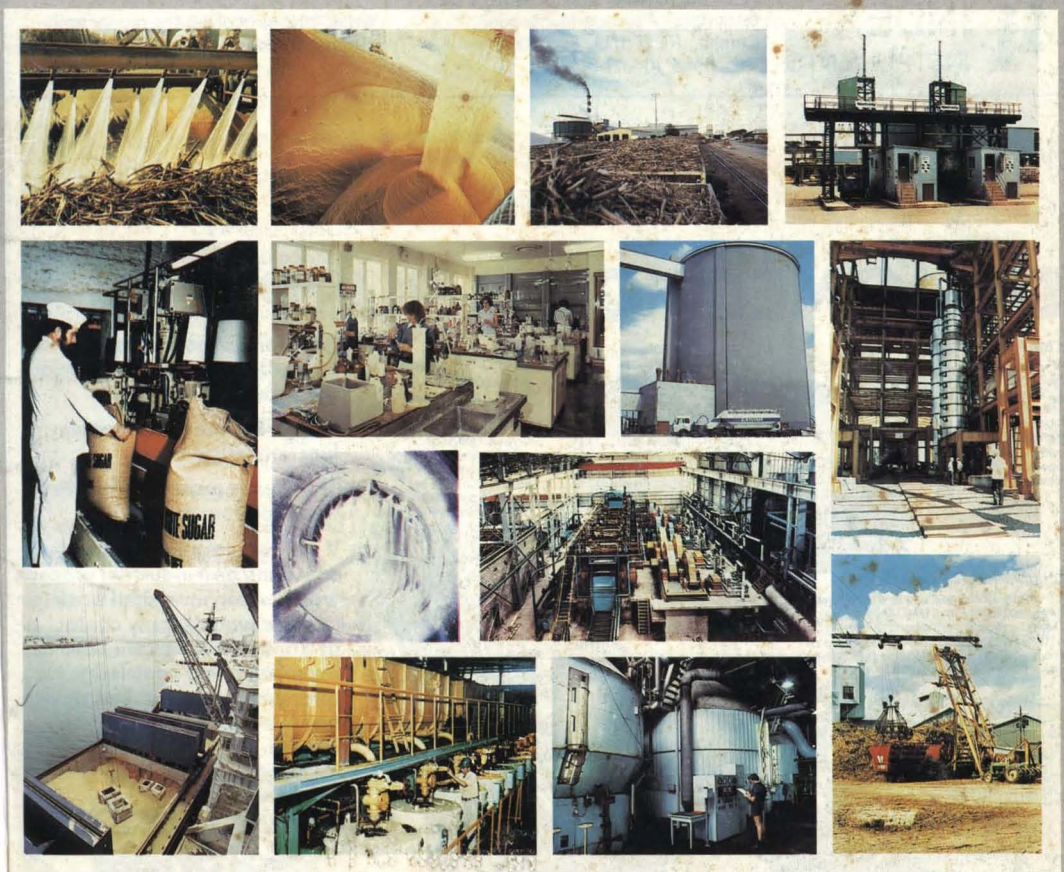
INTERNATIONAL SUGAR JOURNAL



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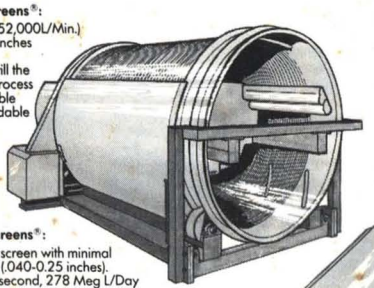

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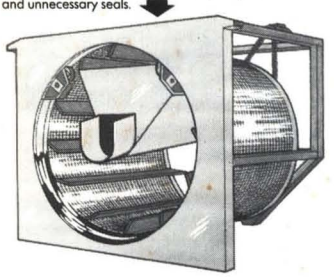

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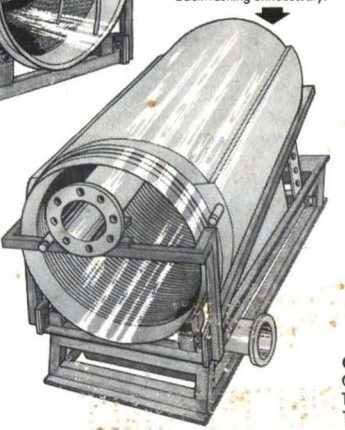

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CONTENTS

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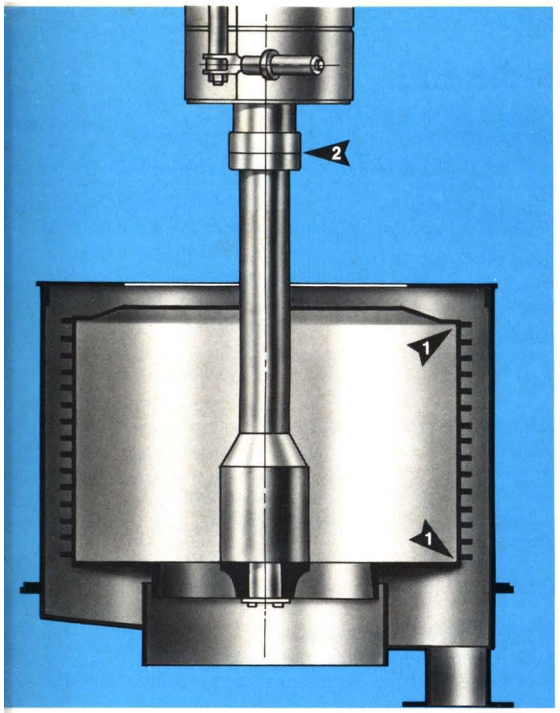

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News and views

World sugar prices

During the first three weeks of November sugar prices strengthened owing to a number of bullish factors including doubts over the availability of Brazilian sugar to meet its US export quota and other sales targets, the increase in the US sugar supply quota, expectation of further purchases by India and China, concern over the USSR sugar crop, etc. Speculative funds were drawn into the market and the London Daily Price for raw sugar rose from $344.60 on November 1 to $381.40 per tonne on November 20, while that for white sugar rose from $388.50 to $408 per tonne.

Brazil made arrangements to import large quantities of methanol and a mix of 33% methanol, 60% ethanol and 7% gasoline was proposed for fuelling the vehicles usually running on 100% ethanol. This would reduce the demand for alcohol and liberate cane for sugar manufacture, easing that supply situation. The US quota was increased but not by so great an amount as had been thought possible, and news from the USSR indicated that sugar outturn had been higher than feared and was a significant improvement on that of 1988.

Reports from China and India indicated that early purchases were not likely and as a consequence, the market readjusted during the remainