow considerably, has been disappointing, according to a Landell Mills report. This is despite processing innovations which have resulted in a price drop to around 35 cents/lb. As crystalline fructose has 1.3 to 1.7 times the sweetness of sucrose, these prices should make it competitive, the report said, adding that, so far though, its hygroscopic nature has limited its use to niche markets.

7 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 125 - 128.

Sugar Industry Technologists 48th Annual Meeting, 1989

The 1989 Meeting of Sugar Industry Technologists, Inc., is to be held for the first time since 1970 in the "Crescent City" of New Orleans, Louisiana. New Orleans is unusual in having three sugar refineries close at hand, namely the Colonial Sugar Company facility at Gramercy, the Supreme sugar refinery at Labadieville, and the Amstar Corporation's Chalmette plant at Arabi. The last is described elsewhere in this issue, while members of SIT attending the Meeting will have the opportunity of visiting it and the Colonial Sugar plant on May 10. All three are joint hosts for the meeting.

Sugar refinery technologists from many countries are expected to attend and papers will be presented by authors from Australia, Canada, France, Portugal and the UK, as well as the US.

The papers will be presented at sessions in the Conference hotel, the Westin Canal Place, which is adjacent to the Mississippi River and the French quarter of New Orleans. During two days 14 technical papers will be presented, while a discussion will be held on the formation of a technical forum for sugar industry technologists, led by Peter Carrell, and a symposium on packaging will be conducted by Christian Laur.

The technical papers include the following:

1. The APV plate evaporator, by Mario de Campos Vidal;
2. Experience with starch and dextran in a refinery, by Tom Wilson;
3. Reverse osmosis for waste heat and water recovery, Part II, by K. W. Lee, G. Keblish and C. C. Chou;
4. Evaluation of continuous sugar crystallization at Colonial Sugar, by J. McCulla, E. Betancourt and J. de Chazal;
5. Operation experience and performance of the resin decolorization station at the Thames refinery, by A. M. B. Latham;
6. Use of statistical process control in the sugar industry, by Tom Wilson;
7. Affination of beet low raw sugar, by Micheal Cleary;
8. Decolorization by ion exchange resins with regenerant recovery, by Luis Rocha San Miguel Bento;
9. A mechanical blending system for production of dark soft sugar, by Goran Belic;
10. Replacement of lead in polarization analysis, by Margaret Clarke;
11. Modelization of the crystallization section, by Philippe Dauvois;
12. Computer control of the flow through a resin station, by J. A. Fitzpatrick;
13. Plate and frame filtration of carbonatation muds at Pyrmont refinery, by Peter Field; and
14. Common non-sugars and extraneous matter, by Jimmy Somner.

As always, a Ladies program has been arranged by a committee of local members' wives and is announced as being intended to include New Orleans specialities, including history and traditions, jazz, good food and Southern hospitality, a visit to a "Mardi Gras World", and a tour of Audubon Zoo as well as a demonstration of Creole cooking.

Facts and figures

By-products seminar

The Cuban Institute for Sugar Cane Derivatives Research (ICIDCA) is organizing a second international seminar on sugar and sugar cane derivatives, scheduled for April 1990 at the Palacio de Convenciones in Havana, to cover all aspects of by-products including animal feed, moulded products, paper and pulp, furfural and energy optimization, etc. Persons interested should write to ICIDCA, Via Blanca y Carretera Central No. 804, San Miguel del Padrón, Zona Postal 10 - C.11000, La Habana, Cuba (Telex 511667).

Deccan Sugar Technologists 1988 Convention

The 38th Annual Convention of the DSTA was held in Pune, Maharashtra, India during September 9 - 11, 1988 in the presence of about 1300 delegates. In all, 90 papers were presented, of which 48 were to the Agricultural section, 13 to the Manufacturing section, 18 to the Engineering section, 5 to the By-products section and 6 were general papers. Three seminars were held on "Sugar cane cropping under limited water conditions", "Planning and execution in sugar factories" and "Expansion of a 1250 t.c.d. plant to 2500 t.c.d. with minimum expenditure and maximum energy saving".

German sugar company fusion

Zuckerfabrik Franken GmbH, with four sugar factories, and Süddeutsche Zucker-AG, with seven sugar factories, have merged to form a new company, Südzucker AG Mannheim/Ochsenfurt, with administration offices in both cities.

Cuban aid for the Ghana sugar industry

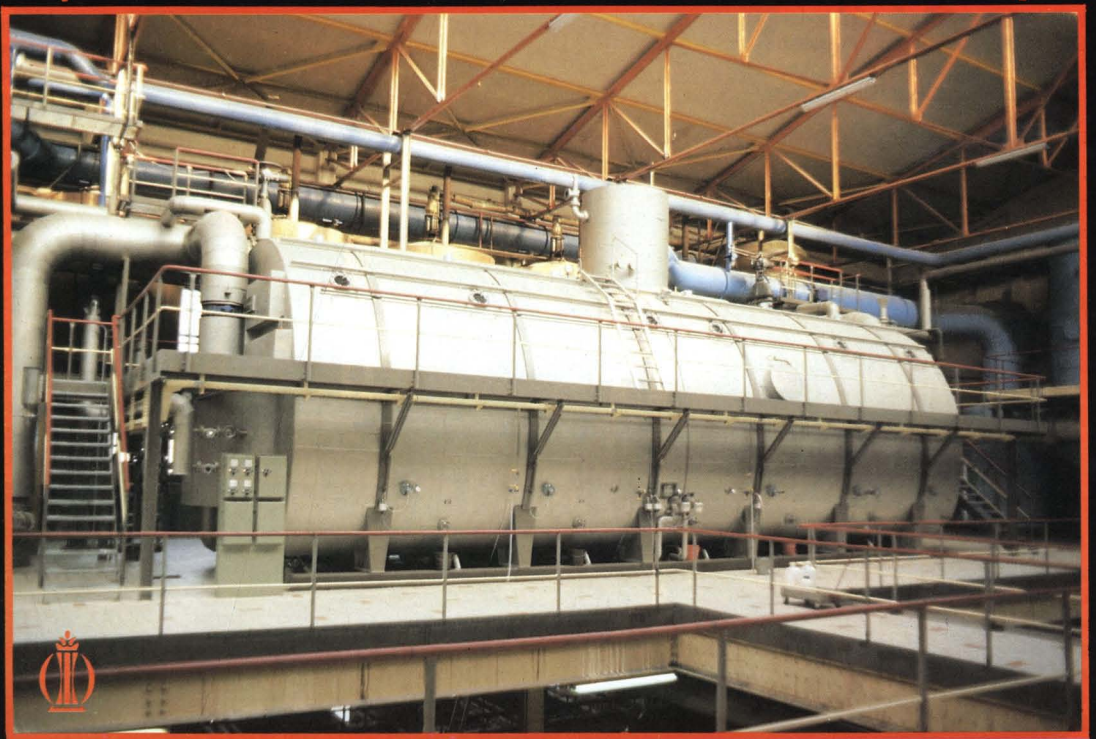
Under an agreement which was to be signed in April, Cuba is to finance the reconstruction of the Komenda sugar factory in Ghana along with provision of processing technology and technical assistance.

Guyana sugar production, 1988[1]

Sugar production in Guyana in 1988 reached only 167,550 tonnes, tel quel, against the original target of 230,000 tonnes and the lower figure of 216,700 tonnes, revised after the Spring crop failed to meet its target by 21,000 tonnes[2]. The output compares with 220,995 tonnes produced in 1987. In 1988 Guyana had to import sugar for domestic consumption in order to meet its EEC quota from local production, while its US quota had to be redistributed among other Caribbean Community members.

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 56.
2 *I.S.J.*, 1988, **90**, 193.

FS Continuous Vacuum Pan in the Beet Sugar Industry



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Amstar Sugar Corporation's Chalmette cane sugar refinery

By Fred Goodrow
(Technical and Quality Control Supervisor, Chalmette Refinery)

Introduction

The Chalmette refinery of the American Sugar Refining Company was constructed during the period of 1905 - 1909 on a seventy-acre tract of land located on the Mississippi River, just downstream from New Orleans. Although located in the community of Arabi, the refinery was named for its proximity to the Chalmette National Battlefield, where the historic Battle of New Orleans was fought.

When operations began on May 17, 1909, the refinery could process 1500 short tons of raw sugar daily, using a work force of 1600 employees. Over the years, the plant has been continually modernized, and upgraded to its present capacity of about 3000 tons daily, with a work force of about 400 employees.

General view of the refinery

Current operations

Over the years, the American Sugar Refinery Company became the Amstar Sugar Corporation, the nation's largest cane sugar refiner. The Chalmette refinery is the largest of the corporation's three refineries, and is the largest in the southern United States. Amstar Sugar Corporation markets grocery, industrial, and institutional sugar products under the well known Domino® trademark.

In addition to the production and packaging facilities located at Chalmette, Customer Service, Purchasing, Financial, and the District Sales Offices are located at the refinery. Nearly 400 people are employed at the plant, and many more in the community are employed by companies that provide goods and services to the plant. The Chalmette refinery is the largest employer in the community, and as such is an important element in the local economy.

Raw sugar handling

Raw sugar in ocean-going ships and barges is received at the refinery's 1100 foot long dock. Water depth alongside the dock exceeds 45 feet year-round, easily accommodating the largest raw sugar vessels. Cargoes exceeding 35,000 tons have been discharged at Chalmette. Raw sugar supplies from around the world have been processed by the Chalmette refinery. Currently, the major suppliers include Louisiana, Hawaii, Texas, Florida, and various countries in the Caribbean basin.

Vessels are discharged using two movable Colby cranes equipped with 5-tons capacity clamshell buckets. Each crane is capable of handling 350 tons of raw sugar per hour. From the cranes, the sugar is conveyed by belt to a 15 tons capacity Parsons receipt scale where it is weighed and continually sampled. The samples, and the weight of the sugar are used for settlement purposes. After weighing and sampling, the raw sugar is conveyed directly to processing or to two raw sugar warehouses, with a combined storage capacity of 80,000 tons.

Raw sugar in trucks from local producers is discharged directly to the raw sugar sheds after weighing and sampling. When raw sugar is not being discharged at the dock, it can be reclaimed from the storage warehouses and introduced to the process with a large front-end loader.

Affination

Raw sugar is introduced to the first step in the refining process in the wash house. Here, the sugar is again weighed and sampled in order to account accurately for the input to the process on a daily basis. After weighing, the sugar is blended with affination syrup in two minglers to a controlled magma consistency. Affination syrup addition to the minglers is controlled by monitoring the motor load on the mingler drive motors. Both minglers overflow to mixers which feed sixteen Western States centrifugals (48 × 30 inches). Wash times on the centrifugals are determined through laboratory colour and purity analysis of the whole, and washed raw sugar, along with historical values on previous shipments of raw sugar from the same source.

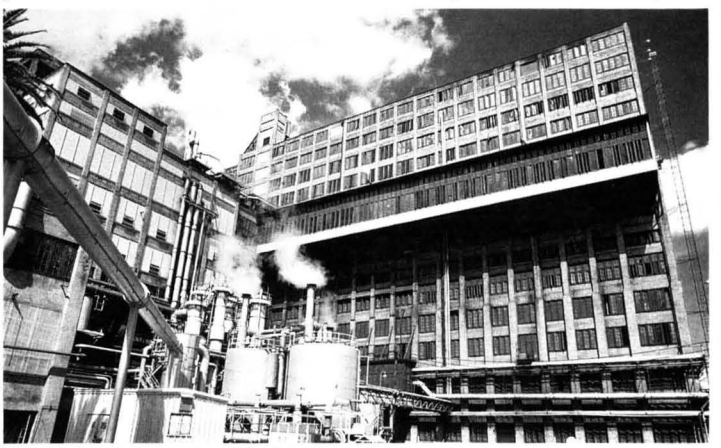
After washing, the raw sugar is melted (dissolved) in high purity sweet water, and is automatically adjusted to 68° Brix and 7.4 pH. Affination syrup collected from the centrifugals is automatically adjusted to 7.0 pH, and is either re-heated and applied to the incoming raw sugar, or directed to the remelt, or recovery side of the refinery.

The melted washed raw sugar, called washed sugar liquor, is blended with melted sugars recovered from the remelt operation. The combination of

washed sugar liquor and remelt liquor is called melt liquor. Melt liquor is pumped to the carbonatation station for further processing.

Carbonatation

The carbonatation process used is conventional, with subjection of the melt liquor to the action of carbon dioxide after treatment with milk of lime. The total residence time in the three saturator bodies is about three hours. After carbonatation, the calcium carbonate, along with the entrapped particulates, colorants, and some ash constituents, is physically separated by Sweetland press filtration of the melt liquor. Twelve deep-bodied presses are dedicated to melt liquor, and four are reserved for sweetening-off the calcium carbonate once it is discharged from the primary presses.



Carbonatation station (left-centre), filter/char house (background right) and pan house (background left)

Decolorization

Two sets of bone char filters are used at Chalmette to produce low coloured and low ash liquors for the production of white sugars and soft (brown) sugars. Typically, on No. 1 set, which is the highest quality char, once-filtered "A" liquor is followed by press-filtered melt liquor. Some sugar syrup for the production of liquid sugars is also filtered on No. 1 set. On No. 2 set, in addition to once-filtered "A" liquor, and press-filtered melt liquor, soft liquor, for the production of soft sugars, is also filtered.

Once the capacity of the filter to remove colour and ash is exhausted, the char is washed with hot water for 30 hours. After washing, the char is revivified in eighteen natural gas fired pipe kilns at 1025°F to 1050°F.

Evaporation

"A" liquor evaporation is performed in a Blaw-Knox falling film triple-effect evaporator. Decolorized liquor from char filtration is fed at 66° Brix to the evaporator, where water is removed at the rate of 45,000 pounds per hour. The density of the evaporator discharge is monitored by a Dynatrol instrument, which regulates steam flow to the evaporator. Sweet water evaporation is accomplished utilizing vapours from the last body of the "A" liquor evaporator.

Pan house

Six white sugar vacuum pans of 2000 cubic foot average capacity are utilized in a straight four-boiling scheme to produce white sugar.

Four mixers of various capacities feed the white magma to twenty-four Western States batch centrifugals (48 × 30 inches). Drying of the sugar is handled by six rotary granulators. Wet sugar enters the granulators at 1.0% moisture, and exits at 130°F and 0.03% moisture.

Following drying, the white sugar is scalped through three Rotex screeners prior to conveying to one of six U-bins. The U-bins allow the sugar to repose before final conditioning takes place in the conditioning silos. At Chalmette, all four white strikes are blended into a single stream for conditioning, screening, and end-product use.

On the remelt or recovery side of the pan house, three pans of 2000 cubic foot average capacity are used in a three-boiling scheme to produce high, medium and final strikes. All remelt strikes are spun in nine Western States CC-3 continuous centrifugals (34 × 34 inches). The final strikes are cured in three batch crystallizers prior to spinning.

Melted high and medium sugars are combined to produce the remelt liquor stream that will be mixed with the washed sugar liquor streams just prior to carbonatation. Melted final sugar is used to boil high or seed strikes.

A tenth pan is used exclusively for the production of natural soft sugars. Various grades of soft sugars are spun in batch centrifugals, and then conveyed to the packaging lines.

Conditioning

Initial drying of the sugar is accomplished in rotary granulators. After reposing in the U-bins, the sugar is distributed into two conditioning silos. In these silos, sugar flows counter-current to conditioned air that is introduced through a distribution system on the bottom of the silos. Residence time in the silos is about twenty-four hours, and the conditioned sugar exits the silos with a moisture of about 0.015%.

Following conditioning, the granulated sugar is separated using twenty Rotex screeners to produce sugars meeting the particle size requirements of various company, and customer specifications.

Amstar Sugar Corporation's Chalmette cane sugar refinery

Packaging

The various industrial and grocery packaging operations are located on two floors of the refinery's Production Centre. Granulated sugar is packaged in 2, 5, 10, 25, 50, and 100 pound bags, along with 2 pound cartons, and heat-seal packets. Additionally, granulated sugar is packaged in 4, 40, and 50 kilogram bags for export.

Granulated sugar is milled to produce confectioners or powdered sugars in various grades. Confectioners sugars are marketed in 2, 25, 50, and 100 pound bags, and 1 pound cartons.

In conjunction with production of white sugars, natural brown or soft sugars are produced in various grades. Soft sugars are packaged in 2, 25, 50 and 100 pound bags, and 1 pound cartons.

Liquid sugar

At Chalmette, No. 1 Sucrose Syrup, and Crystal Fifty Invert Syrup are produced to meet various customers specifications. Sucrose syrup is produced by melting wet fine granulated sugar collected prior to the granulators. The melted sugar is treated with activated carbon, filter aid, and is press filtered in two Pronto presses. Crystal Fifty Invert Syrup is produced with the same equipment, except it is acid-hydrolysed, and flash evaporated to higher density. Finished liquid sugars are shipped via truck or rail.

Shipping

Finished products are shipped out of Chalmette by truck, rail, barge, and by ship. In addition to a covered loading dock that can accommodate eighteen trucks for simultaneous loading, package rail cars can also be loaded under cover. Bulk loading of trucks, sea vans, and rail cars is accomplished in a separate covered bulk loading station.

Laboratory

Around the clock laboratory services are provided to the refinery. Technical control, finished product, microbiological, and environmental testing are all carried out at the refinery. Incoming raws, and other incoming products are tested both at Chalmette, and at the Corporation's Operations Laboratory in Brooklyn, New York.

Turbogenerators for supplying power to the refinery

Refinery services

In addition to local utility-supplied electricity, three turbo-generators are used as required to provide electrical power to the plant. Total capacity of the three turbo-generators is 11,970 kVA (9000 kW).

Seven boilers of various capacities, totalling 375,000 pounds of steam per hour, are available for use in the refinery. Potable water for processing and other uses is produced by the refinery's water treatment plant.

Complete engineering, and maintenance support is provided to the plant through the maintenance, machine, electrical, instrument, iron, millwright, and pipefitter shops. Inventories of parts necessary to maintain the plant are kept on-site.

Waste-water treatment plant

In order to ensure compliance with environmental regulations, a biological oxidation treatment plant is used to treat waste-water containing small quantities of sugar from the char washing operations.

Brazil sugar exports, 1988[1]

	1988	1987
	tonnes, raw value	
Algeria	15,000	103,207
Angola	22,659	17,162
Bulgaria	63,146	25,000
Cape Verde	0	10,285
Chile	3,742	15,806
China	363,432	0
Egypt	142,745	28,092
Finland	0	12,000
Haiti	17,105	0
India	0	223,505
Indonesia	27,715	77,023
Iran	158,196	135,813
Iraq	101,089	348,676
Jamaica	23,817	21,652
Jordan	41,683	44,863
Kenya	0	30,661
Malaysia	15,590	17,800
Morocco	97,000	124,000
Nigeria	22,521	239,202
Pakistan	27,281	0
Paraguay	0	2,393
Peru	38,975	90,723
Portugal	0	43,800
Sri Lanka	40,841	35,668
Sudan	0	34,521
Sweden	24,000	0
Syria	12,991	0
Tunisia	11,400	25,200
Uganda	0	31,125
USA	126,648	121,568
USSR	193,397	620,554
Venezuela	82,061	43,750
Yugoslavia	12,600	0
	1,685,634	2,424,049

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S9, S95.

Distribution of magnesium and silicon in resin used for desalting of technical sugar solutions

By Fumio Maekawa*, Kohji Kawasaki*, Kiyoshi Maekawa†, Masahiko Komoto‡and Satoshi Fujii‡

Introduction

A reverse ion-exchange system has been developed and operated for both decolorization and deionization of sugar liquor at the C. Itoh sugar refinery since 1974. In this system, strongly basic anion exchange resins (AER) have been used in their hydroxide form as well as in their chloride form.

The refinery has confronted some problems in the operation of the system. A serious one was that the resin in the hydroxide form shows a tendency to deteriorate easily during repeated use and consequently to become hard to regenerate with NaOH. It seemed that the deterioration or fouling was caused by accumulation of both insoluble inorganic substances and organic colouring matter[1-3] which were difficult to remove by the ordinary method of regeneration. An effective restoration method needed to be developed.

Examination of the development of economical methods suggested that the most effective was the treatment of the fouled resins with 4% HCl at 70°C, followed by 10% NaCl solution containing 1% NaOH and at the same temperature. This method has been adopted in a modified reverse system (the MAK system[4]) at the refinery, and has performed well. In the course of further research the accumulation of organic colorants in the used resin and their behaviour during elution by several restoration methods tested have been investigated in detail[1,5]. Elucidation of the state of accumulation and elimination of the inorganic substances were also attempted.

Fumio Maekawa

Kohji Kawasaki

Kiyoshi Maekawa

Masahiko Komoto

Satoshi Fujii

Results of an atomic adsorption analysis of the ash in fouled resins suggested[1,3] that the inorganic contamination was ascribable to accumulation of Mg and Si compounds. In order to study the restoration effect, it was necessary to examine what part of the resin suffered from the inorganic contamination and which restorative method is effective for the removal of the fouling.

Recently, various apparatus for local analysis have been developed. An EPMA X-ray microanalyser is one such and makes it possible to analyse elements over a small area. We employed an EPMA apparatus to elucidate the distribution of the inorganic contaminants and their response to regenerants applied to the resins.

Materials and methods

Resins: The resin used was Amberlite IRA-900(OH), a strongly basic quaternary ammonium anion exchange resin. Fouled resin (FR) was Amberlite IRA-900 resin that had been used for more than 20 cycles in a reverse desalting system at the C. Itoh sugar refinery. Restored resin were: Rr-1 (FR treated with 4% HCl at 20°C); Rr-2 (FR treated with 4% HCl at 70°C); and Rr-3 (FR treated with 4% HCl at 70°C followed by 10% NaCl solution containing 1% NaOH).

Specimen preparation: Sample resins were air-dried and sliced with a microtome in a conventional manner. A round piece of the sliced resin was cemented onto a polished brass block with a adhesive to give a flat surface and cleaned throughly with ethanol. The surface was coated with a layer of carbon.

Instrumentation: A Shimadzu EMX-SM electron probe X-ray microanalyser equipped with a Philips EDAX-9100 energy dispersion (ED) system was used in this study with an accelerating voltage of 20 kV and a specimen current of 0.01 μA. ED spectra were collected using an EDAX PV-9900 computing analyser

Table I. Concentration of inorganic substances in fouled resin as determined by EPMA ED

	Edge			Middle		
	AT %	"O" %	% SE	AT %	"O" %	% SE
Na	0.70	1.04	14.35	0.00	0.00	0.00
Mg	10.65	20.72	0.78	0.10	0.18	110.33
Al	1.35	3.33	3.22	1.17	2.77	6.41
Si	19.92	57.77	0.35	20.63	57.86	0.43
S	1.79	8.32	1.69	4.89	21.95	1.18
Cl	1.88	3.22	1.58	9.31	15.40	0.70
Ca	0.07	0.18	28.06	0.04	0.11	93.69
Fe	1.41	5.42	1.87	0.46	1.73	8.71
Others	62.23			63.41		

AT %: Atomic Weight %; "O" %: Oxide %; % SE: Standard Error

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‡ Faculty of Agriculture, Kobe University, 1-Rokkodai, Nada-ku, Kobe, Japan.

1 Maekawa *et al.: Nippon Shokuhin Kogyo Gakkaishi*, 1977, **24**, 366.
2 Fujii *et al.: I.S.J.*, 1980, **82**, 199.
3 Maekawa *et al.: Proc. Research Soc. Japan Sugar Refineries Tech.*, 1978, **28**, 78.
4 Maekawa & Kawasaki: *I.S.J.*, 1985, **87**, 127.
5 Kawasaki *et al.: Proc. Research Soc. Japan Sugar Refineries Tech.*, 1978, **28**, 86.

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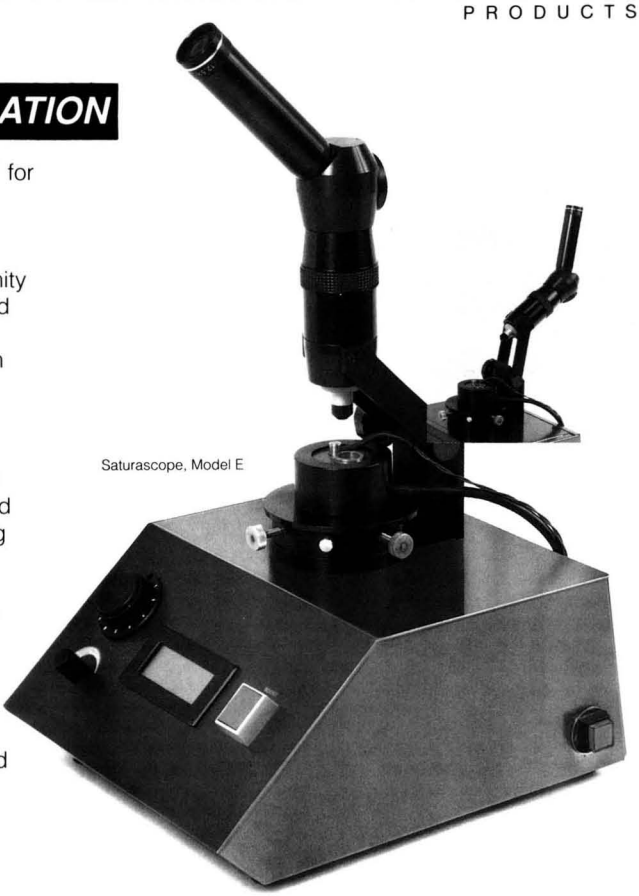
Using a polarised light source, the massecuite is examined through a X150 microscope which allows the crystal melting point to be indicated on the digital indicator. The heating element uses 110/220 volt single-phase A.C. and is provided with a coarse and fine control for the rate of heating.

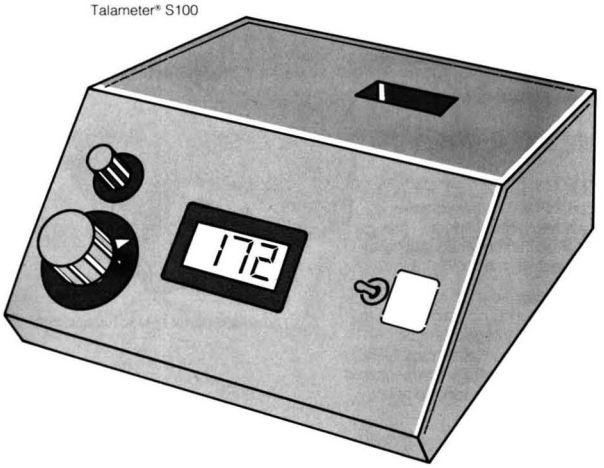
The microscope is attached to the instrument by means of a pivotal mount, thereby allowing increased accessibility to the sample cup and minimum re-adjustment of the focusing system.



Saturascope, Model E

SUGAR COLOUR

Talameter® S100



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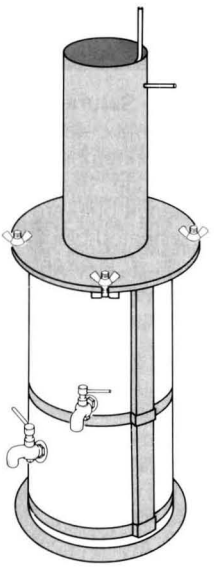
The outer vessel is lagged to prevent heat losses. The spiral conductor tube, surrounded by a water jacket with cooling water inlet and outlet, is permanently connected to the digester body top cover which in turn is fitted to the body by means of thumb screws and rubber gasket.

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



Deerr Type Bagasse Digester

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

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

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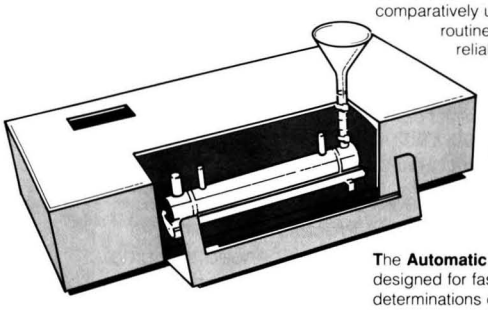
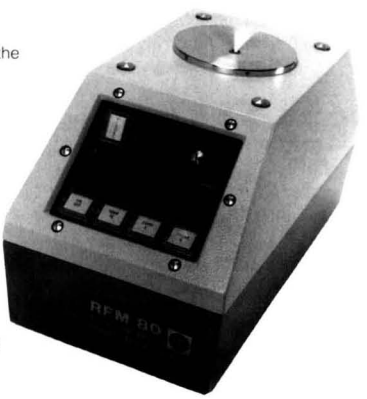


Automatic Digital Polarimeter



Automatic Digital RFM80 Refractometer

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

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

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system (Philips). These were processed using software for a universal quantitative analysis (the QUAN package). Concentrations of elements were obtained from the ED spectra using a Z.A.F. correction. Quantification was carried out by a non-standard method.

Elemental analysis was carried out at the centre of the sliced resin bead and also at the edge, which corresponds to the surface of the whole resin. Line analysis of Mg and Si were performed by scanning across the sliced resin. The analysed resin samples were approximately 1 mm in diameter.

Results and discussion

Amounts of inorganic elements in FR were determined using the EPMA-ED technique. As shown in Table I, the amount of inorganic contaminants were expressed separately in the edge part of the resin bead (the surface of the resin) and the centre. It was found that abundantly accumulated elements were Mg and Si at the edge of the resin and Si, S and Cl in the middle. Other elements were only minor contaminants. When FR was subjected to an ordinary NaOH-regeneration process, Mg and Si were eliminated hardly at all, as has been previously reported[1,3,4]. Consequently, these contaminant elements – Mg and Si – were dealt with thereafter. Figures 1 - 4 show the results of line analyses of Mg and Si in the round-sliced resins which had been treated with various restoration reagents.

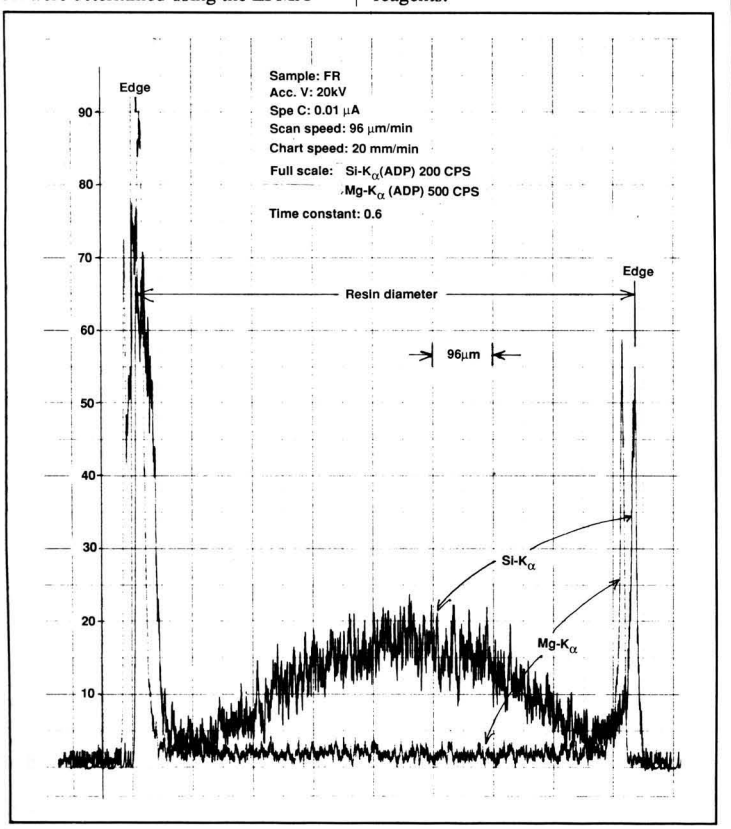

Fig. 1. Line analysis of Si and Mg in fouled resin (FR)

Deteriorations of the AER by magnesium ions has been explained by the fact that a water insoluble hydroxide is formed during contact of the Mg^{++} ion with the resin and is deposited in its matrix. Figure 1 and Table I show that Mg is deposited not throughout the resin but close to the surface. This phenomenon has not been demonstrated using other, older techniques. Treatment of FR with 4% HCl at 20°C resulted in only partial Mg elimination (Fig. 2) although HCl is able to dissolve $Mg(OH)_2$. With hot HCl at 70°C, however, the deposit was almost completely eliminated (Fig. 3). Fig. 4 shows that the Mg compounds could be completely removed by treatment with 4% HCl at 70°C, followed by 10% NaCl solution containing 1% NaOH at 70°C.

Generally speaking, Si compounds are adsorbed only with difficulty on AER, and once adsorbed are easily desorbed using NaOH solution. The present experiment shows that Si compounds accumulated in FR not only on the surface but throughout the bead (Fig. 1 and Table I). The distribution of Si in the fouled resin was not uniform, however; it accumulated predominantly near the surface with little in the intermediate part and then gradually increased toward the centre (Fig. 1).

Variation was observed in the elimination of Si compounds with different restoration methods tested. With 4% HCl at 20°C only small amounts of Si were eliminated from both the edge and middle parts. With hot HCl practically the same amount of Si was eliminated as that with cold HCl (compare Figs. 2 and 3). Thus it seems that there was no effect of the temperature elevation.

On the other hand, NaCl solution containing NaOH, applied after the HCl, showed a remarkable elimination effect and after treatment Si could not be detected practically all over the resin section (Fig. 4). A reverse procedure, i.e. treatment with NaOH/NaCl prior to treatment with HCl, did not have a significant effect (data not shown). At

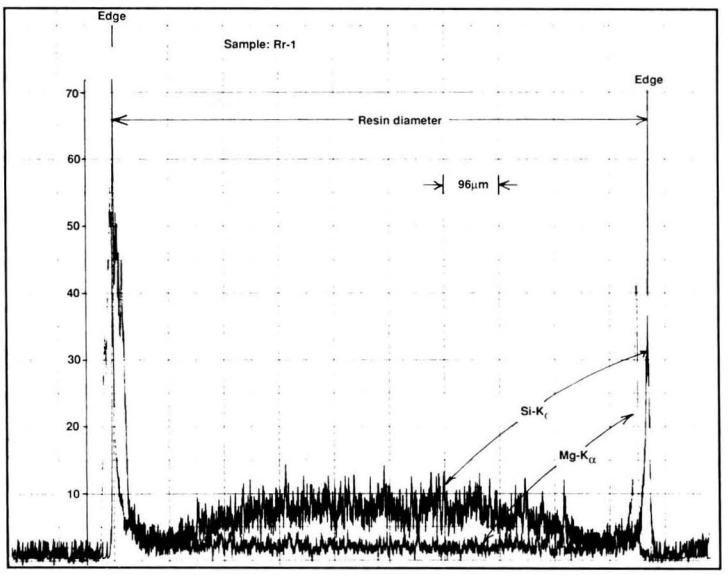

Fig. 2. Line analysis of Si and Mg in restored resin (Rr-1) with 4% HCl at 20°C

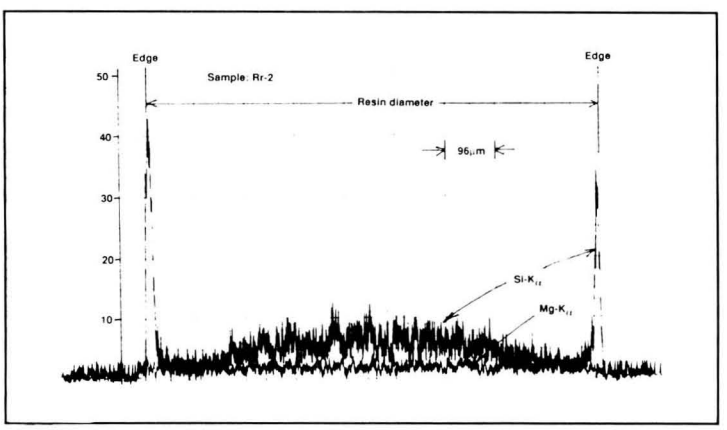

Fig. 3. Line analysis os Si and Mg in restored resin (Rr-2) with 4% HCl at 70°C

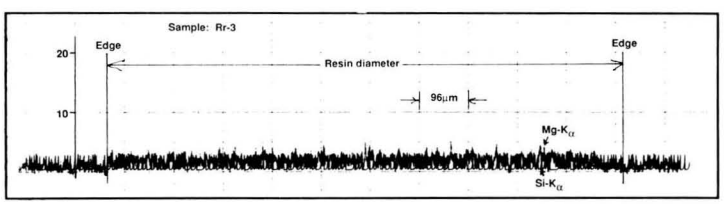

Fig. 4. Line analysis of Si and Mg in restored resin (Rr-3) with HCl the NaOH/NaCl at 70°C

the present time, the structure of the Si compounds accumulated in the fouled resin is unclear. It would seem, however, that both HCl-soluble Si compounds and HCl-insoluble but NaOH/NaCl-soluble Si compounds may be present.

From these results, a plausible explanation for the inorganic fouling of the resins and for the restoration effect may be presented. Mg^{++} ions present in the sugar liquor to be purified first encounter an alkaline environment in the resins. Insoluble compounds, maybe $Mg(OH)_2$, are immediately formed and deposited in the pores near the surface of the resins. Consequently the Mg^{++} ions do not diffuse to the internal part of the resins, clogging up the fine pores.

Silica polymers present in feed solution further plug up the resins, which leads to obstruction of feed solution flow through the pores of the resin and to apparent fouling, although the ion-exchange capacity of the inner part of the fouled resins remain unchanged. It has been demonstrated that the apparently fouled resins showed some residual ion exchange activity when they were powdered[6].

Usually, silicate ions pass through the resins when these are new and, even when they have accumulated on the resin, can easily be removed from the surface by each regeneration treatment. Silicate remaining at the middle of the resins, however, polymerizes gradually and becomes insoluble.

The advantage of the restoration method recommended, namely, the treatment with hot 4% HCl followed by 10% NaCl solution containing 1% NaOH, is in that the first regenerant (hot HCl) dissolves Mg compounds and part of the Si compounds accumulated near the surface, and opens out the plugged pores of the resins, whereby the second regenerants (NaOH/NaCl) can penetrate throughly into the internal part of the resins and can dissolve residual Si compounds. As previously reported, the regenerants can also dissolve organic

(continued on page 97)

6 Maekawa & Kawasaki: Japanese Patent Application (Tokugan) No. 60-145100 (1985).

ISJ Abstracts

Cane sugar manufacture

Reduction of whole raw sugar colour in Hawaii

P. O. S. Skinner. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-8 - F-10.

Causes and measurement of colour are briefly discussed and methods of removing colour in the factory described, including clarification, boiling and centrifugal treatment. Adoption of the *B*-magma boiling scheme is recommended as the best means of achieving a required colour reduction for refining purposes.

High pol raw sugar

J. H. Payne. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-11 - F-15.

See *I.S.J.*, 1988, **90**, 137 - 140.

How sugar colour can be improved

J. C. P. Chen. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-16 - F-22.

After discussing the differences in approach to colour between cane processors and sugar refiners, the author examines sources of sugar colorants and methods of preventing and removing colour; these include cane burning to remove trash (10% of which in processing could be responsible for a 39% increase in *A*-sugar colour), destruction of phenol oxidases in cane by heating at 80°C for 10 minutes (a disadvantage being the treatment time), phenol decomposition by various means, mill sanitation, juice and syrup clarification and the use of surfactants in boiling.

History and development of raw sugar quality in South Africa

A. van Hengel. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-23 - F-25.

An account is given of measures adopted, particularly in South Africa, in order to obtain a raw sugar of high refining quality. Two stages of development are discussed: 1962/75 (during which period adoption of the partial remelt system and enzyme treatment of syrup for starch removal led to a sugar of excellent colour and filtrability but with a subsequent considerable drop in quality after the introduction of continuous centrifugals) and 1975/87 (marked by the introduction of VHP coated sugar and diffusers, with a modified boiling scheme that gave 15% colour reduction and syrup clarification by the Talodura process which failed to reduce molasses sugar content but was proposed as a means of reducing sugar colour). It is stated that, despite the various means used to improve export sugar quality, for a number of reasons the position in South Africa is not as good as it was some 10 years ago.

Syrup separator operation at Oahu Sugar Company

W. F. Dang. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-26 - F-29.

The performances of molasses separators to reduce final molasses purity when aiming for high-pol raw sugar of very low colour are reported. Each separator is installed on a centrifugal and is automatically timed to start operating at the same time as the second of two wash cycles; a water ring flushes molasses from the curb before the next molasses fraction is fed, and the separated low-purity fraction (green molasses) is boiled in the strike of next low purity, while the wash molasses is returned to the same type of strike from which it originated. A purity difference of about 2 units between the two fractions is typically obtained.

Computer-driven automatic welder

L. C. Britton. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-43 - F-44.

Details are given of an automatic computerized welder which is used in the regular overhaul of a French screw press placed after the 4th mill and to machine various cane mill parts at McBryde Sugar Co.

Paia control system

R. P. Lawler. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-45 - F-48.

The various process parameters that are the subject of automatic control are discussed. All of the measured variables are gathered into the main console database for overall plant performance analysis and diagnosis and to allow adjustments to be made to power generation and cane throughput within the limits of the existing conditions under which variations in the boiler steam load must be minimized or smoothed sufficiently to avoid pressure fluctuation.

Updating the Hamakua Sugar Company factory consolidation

J. W. Bersch. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-49.

A brief account is given of the initial phase (involving the power plant) of a program under which Haina factory was to be expanded to allow it to process cane normally supplied to it and to Ookala factory which was due to close. The economics involved are set out.

HSPA factory audits

K. Onna, C. M. Kinoshita, T. Moritsugu, G. E. Sloane, B. J. Somera and R. R. Tamaye. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-50 - F-55.

An audit of nine Hawaiian sugar factories is discussed and recommendations for each process or plant operation are made on the basis of the findings whereby sugar losses can be reduced and improvements made in steam and power generation and utilization. It is shown that about one-third of the monetary savings can be achieved with little or no capital expenditure.

Prepared cane belt transport system and factory waste water system

L. M. Tabata. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-56 - F-59.

A computer-controlled cane belt transport system is described that was installed at Lihue to feed cane to the factory from a cleaner located a quarter of a mile away. The new system, designed to replace a flume and facilitate waste water disposal in fields other than those previously receiving it (which were sold to a hotel group), consists of a collar roll conveyor for final cleaning and transfer of the cane to a knife apron conveyor which feeds to a belt conveyor passing underneath a suspended magnet at the drop-off point; this is followed by the main conveyor along which the cane passes to a switching station chute for transfer to further conveyors feeding two separate mill tandems. The quality of cane preparation by the primary and secondary knives affected the operation of the system; a deterioration in performance led to choking at the transfer points and switching station, with long stalks overhanging the belts, dropping of cane and lodging. Installation of a new set of knives led to a vast improvement in preparation, and a program of regular changing of the knives was initiated; reversal of the rotation of the secondary set gave positive results, subject to suitable clearance and tip speed to avoid excessive amounts of material being passed back to the primary set. The new system resulted in increased sugar recovery and solved the waste water disposal problems.

Constant-horsepower milling trains with turbine-powered hydraulic drives

R. Edlund. *Rpts. 46th Ann. Conf. Hawaiian Sugar Tech.*, 1987, F-60 - F-63.

It is shown how cane mills can be operated at constant horsepower by means of turbine-powered direct hydraulic drives that do not need gearboxes, although there is need for a splitterbox since individual hydraulic pumps are required for independent speed control of each mill in the tandem; however, the limitation of the drive system is the lack of availability of splitterboxes able to handle input horsepower in the range 1000 - 2500 and output horsepower of 250 - 500. Possible solutions are considered, and suitable automatic roller speed control methods described.

Automatic control options for vacuum pans

W. Keenliside. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 135 - 142.

As part of an overall project at the Audubon Sugar Institute aimed at improving the efficiency of boiling house operations and molasses exhaustion in Louisiana sugar factories, a research program was initiated to study crystallization in vacuum pans and to find suitable methods for optimum boiling control. The experimental methods used to sense conditions in the pan are described and preliminary results discussed. Out of four parameters studied, supersaturation was found to be more suitable than conductivity, consistency or mother liquor Brix and has allowed one factory using it for boiling control to reduce its overall sugar loss by about 2% and maintain molasses purity at a more constant level throughout the boiling house. Application of a simple theoretical mass balance analysis to determination of purity changes with massecuite height in low-grade pans is briefly described.

Computer applications in sugar factory operations

A. C. Pilgrim, W. A. Mellowes and K. Abbot. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 143 - 153.

A micro-computer program for laboratory data processing is described which comprises four options: laboratory calculations (including up-to-date manufacturing reports, Brix and pol balances and an evaporator performance report), a report-generating facility to cover any specified period, a graph-plotting facility and a simulation facility to carry out trial calculations and to simulate milling based on a model developed.

The assessment of evaporator performance - a practical PC programmed approach

R. B. Gray. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 154 - 162.

Application of a micro-computer program to assessment of evaporator performance as affected by scale formation is described and the results obtained are discussed.

Automation of cane and juice scales

R. L. A. Lake. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 163 - 171.

Descriptions and diagrams are given of the computerized, load cell-based cane and juice weighing systems at Caroni sugar factories; the operational procedures for both are explained and successful trials reported.

Some trials for improving cane preparation and milling efficiencies

K. Khan. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 172 - 174.

Cane preparation was substantially improved by lowering the number of knife holders on the first set of knives, increasing knife length and reducing the setting, while hooked knives were installed on the second set but with no change in the number of holders. Blockages by cane on the carriers were also considerably reduced by adjustment to the sets. Removing the pinion from the discharge roller on the last mill led to a number of problems in milling and a reduction in the crushing rate, so that the pinion was to be re-installed for the next season.

The Portvale evaporator

M. C. Hutson. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 175 - 187.

The existing quadruple-effect evaporator system at Portvale is designed for a crushing rate of 110 tch. Possible alternative arrangements are described, including modifications that are to be made to the layout of the juice heaters operated on bled vapour at the current crushing rate and for increased crushing rates of 120 and 150 tch.

Bagasse dryers for Caribbean sugar factories

D. R. McGaw and A. C. Pilgrim. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 188 - 194.

The theory of bagasse drying is briefly examined and the suitability of various types of dryers for use in Caribbean factories discussed. Mechanical types are considered unsuitable because of their large space requirements and high capital costs, while bagasse particles in Caribbean factories are too large and of the wrong shape to be suitable for pneumatic/fluidized-bed drying. However, gravity-flow packed-bed systems would possibly meet requirements, and it is suggested that one of two designs (counter- or cross-flow) be built for testing.

The use of dextranase as an aid in the processing of liquors derived from stale cane

G. A. Menezes. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 244 - 254.

In trials at Frome and Brechin Castle factories, addition of Amano Dextranase to syrup being fed to the pan station at 2 ppm on cane weight reduced the dextran content in raw sugar from 374 to 199 mau (milliabsorbancy unit) and from 384 to 245 mau, respectively, and also increased exhaustion to give a lower final molasses purity; even a dosage rate of 1 ppm reduced the dextran level to well below that at which penalties are applied, although continuous dosing is recommended where the initial contents are very high.

Analysis of electric motor-driven systems in the sugar industry: electricity conservation in boiler fans and irrigation pumps

S. F. Baldwin and E. Finlay. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 255 - 268.

Preliminary results from analysis of the performance of a boiler fan at Bernard Lodge factory and of an irrigation pump at Clarendon indicated a significant potential for electricity economy and for increase in the amount of power that could be sold to the utility grid. Details are given of the analytical and diagnostic procedures used.

The advantages of using a high-slip motor for cane knife duty

S. B. Carrington. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 274 - 278.

The benefits derived from replacement of steam engines by electric motors as drives for heavy-duty cane knife sets at three factories in Barbados are discussed and details given of the motor and flywheel characteristics. Experience at the factories has demonstrated the need to use drives having high slip factors of up to 15% in conjunction with large flywheels.

Biomass-fired steam-injected gas turbine cogeneration for the cane sugar industry

E. D. Larson, J. M. Ogden, R. H. Williams and M. G. Hylton. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 279 - 300.

The prospects of using a bagasse-gasifier steam-injected gas turbine to generate sufficient power for sale to the utility grid were studied. In a proposed scheme, some of the air from the compressor of the turbine would be fed to the pressure gasifier and the rest used to burn the gas in a combustor (after removal of particulate material from the gas); the hot turbine exhaust gases would be used to raise steam in a heat recovery steam generator, some of the steam then being used to operate the gasifier and the remainder used for process or injected into the combustor to increase both power output and electrical efficiency. A case study based on Monymusk factory operations indicates favourable economics by comparison with a steam turbine under both Jamaican and Brazilian conditions and would generate electricity at a cost lower than that produced by alternative installations such as hydroelectric power stations.

The origins of colour in Jamaican raw sugar

W. Ricketts. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 301 - 309.

Crusher and mixed juices from the milling stations of two factories as well as clarified juice and intermediate process samples were analysed for phenols and the colour of juices and raw sugar measured as absorbance. Results showed a correlation between raw sugar colour and its phenol content ($r = 0.79$). The relative contributions to sugar colour of colorants present in the cane and those formed during processing are discussed. At both factories the level of sugar colour was higher than the average for Jamaica and the amount of extraneous matter was also high; one factory also processes a relatively large amount of green cane.

A review of the double purging of low-grade massecuite at Guysuco factories

G. H. E. James. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 311 - 318.

Details are given of the double purging of *C*-massecuite at four Guyana sugar factories which also practise 2-massecuite boiling. When juice purities are sufficiently high (78 - 79), 1st-purge magma in excess of that needed for 2nd-purge footing is remelted and mixed with syrup for boiling in high-grade pans; for juice purities no higher than

70, all of the 1st-purge magma is subjected to the 2nd purge and the excess magma of approx. 90 purity remelted and boiled with the syrup in the high-grade pans. Results included a 6-unit rise in purity of the magma, a 1-unit rise in the *A*-massecuite boiled from it (despite a fall in juice quality at three of the factories) and a fall in raw sugar colour. Elimination of massecuite additives at three factories and a reduction in their use at the fourth plus a cut in operating maintenance have helped towards the costs of converting the low-grade stations (including installation of a second battery of centrifugals).

First results on the operation of a small-scale sugar factory based on cane separation

H. C. C. Bourzutschky and W. O. Ricketts. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 320 - 336 + iii.

An account is given of the development of the Tilby cane separator[1] and of a unit of 10 tonnes/hr nominal cane capacity installed in a small-scale factory in Jamaica together with a single-spindle press for juice extraction from the pith. Details are given of the operation of the plant and of its performance in trials in 1987. The rind:pith separation ratio averaged 35 - 40:65 - 60 with a best value of 26 - 28:74 - 72 compared with a desirable ratio of 20 : 80 or better. The cane and juice quality was poor, with very high invert levels and low pH, and cane variety and maturity appeared to have greater influence on extractor performance than significant quantities of rind in the pith, so that no conclusions could be drawn on juice extraction; extracted pith contained 45.76 - 51.95% moisture and 4.74 - 7.34°S. The juice was twice screened and mud removed by centrifuge. It is planned to sterilize the juice for production of a cane juice beverage, to concentrate it to yield a table syrup or to crystallize it to provide an amorphous sugar; however, neither the high-concentrator nor the crystallizer were operable because of the need for a functional Brix meter. It is also planned to produce charcoal from the separated rind. The pith is used as boiler fuel. Information is given on the energy consumption and economics of the system. The main objective is to provide an alternative to normal cane processing which would be suitable for small cane areas (2 - 4 acres). An investment of US$6 million would provide a plant to process about 105,000 tonnes of cane annually.

Results of core sampling tests done in Jamaica in 1986 and 1987

E. Finlay. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 341 - 353.

Tests were conducted at six factories in 1986 and at one of these (New Yarmouth) in 1987 using a Santal TA horizontal core sampler as a possible alternative to the cane evaluation system based on 1st expressed juice analysis and a calculated average weekly cane fibre content for each supplier. The core sampler, having a 1300 mm tube of 200 mm diameter, removed a 20 - 30 lb sample per load; this was then prepared by a Rietz prebreaker, mixed thoroughly by hand and a 1-kg sample removed for juice extraction by hydraulic press. Core sampling gave higher Brix and pol values because of the diluting effect of cane washing on crusher juice; at two factories where cane was not washed or only to a minimum degree, core sampling gave juice analyses close to those of factory crusher juice. The core sampling method also allowed determination of individual fibre contents in each cane load and was not affected by the point at which the sample was taken. From the results at New Yarmouth in 1987, high positive correlation (r = 0.91) was found between bagasse % cane (press residue) and fibre % cane as expressed by: 0.389 bagasse % cane + 1.357.

Acetic acid production in cane diffusers and the resultant effect on vapour pipe corrosion in evaporators

K. J. Schäffler. *Paper presented at Conf. on Sugar Processing Research*, 1988, 11 pp.

Serious corrosion of vapour and condensate pipes at Felixton factory in South Africa was caused by high levels of acetic acid in vapours as a result of lime addition in the diffusers; as found by Ivin *et al.*[2], acetate esters in the hemicellulose fraction of bagasse may hydrolyse in the presence of lime to form Ca acetate, and the investigations at Felixton revealed approx. 90% of the acetic acid in evaporator juices to be in this form. Omission of liming caused a fall in acetic acid to an acceptable level, although additional ester hydrolysis appeared to occur in clarification and mud filtration. A simple model was developed to show the combined effect of pH and temperature on acetic acid formation.

Effect of extraneous matter on millers' and growers' costs

W. B. Clarke, M. R. Player and G. H. Weiss. *Proc. 10th Conf. Australian Soc. Sugar Cane Tech.*, 1988, 39 - 46.

The financial effect of extraneous matter, especially dirt, is examined using mathematical models to describe three modes of factory operation: (1) where the length of the season, crushing rates and efficiencies are maintained by ensuring that sufficient plant is installed and the value of increased dirt in cane is given as the cost of the extra plant and additional operating costs involved; (2) where the season is unchanged and all the cane is crushed but the plant efficiencies are governed by the ease or difficulty of the task as a function of dirt content and no additional equipment is used; and (3) crushing all available cane and adjusting the length of the season to maintain plant efficiencies at a specified level as a function of dirt content. The three systems and their financial implications are analysed and their applicability to the Australian sugar industry discussed.

1 *I.S.J.*, 1980, **82**, 96; 1981, **83**, 296 - 300; 1984, **86**, 23A; 1985, **87**, 102A.
2 *ibid.*, 1988, **90**, 72A.

Beet sugar manufacture

Laboratory evaluation of the efficiency of anti-scale preparations

H. Gruszecka. *Gaz. Cukr.*, 1988, **96**, 95 - 96 *(Polish)*.

The effectiveness of Antiprex (a product of Allied Colloids Ltd.) as an anti-scale agent in Polish sugar factories is noted and a method described for appraising anti-scale agent performance based on increase in solubility of Ca sulphate when the preparation is added; the aqueous sulphate solution is evaporated until it becomes turbid, and a graph drawn of Ca sulphate concentration (as determined with 0.01M EDTA) *vs.* change in solution volume. Application of the method showed that Kebo-DS (manufactured by Keller & Bohacek) and a Polish preparation gave almost the same results as Antiprex; all three were used at 50 ppm.

Microbiological tests in sugar production

L. Kerekes. *Sugar Tech. Rev.*, 1988, **14**, 119 - 135.

Investigations in Hungarian factories showed that heat processes do not kill all the spores of *Bacillus stearothermophilus*, while increase in the number of aerobic acid-forming sporulating thermophiles in thick juice result from secondary infection in the vacuum pans and crystallizers and not from juice infection. Although the work of the centrifugals ensures that the number of thermophiles in white sugar is considerably lower than in the massecuites, aerobic mesophiles and secondary fungi make up a heterogeneous microbial/mycofloral population. However, improvements in the levels of hygiene in factories have brought about a positive change in the microbiological standards of Hungarian sugar. (See also Kerekes: *I.S.J.*, 1987, **89**, 73A.)

Technological membrane separation processes in the food industry: a review

V. N. Golubev and A. D. Tsintskiladze. *Izv. Vuzov, Pishch. Tekh.*, 1988, (3), 14 - 21 *(Russian)*.

A survey is presented of membrane separation processes, including the application of electrodialysis and ultrafiltration of raw juice to remove colloids and other non-sugar material such as nitrogenous compounds, and the use of semipermeable membranes of high selectivity to concentrate sugar solutions by reverse osmosis.

Examination of recrystallization conditions during massecuite boiling on a plane heat exchange surface

S. I. Potapenko, A. I. Ukrainets and I. S. Gulyi. *Izv. Vuzov, Pishch. Tekh.*, 1988, (3), 62 *(Abstract only)*.

The hydrodynamic properties of a bed of massecuite were determined from analysis of the velocity profiles which showed that movement of the massecuite was governed by the temperature patterns throughout the height of the bed. It was found that recrystallization conditions during massecuite boiling on a plane heat exchange surface were occasioned by migration of crystals in the boiling massecuite and by the hydrodynamic and temperature characteristics.

The alkaline extraction of sugar beet

J. Ponant, S. Foissac and A. Esnault. *Zuckerind.*, 1988, **113**, 665 - 676 *(English, German)*.

See *I.S.J.*, 1989, **91**, 17A.

A centrifugal beet slicer with annular suction

Z. Ya. Telis and V. I. Labai. *Sakhar. Svekla*, 1988, (4), 44 *(Russian)*.

Annular ducting around the inside top edge of a centrifugal slicer is designed to draw off steam injected into the slicer during operation so as to keep the knives clean. It is of approximately triangular section with the base of the triangle sloping down towards the wall of the drum and provided with downward sloping slots; for the sake of evenness in the removal of the steam, the slots are identical in width but are of increasing length with distance from the pipe linking the ducting to an exhaust fan. Angled deflection pieces in front of the slots prevent their blockage. The steam escapes through apertures in the knife frames and then, under the effect of centrifugal force and the force created by the difference in density between descending air and the steam, follows a vertical path up to the ducting where it is drawn off in a horizontal stream. The system improves working conditions and reduces heat consumption.

Pre- and main liming under plug flow conditions

L. M. Khomichak, N. A. Arkhipovich, S. P. Olyanskaya and V. A. Kulikov. *Sakhar. Svekla*, 1988, (4), 45 - 47 *(Russian)*.

Wide scatter has been found in the juice residence time in linked preliming and main liming vessels designed to provide complete mixing of the contents. To overcome this and attendant problems, a vessel has been designed for preliming and cold and hot main liming; it consists of two horizontal rows (one inverted) of vertical U-shaped sections with their dividing walls ending alternately short of the top and bottom, so that flow follows a zigzag course. Raw juice is fed at the base and recycled carbonatation mud towards the top of the first section; milk-of-lime enters the top of this section through a series of feed pipes from a manifold and is distributed in the preliming sections and cold main liming sections through horizontal grids formed by perforated tubes at different heights. The number of sections for preliming and the two main liming stages is determined by their height and the process temperature. After cold liming, the juice is pumped through an external heater before returning to the system for hot liming at 85 - 90°C. The juice residence time in the individual sections is dependent on the optimum hot liming

period, while the flow rate must be at least 0.033 m/sec to prevent back-mixing and settling of particles at the bottom of the sections. Pilot plant tests at a sugar factory supplying hot raw juice (so that cold liming was not possible) demonstrated the superiority of the system over conventional treatment in terms of reduced 2nd carbonatation juice lime salts and colour contents. Best results were obtained by recycling 2nd carbonatation juice; omitting 1st carbonatation mud recirculation gave better results than with recycling but gave a much lower settling rate.

A unit for press water treatment

N. N. Krutikov, V. A. Boldyrev, B. N. Zharik and L. M. Osadchii. *Sakhar. Svekla*, 1988, (4), 47 - 48 *(Russian)*.

A system for press water treatment comprises a collecting tank where gases are drawn off, a surge tank, a separator with parabolic screen feeding the water by gravity to another collecting tank, sterilizer, settler and heat exchanger which raises the temperature of the water entering the diffuser to 68 - 72°C; the nominal throughput is equivalent to 6000 tonnes of beet/day and trials showed a pulp content reduction to 0.2% on beet.

A contact heater for fuel oil

V. A. Tsymbal and A. F. Karpenko. *Sakhar. Svekla*, 1988, (4), 48 - 50 *(Russian)*.

Details are given of a compact, vortex ejector-type oil preheater and its performance at a sugar factory. Boiler water is used as heat carrier and forms an emulsion with the oil which burns with a short, bright straw coloured flame and at lower excess air than non-wetted oil. Tests on a 35 tonnes/hr Skoda boiler at a sugar factory showed that boiler efficiency rose by approx. 0.30% provided the water content in the emulsion did not exceed 10%.

Reducing sugar losses in flume-wash water

A. L. Shoikhet, L. I. Chernyavskaya, A. I. Sorokin, A. P. Pustokhod and M. P. Gorodnik. *Sakhar. Svekla*, 1988, (4), 52 - 54 *(Russian)*.

Methods are described for establishing the actual quantities of water used for fluming and washing and the residual amount in mud from settlers as a step in calculating sugar losses. Experience at one sugar factory is cited to show how sugar losses may be decreased by minimizing damage to beets, cutting the time the beets are in the water, removing beet pieces and tails, and ensuring a water temperature no higher than 20°C and a pH no lower than 8.5.

Water as a basic melassigenic agent

T. P. Khvalkovskii. *Sakhar. Svekla*, 1988, (4), 54 - 56 *(Russian)*.

It is pointed out that water, by dissolving both sucrose and non-sugars, is melassigenic and that molasses sugar can be reduced only by decreasing the water content, increasing low-grade massecuite exhaustion by lowering the crystallization temperature and reheating this massecuite before centrifugalling so as to reduce the viscosity of its run-off. A table is given of the melassigenic coefficients of specific non-sugars as affected by dilution with water, and a method for setting molasses standards is described.

Recent experiences with a new foam oil for the control of foam in a beet sugar factory

S. M. Radford and J. R. Elvin. *Paper presented at Conf. on Sugar Processing Research*, 1988, 17 pp.

A Tate & Lyle anti-foam agent, Talox A, based on a block copolymer of ethylene oxide and propylene oxide and effective at high temperatures, proved excellent in eliminating foam that had formed in diffusion and in preventing foam formation. In trials at four factories in the 1986/87 campaign, use of a dosing system specifically designed for its use allowed between 38% and 47% less Talox A to be required than another anti-foam agent previously used at the factories; this allowed a cut in the costs of treatment despite the fact that Talox A is more expensive than most anti-foam oils on the market. For the Steffen process, requiring an anti-foam agent active over a wide temperature range (10 - 90°C), Talox DS proved more effective in trials than the product used previously and at a 10% lower consumption.

Observations on colour development in stored sugar samples

J. A. Richmond. *Paper presented at Conf. on Sugar Processing Research*, 1988, 17 pp.

Problems in the form of colour formation and excessive ash in sugar at Holly Sugar Corporation was a result of storage at high temperatures and reductions in wash water consumption in the centrifugals. While the introduction of dry air conditioning of sugar in one of the silos for a minimum of 24 hr reduced the rate of colour development during storage, and modifications to juice purification resulted in juice of lighter colour and greater thermal stability, the decrease in wash water consumption had an adverse effect and was seen as a false economy.

The rheological properties of filtration mud from 1st carbonatation juice

I. A. Oleinik, M. Kh. Likhitskii, R. M. Polishchuk and K. I. Bazhal. *Sbornik Pishch. Prom.*, 1988, **34**, 51 - 52 *(Russian)*.

The critical shear stress of filter cake was determined as a function of flocculant usage and time of contact between the dispersed particles in the range from 1 - 120 min. The results showed that under satisfactory settling and filtration conditions the critical shear stress rose considerably as a result of flocculant addition and became still greater with increase in flocculant usage and time of contact between particles.

Sugar refining

Continuous vacuum pan operation at Colonial Sugars Inc.

E. O. Betancourt, J. L. de Chazal and J. D. McCulla. *Paper presented at Conf. on Sugar Processing Research*, 1988, 12 pp.

The Langreney continuous vacuum pan, Type CA, installed at Colonial Sugars Inc. is a vertical cylindrical vessel with three massecuite circuits; a larger external annular space houses a floating calandria and is divided into an outer and inner circuit C1 and C2, respectively, by a vertical baffle, while the inner cylinder is the third circuit C3 having about one-sixth of the total heating surface and provided with a stirrer which allows the massecuite to be heavied up. Cross-sectional baffles above the calandria restrict sideway movement and divide C1 and C2 each into six sectors in which the heating surface increases from inlet to outlet to allow a higher boiling rate as the grain develops and moves towards the exit. Each sector is provided with a sampler and a resistance thermometer that transmits a signal to a programmable controller for calculation of supersaturation; the tubes in each sector are laid radially and equidistantly to prevent dead spots so as to maximize natural circulation which is further increased by the conical bottom of each circuit. Intermixing of growing crystals with incoming seed magma is prevented by baffles in the 1st sector at five points above the calandria. Syrup drinks are fed from two manifolds above the pan, higher-purity liquor going to C1 and lower-purity liquor to C2; each manifold contains 30 dosing tubes, five per sector. Details are given of the pan instrumentation, automatic microprocessor control and of the high remelt boiling process for which the pan is used; a mixture of concentrated sweetwater and affination syrup having a purity of 80 - 86 is fed to C1, while C2 receives a liquor of 59 - 65 purity which is the separated wash portion from the high remelt centrifugals plus repurged crystallizer sugar, and C3 is used to boil back the syrup from the remelt strike at approx. 51 purity. An uninterrupted stream of seed grain prepared in a batch pan is fed to the continuous pan at a pre-selected flow rate. By comparison with the 2-strike system used previously, application of the continuous pan has raised the average purities of the high remelt sugar without increasing the amount of wash water used in the centrifugals, and exhaustion in the high remelt station has improved by 12.9%. Benefits of the new installation include considerable flexibility in massecuite purity control and the ability to cope with process or raw sugar abnormalities.

Statistical quality control in the sugar industry

L. Fitzgerald. *Paper presented at Conf. on Sugar Processing Research*, 1988, 21 pp.

The aims and implementation of a statistical quality control scheme are explained.

Effects of grain size and moisture on white sugar quality

R. Priester. *Paper presented at Conf. on Sugar Processing Research*, 1988, 8 pp.

In investigations at Savannah refinery, bagged sugar of high and low moisture content (0.055% and 0.025%, respectively) was stored for 1 week in an environmental chamber at 120°F and 40°F and 90% and 30% R.H. before a further week's storage in a normal air-conditioned room in which the conditions (75°F and 50% R.H.) were typical of those found in a grocery store. The low-moisture sugar initially exposed to the high relative humidity, regardless of temperature, was found to be hard after the 2nd week, while that stored at an initial low R.H. was free-flowing, again regardless of temperature. The high-moisture sugar was found to be hard at the end of the experiment where it had been initially exposed to the higher temperature at either R.H. level, while the lower R.H. and lower temperature were the best initial conditions under which the high-moisture sugar was free-flowing after the 2nd week. On the basis of these results, packaging materials were selected that would allow the sugar to remain free-flowing under widely fluctuating environmental conditions while a protection sheet coated with a moisture barrier was placed on each pallet to prevent moisture migration into the sugar that had occurred on occasions and caused caking. A new white sugar vacuum pan was installed and a number of controls introduced in the pan station so as to ensure a more consistent grain that would dry better in the centrifugals and granulators and meet customer requirements. A sugar aeration and wet deduster system is being installed in a silo for which the design criteria are an input and output sugar temperature of 135°F and 100°F, respectively, and corresponding moisture contents of 0.070% and 0.0125%.

Optimization of condensate recovery at Hulett Refineries

D. J. Tayfield. *Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc.*, 1988, 90 - 93.

During 1977/85, the refinery in question used boiler make-up water at an average rate of 20% on total boiler feed. In recent years much effort has been spent on reducing this rate by providing means for recovery of additional condensate from process vapour. Modifications to the system included conversion of a shell-and-tube heater (previously used to heat process water) for use as a spare hot water heater or as a condenser for 2nd effect vapour, installation of a new condenser able to handle a wide variation in load from a small amount of surplus vapour not treated in the shell-and-tube condenser, and adoption of a new vapour control system. Wherever possible, direct injection heating with steam or vapour has been replaced with indirect contact heat exchange to allow recovery of condensate. Introduction of the changes has reduced the make-up rate to 12%.

Laboratory studies

Laboratory studies on *Pseudomonas paucimobilis*

B. Dewar and V. Wang. *Paper presented at Conf. on Sugar Processing Research*, 1988, 19 pp.

Details are given of laboratory investigations on a micro-organism, *P. paucimobilis*, hitherto unknown at Redpath refinery where it was found in large numbers as yellow pigmented colonies. The source was eventually traced to a storage tank used for a non-standard product called Low Colour Sucrose as well as serving as a back-up tank during heavy sucrose production runs and thus employed only intermittently; unlike other storage tanks at the refinery, the one in question has a sump which was never fully drained before normal sanitation and could thus act as a breeding ground for bacteria. Adoption of an adequate cleaning procedure solved the problem.

Sucrose losses in sugar and food processing - effects of impurities

G. N. Richards. *Proc. Conf. Sugar Processing Research*, 1988, 12 pp.

The effects of small amounts of impurities such as salts and reducing sugars on the thermal degradation of amorphous sucrose[1] and in very concentrated aqueous solution were studied. In both cases, a lag phase has been observed before any loss is observed, and the investigations concentrated on the effects of various salts on this lag, with suggested explanations of the phenomena.

Composition of dextran in raw sugar and sugar cane juice

E. J. Roberts, M. A. Clarke, M. A. Godshall and T. B. T. To. *Paper presented at Conf. on Sugar Processing Research*, 1988, 8 pp.

Details are given of the procedure used to isolate dextran from raw sugar and of its subsequent hydrolysis, acetolysis, methanolysis and enzymolysis which was followed by TLC of the alcohol-soluble dextranolysate as well as GLC and gel permeation chromatography. Isolation of micro-organisms from cane mud and their culture for testing on various substrates (sucrose and filtered or unfiltered juice) for dextran production are also described. From the studies it was apparent that mannose residues found in the dextran were not formed by glucose isomerization during analysis but were part of the oligosaccharide degradation products. The organisms (wild cultures) isolated from cane mud produced dextran containing mannose residues regardless of the substrate, while classified *Leuconostoc mesenteroides* (B512-F) gave dextran that contained no mannose. The small amount (2 - 3%) of mannose residues in cane and raw sugar was probably covalently linked to the glucose chain and was possibly introduced during dextran synthesis by wild strains of *L. mesenteroides* found in the soil and yet to be identified.

Structural studies on a fructan from sugar beet and sugar cane juice

M. A. Clarke, E. J. Roberts, W. S. C. Tsang, M. A. Godshall, Y. W. Han, L. Kenne and B. Lindberg. *Paper presented at Conf. on Sugar Processing Research*, 1988, 8 pp.

A highly water-soluble fructan (fructan-HS) is reported that was synthesized in high yield (>80% on available fructose) by *Bacillus polymyxa* on sucrose. Analysis by nuclear magnetic resonance and methylation showed the structure to be a β-(2→6) linked polymer of fructose with 12% branching. *B. polymyxa* may be grown on raw, untreated cane or beet juice to yield fructan-HS but the yields were lower than on an optimum medium containing 8% sucrose. The fructan could serve as a source of fructose which is released by acid hydrolysis.

Structure of colorants

M. A. Clarke, W. S. C. Tsang and M. A. Godshall. *Paper presented at Conf. on Sugar Processing Research*, 1988, 8 pp.

The structure of a polysaccharide-type colorant found in cane and of similar compounds found in other graminaceous plants is discussed. Ferulic acid is a small substituted phenolic compound which can serve as a cross-linking component between the major cell wall polysaccharides to provide stability; the cross-linkages are easily broken during processing, with solubilization of some of the polysaccharides. However, the ferulic acid ester linkage is less easily hydrolysed but remains attached to the backbone even when the polysaccharides are degraded into small units, and it has been suggested that the acid preserves the glycosidic linkages in the immediate vicinity of its point of attachment and prevents enzymatic hydrolysis. Ferulic acid is always to be found in raw and refined sugar; it is a very pale yellow compound that can readily react to form darker coloured compounds. Studies on beet pectin, which is a soluble polysaccharide composed primarily of galacturonic acid and monosaccharide residues, have revealed ferulic acid groups esterified onto galacturonic acid units of the rhamnogalacturonan backbone analogously to the ferulic acid-hemicellulose complex in cane, in which ferulic acid could be esterified onto the glucuronic acid residues of indigenous sugar cane polysaccharide (ISP). It is proposed that some colorant and colour precursor in both cane and beet sugar factories passes through the various processes attached to polysaccharide as a soluble complex; the material preferentially enters the sugar crystal and may, during storage (particularly at high temperatures), de-esterify to release colorant. The de-esterification may also occur in process under the effect of high alkalinity; since the colorant is then no longer associated with polysaccharide it is less likely to co-crystallize with sucrose. The fact that sugars of equal whiteness can be crystallized from carbonatated liquor of much higher colour than phosphatation liquor is attributed to a sufficiently high pH in carbonatation to hydrolyse the

1 Richards: *I.S.J.*, 1986, **88**, 145 - 148.

ferulic acid groups unlike the conditions in phosphatation; the hydrolysed acid will contribute less to crystal colour than to syrup or liquor colour.

Near-infrared spectroscopy in sugar analysis. Beet sugar manufacture

G. Vaccari and G. Mantovani. *Paper presented at Conf. on Sugar Processing Research*, 1988, 13 pp.

From NIR analyses of beet brei, raw juice and thick juice at one factory and of molasses at another it was concluded that calibration curves obtained in one year could be used in other years after only minor correction using a limited number of samples, although for greater accuracy it would be desirable to revise the curves during the post-campaign period by applying NIR analysis to representative samples from the campaign that had already been analysed by traditional methods so as to increase the number of available data. However, allowance would have to be made for differences between beet samples from different areas in calibration of beet brei analyses. The use of the NIR instrument used for the on-line control of Brix and pol of different products is considered a possibility.

NIR analyses of sugar products

S. H. Stevens. *Paper presented at Conf. on Sugar Processing Research*, 1988, 20 pp.

The benefits of near-infra red analysis as a means of obtaining quantitative information on a given substance (but not for structural studies or identification of organic compounds for which mid-IR analysis is suitable) are discussed and details given of the instrument and calibration procedure used by the author to investigate the applicability of NIR analysis to determination of starch and moisture in powdered sugar and of invert sugar and moisture in agglomerated sugars prepared by spraying invert syrup onto finely powdered sugar followed by mixing and particle size classification. Calibration of the results indicated the value of NIR analysis as an alternative to traditional analytical methods; the major benefits include a drastic reduction in time requirement and in reagent consumption and increase in reproducibility through minimization of the human element.

Sucrose determination with flow injection analysis in the beet laboratory

A. S. Karlzen and J. Tjebbes. *Paper presented at Conf. on Sugar Processing Research*, 1988, 9 pp.

Enzymatic determination of sucrose using flow injection analysis is described. The sucrose is injected into a carrier stream of citric acid and is converted by invertase, mutarotase and glucose oxidase (immobilized on small glass beads) to hydrogen peroxide which is detected by peroxidase; the intensity of the blue colour which forms when a suitable reagent is added to the peroxide is measured by a flow-through spectrophotometer. The valves and timing are controlled by a computer which also reads the colour measurement and calculates the sucrose content from it. The method gives a lower value than polarimetry, has a repeatability with a standard deviation of ± 1% and allows a sample to be analysed in 45 seconds; calibration is needed once per hour and the enzyme reactors and coils used have to be changed every week.

Utilization of laser optic technology to determine crystal size

M. Holle. *Paper presented at Conf. on Sugar Processing Research*, 1988, 10 pp.

A new approach to particle size analysis based on solid-state lasers measures the number of particles by scanning a beam of focused, coherent laser light across individual crystals at a known rate; the crystals are held in liquid suspension and move past the focal point by flow entrainment. Analysis of the back-scattered light allows calculation of the distance covered by the spot of light across a particle, and the total of these distances is the information required. Application of a Lasentech Lab-Tech 100 analyser to dry granulated sugar and to a composite sugar and its fractions is described. The minimum measurable particle size was about 2 μm. Advantages included good repeatability, rapid analysis and the possibility of on-line application, but it is stressed that the usefulness of the technique depends on a good understanding of the type of information obtained.

The use of an infrared dryer in determining soft sugar moisture

F. S. Goodrow. *Paper presented at Conf. on Sugar Processing Research*, 1988, 7 pp.

The traditional vacuum oven method used at Chalmette refinery to determine moisture in soft sugar is too time-consuming to be of practical use for monitoring and control purposes; however, a Mettler LP-16 infrared dryer used in collaboration with a PM200 balance gave values for light and dark brown soft sugars that were comparable with those given by the vacuum oven method. Details are given of the procedure which may be used easily by non-technical personnel in far less time.

Production of carbocalcium saccharates in pre-carbonatation

O. V. Moroz and A. A. Lipets. *Sbornik Pishch. Prom.*, 1987, **33**, 49 - 52 *(Russian)*.

Infrared spectroscopy was used to study insoluble carbocalcium saccharates formed by gassing limed sucrose solutions at 40°, 60° and 80°C to pH 11.0, 11.2, 11.4 and 11.6; the carbonatated solutions were filtered and the mud obtained held in a drying cupboard for 48 hr in the presence of CaX zeolite at room temperature before the IR studies. The results indicated the optimum conditions under which the saccharates are formed and the role played by β-sucrose.

By-products

The use of single and mixed cultures for aerobic treatment of cane sugar stillage and SCP production

B. C. Nudel, R. S. Waehner, E. R. Fraile and A. M. Giulietti. *Biol. Wastes*, 1987, **22**, (1), 67 - 73; through *S.I.A.*, 1988, **50**, Abs. 88-1094.

Cane vinasse was treated by culture of the following micro-organisms singly and in pairs: *Candida utilis, Saccharomycopsis lipolitica, Aspergillus niger, A. orizae, Trichoderma viride, Paecilomyces varioti, Rhizopus* sp., *Azotobacter vinelandii, A. chroococcum, Brevibacterium flavum* and *Corynebacterium acetoacidophilum*. COD decreases ranging from 30 to 65% and biomass outputs from 9 to 23 g/litre were obtained in batch cultures. With *C. utilis* and *A. niger* in a 2-stage continuous culture, the maximum COD decrease was 89%.

Alkaline sulphite-anthraquinone pulping of bagasse with and without the addition of ethanol

D. L. K. Wang, F. Ramirez and R. Patt. *Holzforschung*, 1987, **41**, (6), 383 - 388; through *S.I.A.*, 1988, **50**, Abs. 88-1127.

Depithed Mexican bagasse was pulped by the above process at 155 - 175°C with 12 - 20% total alkali for 30 - 60 min with or without inclusion of 5 - 35% ethanol. Cooking at 165°C with 20% alkali gave the best results. Inclusion of ethanol slightly increased brightness and viscosity but did not affect delignification rate and is not considered advantageous. The alkaline sulphite-anthraquinone process gives good yields of pulp with high brightness and excellent strength, delignified to very low kappa numbers. The pulp can be bleached in two or three stages with chlorine or chlorine-free chemicals (ozone or hydrogen peroxide); use of the latter would permit complete elimination of the effluent COD.

Effect of adding autolysate of beer yeasts on fermentation of molasses wort with *Saccharomyces cerevisiae*

V. N. Shvets, S. R. Todosiichuk and E. G. Chasnyk. *Pishch. Prom.*, 1988, **34**, 79 - 82; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (15), Abs.15 R380.

Autolysate of *S. cerevisiae* Strain 11 was added as enzyme source to ensure complete fermentation of raffinose in molasses wort fermentation with *S. cerevisiae* V-30; the aim was to raise the extent of sugars utilization. The optimum autolysate dose to give increased alcohol yield was 0.05 - 0.3%.

Caribbean rum: its manufacture and quality

R. Harris and D. H. West. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 313 - 339.

After a brief account of the cane and rum industries of Caribbean countries, processes used in rum manufacture are described including the need to minimize the amino-N and *n*-propyl alcohol contents in the final product. The high level of amino-N in Barbados rum is attributed to the use of mechanical cane harvesting and greater cane preparation by shredders; this leads to increased extraction of juice and of non-sugars, including N.

Desalting of molasses by counter-diffusion in the fermentation industry

R. A. Johnson and M. S. Lefebvre. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 340 - 348.

In counter-diffusion, molasses salts are selectively transferred across a semi-permeable membrane into a stream of water, using only their concentration gradients as driving force; the membranes are in the form of hollow fibres through which the molasses is pumped while the stripping water is pumped around the outside in counter-current flow. Removal of salts, particularly potassium, and molasses clarification gave 88% fermentation efficiency compared with 78% for untreated molasses and 80% where only clarification was used. The economics of desalting are considered.

Sugar cane processing to ethanol for fuel purposes

C. E. V. Rossell. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 349 - 366.

A representative of Copersucar describes developments in the manufacture of ethanol from cane juice. Best results and highest yields are obtained by multi-stage treatment of juice, which involves screening, hydrocyclone treatment, liming, heating, clarification and cooling. The Melle Boinot batch fed process with cell recycle and multi-stage continuous fermentation are described and recovery of fermentation by-products such as yeasts and glycerol, vinasse recycle and the distillation process briefly discussed. The current status of the fermentation processes in Brazil and advances in fermentation technology over the last 8 seasons in Copersucar distilleries are indicated and a research program is outlined.

Sucrose chemistry: its position as a raw material for the chemical industry

R. Khan and H. F. Jones. *Proc. Symp. on Chem. & Processing of Sugar Beet and Sugar Cane*, 1987, 367 - 388.

The physical properties, molecular structure and chemical reactivity of sucrose are described and use of the sugar as chemical feedstock and as a source of specialty sweeteners is examined.

Biotechnological advances in the production of alcohol and biogas from agricultural products

K. Buchholz. *Zuckerind.*, 1988, **113**, 681 - 683.

Since the costs of raw material constitute half of the overall cost of ethanol

fermentation, advances in technology will make only limited contribution to the process economics. Of major importance will be developments that (i) provide high levels of conversion and product concentration from cheaper substrates and (ii) raise the overall yield from conventional materials. Typical of the latter are the use of yeast recycle and immobilization of yeast as in the case of a Lurgi continuous fluidized bed system involving yeasts immobilized in spherical biocatalysts composed of a special alginate matrix; this has been applied to various substrates including beet juice and other mixed substrates from a sugar factory. Further desirable advances include the further development of stable biocatalysts and reactor systems with integrated ethanol recovery, and improved treatment or utilization of distillery waste, including molasses vinasse. The various aspects of ethanol fermentation are briefly examined with references to the literature.

Recent developments in ethanol production technology

D. R. McGaw, W. A. Mellowes and A. C. Pilgrim. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 196 - 206.

Developments in fuel ethanol production from sugar industry raw materials as well as from cellulose- and starch-based materials are surveyed, including the advantages and suitable arrangements of continuous fermentation systems with yeast recycle, research on the use of alternative micro-organisms, distillation (with particular reference to energy consumption and the advantages of vapour recompression) and the prospects for alcohol manufacture in the Caribbean.

Dunder as a fertilizer for sugar cane in the Central district of Queensland

W. A. C. Webb and L. S. Chapman. *Proc. 9th Conf. Australian Soc. Sugar Cane Tech.*, 1987, 55 - 58.

Vinasse from a molasses alcohol distillery has been increasingly applied in place of KCl on cane farms in the Central district. In addition to K, it contains N, P, Ca, Mg and S. The recommended rate is based on the optimum K requirements and is in the range 9 - 13 kilolitres/ha. To date, vinasse has not had any adverse effects on the quality of soil, cane or sugar. Although it is offered free to farmers by the distillery, high transport costs limit the distance it can be carried, so that increased use on cane farms is not expected unless cheaper means of transporting it are found; the distillery owners are considering the possibility of piping vinasse to other outlets or of concentrating it to reduce transport costs.

The treatment of rum distillery waste in an upflow anaerobic digester

D. A. Butterfield and S. Thomas. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 207 - 211.

While aerobic treatment of rum distillery waste consumes much energy and yields large quantities of sludge, anaerobic processes have a major drawback in that it they provide only partial treatment and necessitate use of an additional polishing method to give acceptable reductions in pollution load. However, because of the low energy consumption, smaller amounts of sludge produced and the generation of biogas associated with anaerobic treatment, many attempts have been made to design reactors that would maximize the advantages and minimize the disadvantage. The upflow anaerobic sludge blanket (UASB) reactor is described and trials are reported in which treatment was conducted for 40 days at 27°C and hydraulic retention time (HRT) values of 3, 4 and 5 days (corresponding to daily organic loading rates of 38.7, 28.0 and 22.4 kg COD/m^3) and for 55 days at 37°C and HRT values of 1, 3 and 5 days (corresponding to 82.0, 27.3 and 16.2 kg COD/m^3/day); results showed a reduction in COD of 47.9, 52.2 and 61.9%, respectively, for the lower temperature run, and of 49.9, 52.9 and 75.9%, respectively, for the run at 37°C.

An optimal scheme for bagasse processing

A. Young Hoon and S. Thomas. *Proc. 23rd Conf. West Indies Sugar Tech.*, 1988, 212 - 217.

A proposed scheme for bagasse processing involves depithing by a dry or wet method, digestion of the fibrous fraction by cold soda pulping or by the Kraft process to yield pulp which is subsequently bleached, extraction of xylan from the pith with NaOH to yield dissolving pulp as well as a liquid extract which is treated with methanol to precipitate the xylan (the mixture of NaOH and methanol being sent to a recovery unit possibly consisting of an evaporator for separation of the two, the NaOH then being recycled to the xylan extractor which also receives NaOH from the cold soda digester), two-stage conversion of the xylan to furfural with the use of an organic solvent in the second stage to increase yield, and possible production of xylitol sweetener by reacting the xylose obtained in the first stage with hydrogen under pressure in the presence of a catalyst.

The isolation of a non-sugar fraction from sugar cane molasses and its effect when included in rat diets

V. Figueroa and M. Macía. *Cuban J. Agric. Sci.*, 1988, **22**, 165 - 170.

The general use of cane molasses as animal fodder has not been accompanied by a comprehensive study of its chemical composition, which is particularly important for countries such as Cuba where high levels of molasses are used in pig rations. Cuban molasses samples were analysed and an alcohol-insoluble non-sugar fraction obtained which, when incorporated in a diet for rats, significantly reduced their growth by comparison with the results for the normal control diet.

New magnesia clarifying process for sugar refining

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

Introduction

The Tobu refinery (600 tonnes/day) of Mitsui Sugar Co. Ltd. (MSC) developed a new magnesia clarifying process for commercial use six years ago and has been using it in the marketing of refined sugar with good results ever since. Soft white sugar with a good colour and fine crystal form dominates the market in Japan, with the rest going to various types, such as granulated, coarse granulated, coarse granulated brown and soft brown sugars. Sugar users, including confectioners and bottlers, are strict about the quality of sugar. Also, fine liquor just before boiling must be over 99.9 % pure, colourless and transparent to colour value below 70 IU (ICUMSA units). Consequently, most refineries in Japan are generally introducing a three-step clarifying method for liquor; carbonatation first, followed by either bone char, granulated carbon or powdered activated carbon and decolorizing ion exchange resin treatment as the final stage.

Carbonatation as the first step has been widely used because slaked lime can be obtained at relatively low cost. The use of a large amount of slaked lime, however, results in the production of a calcium carbonate filter residue, and there are no established methods for economical reactivation and recycling, so that the filter residue is mostly buried, with attendant disposal costs. A little is used in fertilizers.

Since decolorization by the carbonatation process is not complete (around 50%), the second step, using bone char, granulated carbon or powdered activated carbon, is necessary before the liquor is passed through the ion exchange resin to obtain transparent liquor of high purity. Powdered activated carbon is expensive, however, while both bone char and granulated carbon require a large equipment outlay because of the long holding time made necessary by their low adsorption ability. They also generate a large amount of sweet water because they require much hot water during sweetening-off prior to their reactivation. The sweet water return reduces the density of liquor in the clarifying process, causing much higher demand for heat later in the boiling process.


T. Nakamura


H. Iwabe


M. Kawakami

A simplified energy-saving and low-pollution clarifying process was thus needed, especially by urban refineries in consumer locations.

Magnesia adsorption

MSC took notice of the strong adsorption ability of magnesia adsorbents while the company was examining and testing various past and current clarifying methods.

Magnesia adsorbents had not been put into practical use in spite of their ability to adsorb a broad range of organic and inorganic matter, especially colloidal substances and organic polymers. There were three reasons for this: the magnesia adsorbent itself was not easy to filter, which made it difficult to separate industrially; there were no effective methods for reactivation and recycling of magnesia, necessary because of the high cost of the adsorbent compared with slaked lime, etc.; and sucrose loss in the magnesia cake was large. During joint research with the Japan National Chemical Laboratory for Industry, MSC found that the filtrability was greatly improved and effective reactivation performed during repeated burning at low temperature when magnesia reburned at low temperature was mixed with a filter aid such as perlite (main components: SiO_2 and Al_2O_3). Basic laboratory data on these results are shown in Table I.

Sucrose trapped in the filter cake was found to matter less, because the loss was reduced by hot water treatment of the cake. Basic laboratory data are shown in Fig. 1[1]. The sweet cake was

Paper presented to Sugar Industry Technologists, 1988.

1 Kaga *et al.: Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, **32**, 18.

Table Ia. Relation between reburning modifier ratio and decolorization in recycling test

Cycle	1	2	3	4
	Decolorization, %			
MgO only	74.5	42.6	48.3	-
MgO/perlite = 1/0.5	76.0	66.5	65.0	-
= 1/1	75.8	76.0	73.6	-
= 1/3	76.3	77.5	76.0	75.0
MgO/kieselguhr = 1/1	76.0	75.5	74.1	-

Table Ib. Relation between reburning modifier ratio and filtrability in recycling test

Cycle	1	2	3	4
		Filtrability		
MgO only	51	21	8	-
MgO/perlite = 1/0.5	54	32	23	-
= 1/1	60	51	58	-
= 1/3	105	134	128	132
MgO/kieselguhr = 1/1	58	51	48	-

Filtrability: kg sugar solids/m^2/hr

from normally treated Philippine washed sugar, the amount of water for the slurry was twice the cake weight, and the amount of washing water twice the cake weight.

On the basic of these results, the superior clarifying effect of magnesia adsorbent was able to be applied to the sugar refining process. After repeated test operations using a pilot plant[2], the Tobu refinery of MSC scaled-up the process to a design capacity of 600 tonnes melt per day and started to develop practical operation in 1982.

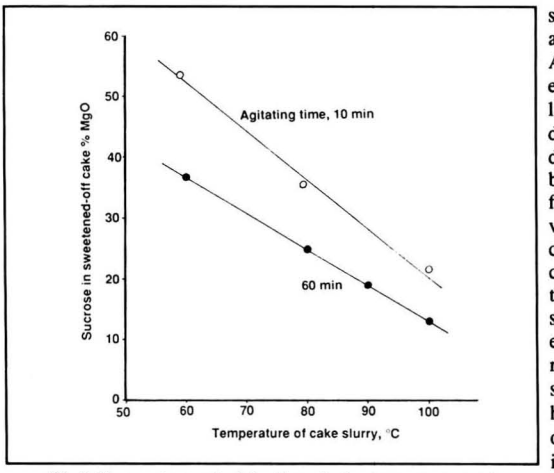

Fig. 1. Temperature and mixing time of cake slurry *vs.* sucrose in sweetened-off cake

Magnesia clarifying process

Process flowsheet

A flowsheet of the new magnesia clarifying process is illustrated in Figure 2. In the basic process, raw sugar is washed and dissolved in water, and raw liquor is mixed either with powdered adsorbent composed of magnesia burnt at a low temperature and perlite etc., or with adsorbents reactivated as explained above. The mixture is warmed in order to adsorb and remove impurities such as colour substances from the liquor. The filtered liquor is partly demineralized by ion exchange resin and then any remaining colour is removed by a decolorizing ion exchange resin suited to the magnesia process, to give a colourless and transparent fine liquor. After the reaction, the adsorbent is separated from treated liquor, sweetened-off and dewatered on a specially designed filter press and then burnt and reactivated in a kiln for recycling. Magnesia reactivated at a low temperature is conspicuously higher in clarifying effect than conventional carbonatation, so that simple combination with an ion exchange resin is enough to refine the liquor to ordinary standards. However, when a high-grade product is required or if raw sugar extremely inferior in decolorization is to be treated, a small amount of powdered active carbon is recommended after the treatment by the decolorizing resin. The spent carbon left in the filter can be recycled and used as a slurry in the raw liquor to make use of its remaining decolorizing ability.

2 Idem: *ibid.*, 30.

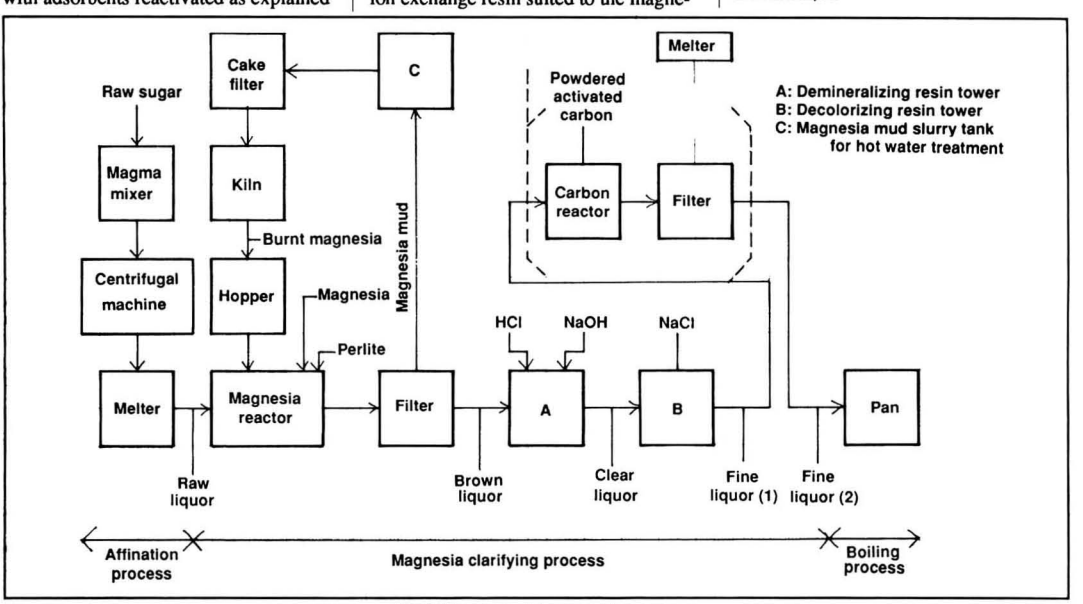

Fig. 2. Flowsheet of the magnesia process

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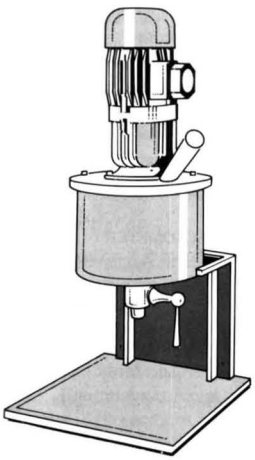
This mill will produce after 5 hours grinding about 95% nuclei of below 10 micron.[1]

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



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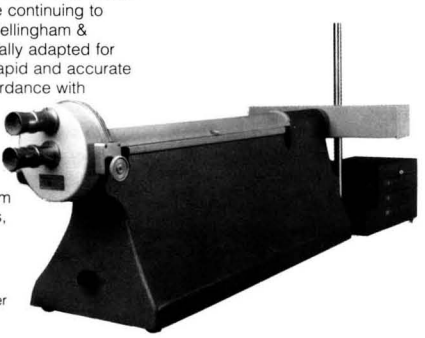

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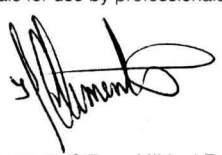

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Clarifying agent used in accordance with Dr. Horne's method.

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For direct ash determinations

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Hands free method for sugar dissolving.

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Custom made instruments for determination of brix.

18 **LABORATORY SUGAR CANE MILL**
Preparation of sugar cane for analysis.

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

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SUMA PRODUCTS

If additional magnesia is added directly to this raw liquor, the decolorizing ability can be doubled. Both the spent carbon and the magnesia can be sweetened-off and reactivated for repeated use at the same magnesia facility. In such mixed use, reactivation of both magnesia and powdered active carbon can be performed stably and effectively, filtration resistance can be reduced and, as will be described later, adhesion of magnesia inside the equipment can be prevented.

Plant description

The magnesia plant comprises the following main facilities:

Main process:

Hoppers to hold fresh magnesia, perlite and burnt magnesia.

Four magnesia reactors running in series: 1st reactor, 6.5 m^3; 2nd - 4th reactors, 8.9 m^3; each reactor is equipped with an agitator and a steam jacket for heating.

Seven magnesia leaf filters of filtering area 83.6 m^2; maximum working pressure is 3 kg/cm^2; five filters are for the 1st position and two for the 2nd position (for check).

Two demineralizing resin towers holding 3.5 m^3 of resin; design space velocity is 8 - 10 m^3 per m^3 resin/hr; resin used is weakly acidic cation exchange resin. (The objective is to remove the 100 - 200 ppm Mg^{++} dissolved in the liquor during the magnesia treatment and to neutralise the liquor at the same time)

Three decolorizing resin towers holding 7.5 m^3 of resin; design space velocity is 2 m^3 per m^3 resin/hr; resin used is strongly basic anion-exchange resin (gel-type styrene).

One powdered activated carbon reactor of working volume 30 m^3 equipped with an agitator.

Three powdered activated carbon leaf filters of filtering area 83.6 m^3 and maximum working pressure 3 kg/cm^2.

Four final check ceramic filters of filtering area 7.1 m^2 and maximum working pressure 3 kg/cm^2.

Magnesia recycling process:

One magnesia mud slurry tank for hot water treatment of working volume 11.5 m^3, equipped with a steam coil for heating and an agitator. (Agitation is for 30 min at 90°C to improve sweetening-off efficiency in the filter press.)

One Auto-filter magnesia cake filter press of filtering area 51 m^2 and maximum filtering pressure 5 kg/cm^2; this is equipped with an expression function for dewatering (maximum expression pressure, 20 kg/cm^2); cake moisture after treatment is 37 - 43% and cake pol 1.6 - 2.4%.

One six-hearth kiln of 3.64 m internal diameter and fired with natural gas on the second, fourth, fifth and sixth hearths; sweetened-off cake with about 40% moisture is supplied at a rate of 1200 - 1600 kg/hr, the cake supply rate being regulated in accordance with main process rate.

Ventilation system for waste gas from the kiln: waste gas is passed through a dry process cyclone, washed with water by a pre-cooler and a scrubber and then led to a chimney. Water used for the washing is recycled after precipitation of suspended solids with a thickener.

The magnesia clarifying plant is totally controlled from the central control room.

Problems settled in practical plant operation

During test operations for the commercial plant, some problems emerged which had not become apparent during operations with the pilot plant.

Magnesia burning

Burning and filtration of magnesia were the greatest problems found during test operations of the commercial plant. Recycling of magnesia by reactivation is one of the major points of this new process. Oxidation and thermal decomposition of adsorbed organic matter are well-known as burning methods for adsorbents. Since both method showed the same magnesia-reactivating ability in laboratory tests, and since the same result was confirmed using a small kiln in the pilot plant, the large refinery kiln design was initially based on the oxidized decomposition method. But practical operation using oxidation decomposition revealed that temperature distribution inside the kiln could not be kept homogeneous because heat from the exothermic oxidation reaction (burning) of organic matter was much higher than in the smaller pilot kiln. Total regeneration efficiency was thus extremely low, because some of the magnesia in the kiln was over heated and the rest only partially burnt. Overheating reduced adsorption ability. In addition, kiln temperature could not be used as a good indicator for kiln control, because the high exothermic heat release from the burning of organic matter caused a wide difference between the temperature of the air and the burnt substance in the kiln. The thermal decomposition method had such disadvantages as a slow reaction rate and more than twice the reaction time compared with oxidation decomposition. In other words, thermal decomposition would require a kiln twice as large.

We thus had to develop kiln operations which perform magnesia burning under strict conditions of thermal decomposition as the base with a certain amount of oxidation decomposition:

1. The kiln would have to be controlled automatically by measuring the temperature of the burnt substance and maintaining the value at its optimum.

2. Aeration for burning (secondary air) would be controlled automatically by measuring residual oxygen concentration in the kiln and maintaining this value at its optimum.

By developing these methods of strict burning control, the high regeneration efficiency obtained in the laboratory and at the pilot plant was achieved in the refinery kiln.

Filtration of magnesia

The second problem for practical

operation was filtration of the magnesia. Magnesia (magnesium hydroxide) has low filtrability, so our main achievement here, besides the superior burning characteristics of the magnesia perlite mixture, was the improved filtrability of the substance.

During test operations, filtrability of magnesia-treated liquor was quite good with no problems, showing the same data as those obtained at the experimental stage. As the filter cycle was repeated, however, magnesia began to adhere and accumulate onto filter cloth fibres and filtration became difficult.

This problem was handled in several ways. A different type of filter cloth was chosen, an automatic filter cloth cleaning apparatus using hydrochloric acid was developed, and the optimum mixture of perlite and magnesia was found, taking decolorizing ability into consideration. It was also found that the addition of some powdered activated carbon reduced adhesion of magnesia.

The magnesia filtration process has thus been improved to a level of almost no problems with regard to treatment capacity and working efficiency.

Treatment conditions of the liquor

In the planning stage, basic conditions for the treatment of liquor with magnesia were set as follows. The amount of magnesia to be added to the liquor was set at the level of 0.4% MgO on Brix, based on the data[1] shown in Figures 3 and 4 and taking general conditions into consideration, such as decolorization rate required, sucrose loss in filter cake and facility costs.

Although a high liquor concentration is profitable from the viewpoint of energy saving, it was concluded that a Brix of around 70° would be the upper limit to achieve satisfactory decolorization efficiency of the magnesia and efficiency of the liquor flow through the ion exchange resin later in the process. Consequently, the optimum temperature and time at this Brix were set at 80°C and 30 minutes, based on the data shown in Figures 5 and 6.

Test operations in the refinery, however, revealed that these conditions, including the amount of magnesia, were not necessarily the best, depending on the activity level of the magnesia and other conditions.

Better treatment conditions for plant operation are now being examined at the refinery, and basic studies done on such things as the formation of colour substances caused by the decomposition of reducing sugars during magnesia treatment.

We have also found that, while the reaction rate of regenerated magnesia is high when it is powdered, the filtrability is lower because perlite in the

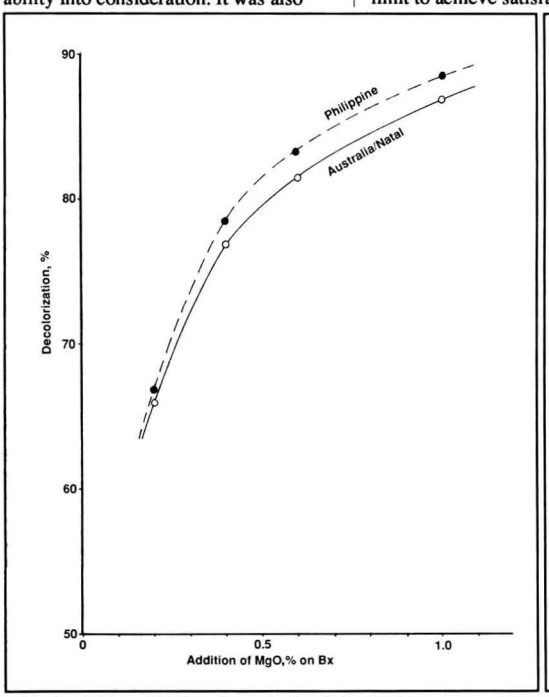

Fig. 3. Addition of MgO *vs.* decolorization (Brix: 70°; Temperature: 80°; time: 30 min.)

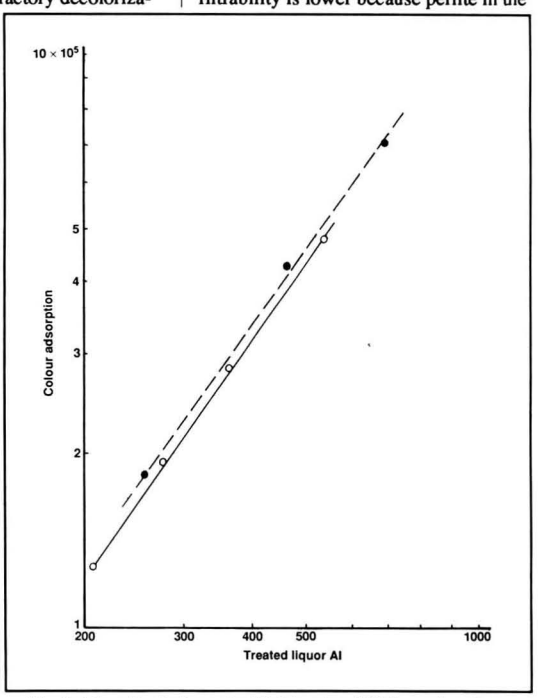

Fig. 4. Adsorption isotherm for MgO treatment [Colour adsorption = (Original liquor AI - Treated liquor AI)/Amount of MgO]

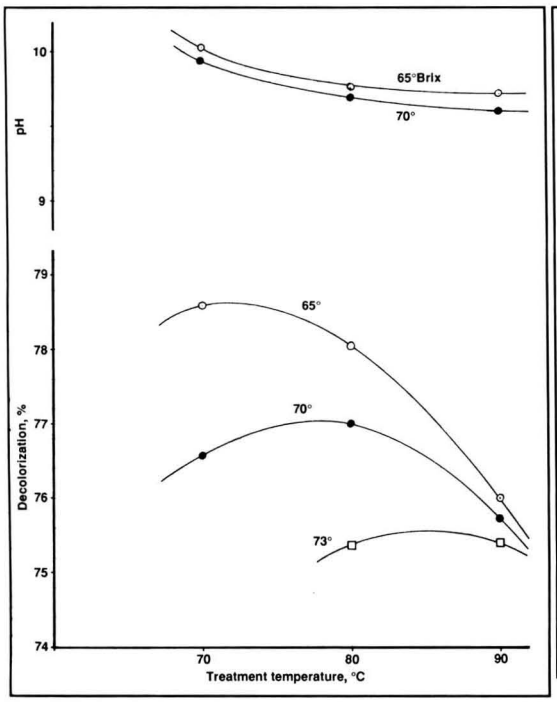

Fig. 5. Relationship between decolorization and treatment temperature, Brix and pH (Raw liquor: Australia/Natal; MgO: 0.4% on Brix; Time : 30 min)

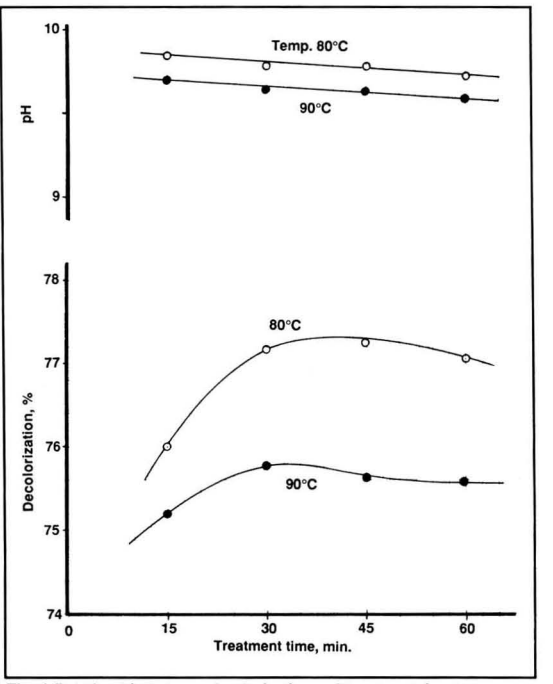

Fig. 6. Relationship between decolorization and treatment time,temperature and pH (Raw liquor: Australia/Natal; Brix: 70°; MgO: 0.4% on Brix)

mixed adsorbent is also powdered. Optimum powdering conditions are thus also being examined in relation to the balance between decolorization efficiency and filtrability.

Replenishment of fresh magnesia

Original plans called for the magnesia/perlite mixture to be completely replaced after 10 repetitions of the recycling.

In tests with the refinery plant, however, magnesia in the early stages of recycling caused trouble with various facilities in the process and increased amount of sucrose adsorbed on the filter cake because the adsorption ability of the fresh magnesia was too high. Further, the properties of the magnesia changed dramatically with recycling, and stable operation required constant adjustment in operating conditions to cope with these changes. This problem was solved and the whole process improved when a new system was introduced, in which fresh magnesia was supplied continuously at a controlled rate, maintaining the decolorization efficiency of regenerated magnesia at a constant level and continuously discarding excess magnesia overflow from the recycling system. In recent operations, the magnesia has been replaced gradually over about 15 repetitions.

Other items developed

In addition to the above, the following items have been developed since the commencement of plant operation and are still being studied for further improvement:

(1) Selection of decolorizing resin suited to the magnesia process (an alkaline NaCl regeneration method has been developed, but is not in practical use).

(2) Development of peripheral facilities suited to the properties of magnesia (adhesion, abrasion, powder, etc.).

(3) Developments regarding pH adjustment and demineralization of magnesia-treated liquor.

(To be continued)

Mauritius cyclone damage [1]

A cyclone which hit the Indian Ocean island of Mauritius is reported to have damaged part of an estimated 200,000 tonnes of sugar in storage awaiting shipment. The exact quantity damaged has yet to be determined. Cyclone damage is also reported to the cane crop on the island and also in Réunion, and a possible decline of 10-15% has been reported[2]. The sugar cane is a very resilient plant, however, and the crop may recover, but in a closely balanced supply and demand situation any such loss possibility can assume importance.

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 75.
2 *The Sugar Situation*, 1989, (453), 2.

British Sugar Technical Centre

On March 17, the new Technical Centre of British Sugar plc was officially opened by the UK Minister of Agriculture, Mr. J. R. R. MacGregor. The new facility is a development from the company's research laboratories at Colney, Norwich, and a £1.8 million expansion program has doubled the size of the facilities. The Centre now employs 70 people, mostly graduates, with room to accommodate up to 100.

The Centre will incorporate the company's Quality and Scientific Service Laboratories, relocated from Peterborough, so that most of the company's scientists will be at one location.

Research and development will concentrate on four areas, the first being process development investigations to maintain the company's position as the lowest-cost producer in Europe. The second area, product development, has already led to successful marketing of flavoured syrups and special icing sugars for industrial use, while research into novel food ingredients promises further commercial success.

The third area is research into new uses for co-products; the launch in September 1988 of Beta Fibre, a human food made from beet pulp, marked the successful completion of a year's research and development work. Further work is under way adding value to animal feed products through improving its nutritional value. Finally, technological diversification through genetic transformation on crops and research into fermentation is broadening the business interests of the company.

Process development research is aimed at increasing the efficiency of sugar extraction from the beet with investigation of benefits to be gained by adjustment of pH and the use of enzymes, osmosis and ultrasonics. Also under study is the production of pressed pulp of high dry solids content so as to reduce the cost of water removal by drying. The Technical Centre is also investigating ways of reducing beet damage during handling which will reduce sugar losses. Other fields of study include the prevention of precipitation of scale-forming materials during evaporation of thin juice so as to economise in energy use and reduce cleaning costs, and improvement in the treatment of waste water.

In addition to new products such as the "Treat" flavoured syrups for use as toppings, British Sugar has developed a dry fondant sugar, a new icing sugar for use by bakers and a special invert syrup for the soft drinks industry. The Technical Centre is looking at the use of food ingredients such as polysaccharides for use in confectionery, etc.

While day-to-day control of their products is the responsibility of the laboratories at each of the company's 12 sugar factories, the Quality and Scientific Service Laboratories within the Technical Centre provide the factories with the tools and skills they require to manage factory product quality effectively. This they do by specification and approval of raw materials, development of quality standards, and establishment of methods and instruments for process and product monitoring. The laboratories are involved in design of plant and also provide advice to customers.

Since the foundation of British Sugar's Research Laboratories they have gained an international reputation as a centre of excellence in sugar science an technology. The new facilities in the Technical Centre will undoubtedly permit the enhancement of that reputation in the future.

Mr. MacGregor unveils a plaque to commemorate the official opening of the Technical Centre, accompanied by Mr. Peter Jacobs, Managing Director of British Sugar plc.

Technical diversification at British Sugar

British Group plc – British Sugar's holding company – is the food and agribusiness division of Berisford International plc. Bristar plans to broaden its interests in two ways. The first element of the diversification program is to move into new industrial sectors by acquiring companies in different but related businesses in food and agriculture.

The second element, being managed from within British Sugar, is a program of technological diversification, taking British Sugar into new business opportunities which build on the company's existing technical skills and expertise. Special emphasis is given to opportunities that use the company's products. The new Technical Centre has a key role to play in identifying and

assessing the potential of these technological opportunities.

Two area of research are genetic transformation of crops and fermentation, both being aspects of biotechnology. Scientists from the Technical Centre are working with experts at universities and research institutes to develop techniques for genetic engineering of the sugar beet to improve its characteristics.

In conjunction with scientists from Cambridge-based sister company Enzymatix, also part of the Bristar Group, research is proceeding to develop ways of making specialist food and animal feed ingredients by fermentation of materials from the sugar factory.

The sugar beet growing area of Eastern England is also an area where very large quantities of straw are produced, and Bristar is developing methods for the large-scale manufacture of paper pulp from this raw material. Bob Bass, in charge of this development, says "It is astonishing how similar is the technology of paper pulp manufacture to that of sugar production, in which British Sugar has such a wealth of expertise". Abundant raw material, technical knowledge and a ready market make it likely that large-scale paper pulp production will soon be a reality in East Anglia.

For 50 years, British Sugar's factories have generated their own power, operating boilers fired by coal, gas and oil, which have had to run continuously during the 4-month campaign with the utmost reliability. Boilers and turbo-alternators provide both steam and electric power for process operations. Equipment has been installed and commissioned by the company's engineers who have also contributed significantly to control instrumentation and protection systems. A comprehensive maintenance program ensures that the optimum performance is achieved by the equipment. With this experience, British Sugar has been well placed to take advantage of the UK government's privatization of power generation, and are not only intending to supply power to the national distribution network but also are offering their expertise to other companies planning to develop similar supply facilities.

Sugar Processing Research Inc. Science Award

Call for nominations

Sugar Processing Research Inc. solicits nominations for the S.P.R.I. Science Award for 1990. This award, presented biennially, consists of a cash honorarium of US $1000, a plaque, and reasonable travel expenses to the award presentation, at the S.P.R.I. conference to be held in San Francisco, California, U.S.A., during May 29 - June 1, 1990. The recipient is expected to deliver an address at the Conference.

Scientistis/Researchers who have at least ten years of active research and development experience in sucrose science and technology, in a research environment of a university and/or research institute and/or company engaged in the business of sucrose processing and production, and have approximately ten recent relevant sucrose and sucrose-related publications in internationally recognised textbooks, or journal which operate a referee system of selection for publication, are eligible for consideration by the Award Committee.

Nominating forms may be obtained from the Managing Director, Sugar Processing Research Inc., P.O. Box 19687, New Orleans, Louisiana, U.S.A. 70179. The deadline for nominations is November 1, 1989.

Distribution of magnesium and silicon in resin used for desalting of technical sugar solutions

continued from page 90

colouring matters accumulated in the resins which cause the organic fouling of the resins.

This study has demonstrated that the method is superior for the restoration of the fouled resins used in our reverse ion-exchange system for sugar refining.

Summary

The accumulation of the Mg and Si compounds in strongly anion-exchange resins used repeatedly in a reverse ion-exchange system for sugar refining, and their response to several regeneration methods were elucidated by a technique using an X-ray micro-analyser and energy dispersion. The results of line analyses of sliced beads show that, in the fouled resin the contaminating Mg compounds accumulated only near the surface of the resins while Si compounds were found both near the surface and in the middle. It is thought that the fine pores close to the resin surface become plugged with these contaminants and feed sugar liquor becomes unable to diffuse into the internal part of the resins. When the fouled resins are subjected to regeneration with 4% HCl at 20°C, only small amounts of both contaminants were eliminated. With 4% HCl at 70°C the Mg compounds were almost entirely eliminated, whereas the extent of the elimination of the Si compounds resembled that with cold HCl. Hot HCl followed by treatment with NaOH/NaCl at 70°C resulted in complete elimination of both the Mg and Si compounds, showing a good restoration effect.

French sugar factory closures

The smallest of the Beghin-Say Group sugar factories, at Lieusaint, has ceased operations from December 31, 1988. The Nassandres factory of Générale Sucrière has also closed, after 120 years of operation.

Facts and figures

New sugar factories for India[1]

A new cooperative sugar factory near Nayagarh, 110 km from Bhubaneswar, was formally inaugurated by the Orissa Chief Minister on December 21 last. A new factory is also under construction in Sivagiri Taluk of Nellai Katabomman district in Tamil Nadu and is expected to commence operations in the current season. With a crushing capacity of 2500 t.c.d. it will be the largest in the district and it has 15,000 acres of registered land in a well-developed cane area with a favourable climate. The operating company, Dharani Sugars and Chemicals Ltd. is the second venture promoted by a group of Indians resident in the United States.

West Germany campaign results[2]

A total of 18,590,134 tonnes of beets were delivered to West German factories for the 1988/89 campaign, 2.41% less than in the previous campaign, and 2,762,509 tonnes of sugar, white value, were produced, of which 350,134 tonnes were as raw sugar. Most came from beets direct, but 19,000 tonnes were recovered from molasses. In 1987/88 total production comprised 2,730,551 tonnes, including 19,070 tonnes from molasses. The sugar content was higher in the latest campaign, averaging 16.98% against 16.30% in the previous.

Poland campaign results, 1988/89[3]

Poland's sugar production in the 1988/89 campaign reached 1,824,000 tonnes, raw value, slightly up from the previous campaign's 1,797,000 tonnes. Beet processed exceeded 14 million tonnes and the average sugar content was 15.5%. The reduction in beet area was made good by higher yields. No exports of sugar are planned this year.

CARICOM sugar target[4]

The six Caribbean Community sugar producers have set themselves a production target of 720,000 tonnes in 1989, 6.9% more than the 673,574 tonnes output of 1988. Some 75% of production will be sold to the UK at a guaranteed price equivalent to $535 per tonne under the EEC's Lome Convention and to the US at $445 per tonne. The rest will be consumed locally, the price obtained depending on government policy and whether the industry is state-owned or not.

USSR sugar beet crop, 1988

The Soviet sugar beet harvest in 1988 amounted to 87.8 million tonnes, 2.5 million tonnes or nearly 3% down from the 1987 crop. Sugar production figures in the USSR are given on a calendar year basis and include sugar produced by refining of imported raws; thus it is not possible to identify the quantity of sugar which is produced from beets for any one campaign. The 1988 sugar production, for instance, at 12.1 million tonnes includes sugar from beets in the later part of the 1987/88 campaign, the earlier part of the 1988/89 campaign, and sugar refined during the calendar year. F.O. Licht GmbH believe[5], however, that their estimate of 9.24 million tonnes, raw value, of sugar will be close to that actually produced from the 1988 harvest.

Australian cane mill crushing record[6]

In the 1988 season Victoria Mill in the Herbert River district of Queensland became the first sugar factory in Australia to crush 2 million tonnes of cane. It processed 2,230,000 tonnes against its previous record of 1,944,790 tonnes.

Drought effects in Brazil[7]

A prolonged dry spell in much of São Paulo state will delay the start of the 1989/90 sugar cane harvest, according to trade sources. The cane harvest, which usually starts early in May will probably not start until the middle of June in most of the state. Some areas of northern São Paulo have not seen any significant rainfall in more than a month, but it is too early to say whether the dry weather will affect the size of the next crop.

Indian sugar production and stocks[8]

According to the Indian Sugar Mills Association, the country produced a record 9,113,000 tonnes of white sugar in the 1987/88 season ended last September, reflecting an increase of 612,000 tonnes over the corresponding figure for 1986/87. The total offtake for domestic consumption was 9,389,000 tonnes including 362,000 tonnes of imported sugar, against 8,687,000 tonnes in 1986/87 including 756,000 tonnes of imported sugar. Exports in 1987/88 were 18,000 tonnes against 20,000 tonnes in the previous year. The closing stocks were 2,431,000 tonnes, which compares with 2,653,000 tonnes at the end of September 1987.

New Indian sugar factories[9]

The Indian government has decided to allow setting up of six cooperative sugar factories in Maharashtra, changing its earlier policy of not permitting any more cooperative factories in the state. The factories are to be set up in Vidarba, Amravati, Akola, Yavatmal, Wardha, Nagapur and Raisad districts.

Singapore sugar imports, 1988[10]

	1988	1987
	tonnes, raw value	
Australia	117,607	103,219
China	4,395	6,786
EEC	4,963	1,387
Hong Kong	291	1,609
Korea, South	628	1,426
Malaysia	71,687	50,502
Thailand	18,626	17,161
Other countries	14,271	166
Total	232,468	182,256

Japan sugar imports, 1988[11]

Japanese raw sugar imports in 1988 rose

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 33, 76 - 77.
2 *Zuckerindustrie*, 1989, **114**, 77.
3 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 52.
4 *Public Ledger's Commodity Week*, January 21, 1989.
5 *Int. Sugar Rpt.*, 1989, **121**, 72.
6 *Australian Canegrower*, 1988, **10**, (17), 24.
7 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 92.
8 *Indian Sugar*, 1987, **38**, 573.
9 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 92-93.
10 *I.S.O. Stat. Bull.*, 1989, **48**, (1), 31.
11 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 105.

to 1.88 million tonnes from 1.75 million tonnes in 1987.

Indonesian sugar imports increase expected[12]

A government spokesman recently said that Indonesia will raise its imports in 1989 to 230,000 tonnes from 180,000 tonnes in 1988. Indonesia's sugar production in the 1988/89 crop year was substantially down from the season before, owing to adverse weather. Although production in 1989 is expected to rise, higher imports will be necessary to bring stocks back to the safety level. Trade sources believe import requirements will be higher.

Denmark campaign results, 1988/89[13]

The six Danish sugar factories sliced 3,518,920 tonnes of beet in the last campaign to produce 505,640 tonnes of white sugar. In the previous campaign 338,843 tonnes of sugar was produced from 2,537,951 tonnes of beet.

Finland sugar imports, 1988[14]

	1988	1987
	tonnes, raw value	
Brazil	–	23,450
Cuba	11,970	65,646
Dominican Republic	12,496	–
Germany, West	–	3,483
Mauritius	24,846	–
Mexico	23,946	11,965
Swaziland	-	13,544
Other countries	30	17
Total	73,288	118,105

Italy campaign results, 1988/89[15]

Beets were grown on 260,000 ha in 1988, down from 287,000 ha in 1987. The yield was also 5% lower and as a consequence the beet crop fell 14.2% to 12,986,000 tonnes from 15,141,000 tonnes in 1987. The sugar content was higher, however, so that sugar outturn fell by 13% from 1,718,000 tonnes to 1,494,000 tonnes. The number of sugar factories fell from 36 in 1987 to 33 in 1988, those at Cecina, Comacchino and Ferrara B. having been closed.

Bangladesh sugar industry expansion[16]

India's Projects and Equipment Corporation has signed a contract with the state-owned Bangladesh Sugar and Food Industries Corporation for the supply of engineering equipment and consultancy services in the rehabilitation and expansion of three sugar factories.

Guadeloupe sugar production, 1988[17]

A crop of 870,674 tonnes of cane was crushed in 1988 by the four Guadeloupe sugar factories against 719,987 tonnes in 1987 when lower rainfall resulted in a lower yield of cane (50 tonnes/ha against 58 tonnes/ha in 1988). Sugar production rose by 20% from 63,193 tonnes to 76,128 tonnes, raw value.

US sugar crop areas and yield, 1988[18]

The cane area harvested in 1988 was estimated by the US Department of Agriculture at 797,700 acres for sugar production and 46,500 acres for seed. This compares with 778,300 and 45,300 acres, respectively, in the year before. The average cane yield for sugar production is estimated at 36.4 short tons per acre compared with 36.0 tons in 1987 and 38.5 tons in 1986. While the 1988 yields are higher in Florida (32.9 *vs.* 32.3 tons in 1987), Louisiana (25.0 *vs.* 22.7 tons) and Texas (31.1 *vs.* 29.9 tons), they were lower in Hawaii (95.5 *vs.* 100.8 tons).

Austria campaign results, 1988/89[19]

The three Austrian sugar factories sliced between them 1,933,707 tonnes of beet and produced 328,627 tonnes of white sugar.

Mexico sugar purchase[20]

A spokesman for the Mexican state sugar firm Azúcar S.A. has confirmed that Mexico bought 270,000 tonnes of white sugar on the international market to cover a possible poor 1988/89 domestic crop. Weather outlook for the state of Vera Cruz and depleted reserves led to the purchase. Mexico hopes to produce at least 3.5 million tonnes of sugar, tel quel, in the current season but this would be down on the previous crop of 3,593,000 tonnes and that was down on the season before. As a result of high exports, sugar stocks have been substantially reduced.

Finland campaign results, 1988/89[21]

From a slice of 1,004,556 tonnes of beet were produced 13,368 tonnes of white sugar and 20,702 tonnes of raw sugar in the 1988/89 campaign. This compares with 56,908 tonnes of white sugar and 2,764 tonnes of raw sugar produced from 451,444 tonnes of beet in 1987/88 when the crop was affected by bad weather.

Malawi sugar production, 1988[22]

Sugar production in Malawi in 1988 totalled 174,171 tonnes, raw value. Sugar cane is grown on only 14,200 hectares of estates owned by Dwangwa Sugar Corporation and the Sugar Corporation of Malawi, and by around 200 smallholders with up to 5 hectares each. All growers are producing to capacity and, since the only way to increase profits is to expand production, preliminary discussions are under way on whether to set up a new estate or expand existing ones.

Sweden campaign results, 1988/89[23]

In 1988/89, the seven Swedish sugar factories produced 288,235 tonnes of white sugar and 77,060 tonnes of raw sugar from 2,442,715 tonnes of beet.

12 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 93.
13 *Zuckerindustrie*, 1989, **114**, 170.
14 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S62.
15 *Zuckerindustrie*, 1989, **114**, 170.
16 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 76.
17 *Zuckerindustrie*, 1989, **114**, 170.
18 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 103.
19 *Zuckerindustrie*, 1989, **114**, 170.
20 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 119.
21 *Zuckerindustrie*, 1989, **114**, 170.
22 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 120.
23 *Zuckerindustrie*, 1989, **114**, 170.

France sugar imports and exports, 1988[24]

	1988	1987
	tonnes, raw value	
Imports		
Belgium	4,641	2,516
Congo	10,476	10,159
Germany, West	8,943	7,013
Guadeloupe	42,546	8,963
Ireland	1,202	0
Ivory Coast	10,690	10,000
Jamaica	0	14,472
Madagascar	12,705	11,539
Malawi	4,365	4,670
Mauritius	16,015	85,332
Réunion	195,019	147,945
Swaziland	49,357	50,178
Tanzania	0	9,600
UK	2,534	916
Other countries	1,552	2,145
	360,045	365,448
Exports		
Albania	0	2,174
Algeria	138,540	39,782
Bahrein	1,739	15,003
Bangladesh	0	44,728
Belgium	252,994	102,550
Benin	7,490	0
Burkino Faso	2,288	5,110
Cameroun	63	2,263
Cape Verde	1,630	3,804
Central African Republic	4,134	4,460
China	1,359	0
Djibouti	3,329	9,462
Dubai	0	33,743
Egypt	187,511	186,990
French Polynesia	3,986	4,808
Gambia	16,587	25,559
Germany, East	579	1,636
Germany, West	146,816	107,045
Ghana	14,274	33,726
Greece	17,038	8
Guadeloupe	1,155	1,078
Guinea	20,160	40,466
Guyana	1,387	1,500
Holland	804,317	65,703
India	23,774	132,297
Iran	0	37,175
Iraq	22,882	15,217
Ireland	4,337	7,059
Israel	0	22,103
Italy	48,425	35,087
Ivory Coast	7,228	11,688
Jordan	67,041	53,165
Kenya	5,435	17,854
Kuwait	15,544	3,825
Lebanon	15,707	25,071
Liberia	3,020	2,842
Libya	22,934	19,348
Madagascar	0	7,230
Mali	6,182	6,346
Martinique	5,800	4,696
Mauritania	17,783	40,752
Mozambique	2,462	0
Niger	11,359	23,621
Nigeria	146,943	197,550
Oman	0	24,332
Pakistan	58	69,816
Peru	76,741	47,663
Portugal	44,521	42,225
Saudi Arabia	71,524	75,275
Senegal	1,107	42
Seychelles	823	1,632
Sierra Leone	6,200	7,353
Somalia	0	9,891
Spain	97,525	82,389
Sri Lanka	416	7,893
Sudan	3,065	56,893
Syria	69,611	109,988
Switzerland	31,610	37,885
Tanzania	1	1,195
Togo	22,302	19,642
Tunisia	1,359	45,350
Turkey	0	200,873
Uganda	0	10,868
UK	21,668	6,908
United Arab Emirates	8,641	0
Yemen, North	35,387	123,478
Yemen, South	2,818	0
Other countries	26,762	28,942
	2,611,994	2,432,614

Switzerland campaign results, 1988/89[25]

The two sugar factories in Switzerland produced 137,889 tonnes of sugar in 1988/89 from 923,635 tonnes of beet, grown on 14,695 hectares.

China sugar imports, 1988[26]

Sugar imports by China in calendar year 1988 totalled 3.71 million tonnes, tel quel, up from 1.83 million tonnes in 1987.

Mauritius sugar production, 1988[27]

Harvesting of the 1988 cane crop started on June 21 and ended on December 23. Then 19 sugar factories crushed 5,517,045 tonnes of cane, yielding 634,224 tonnes of sugar, tel quel, equivalent to 672,087 tonnes raw value. In the previous season 691,134 tonnes, tel quel, of sugar was produced, equivalent to 732,946 tonnes, raw value. Average cane yield in 1988 was 71.8 tonnes of cane per hectare and average sugar extraction was 11.50%. The fall in production was largely the result of below-average rainfall during the growing season.

Hungary campaign results, 1988/89[28]

Provisional figures show an output of 476,000 tonnes of sugar from 4.2 million tonnes of beet in 1988/89, against 490,000 tonnes of sugar from 3.9 million tonnes of beet in 1987/88.

Fiji sugar production, 1988[29]

The Fiji Sugar Corporation's four sugar factories crushed more cane in 1988 but produced less sugar than in 1987. Total cane crushed was 3,185,361 tonnes and yielded 362,818 tonnes of sugar; this compares with 401,057 tonnes of sugar from 2,960,358 tonnes of cane in 1987.

24 F. O. Licht, *Int. Sugar Rpt.*, 1988/89, **121**, S4 - S5, S73 - S74.
25 *Zuckerindustrie*, 1989, **114**, 170.
26 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 121.
27 *Mauritius Sugar News Bull.*, 1988, (12).
28 *Zuckerindustrie*, 1989, **114**, 171.
29 *Reserve Bank of Fiji News Review*, 1989, **6**, (1).

PERSONAL NOTES

For personal reasons, **Mr. Peter van Berckel** has resigned as Director General of the Sugar Bureau in the UK. Pending a further announcement, **Dr. Wilson M. Nicol** will act as Director General. Following **Mr. Graham Somerville's** appointment with the Comité Européen des Fabricants de Sucre (CEFS) in Brussels, **Miss Joanna Scott** is appointed Deputy Director.

Mr. **D. I. T. Walker,** for many years Director of the West Indies Central Sugar Cane Breeding Station in Barbados, has resigned to take up a post as Technical Adviser on cane breeding at the Copersucar Technical Centre in Piracicaba, Brazil. The appointment of **Mr. P. S. Rao,** formerly Deputy Director, as Director of the Station has been confirmed.

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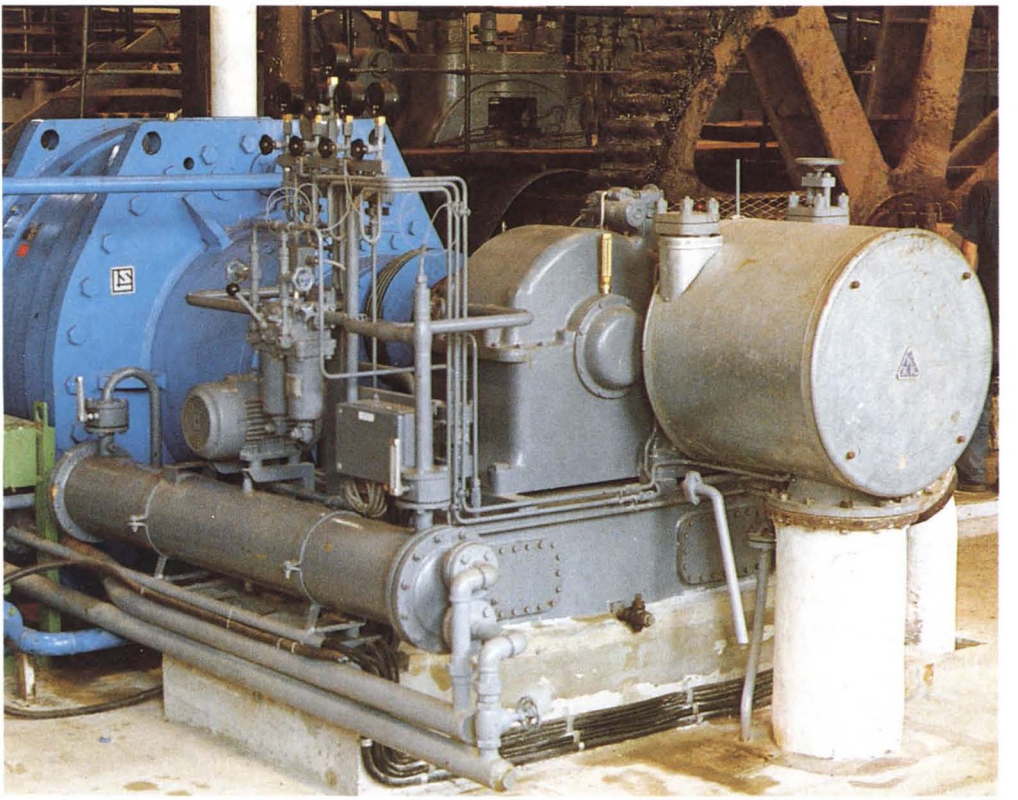

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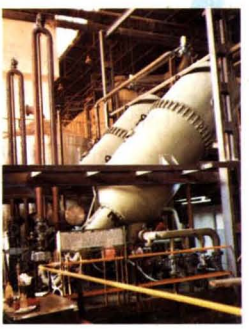

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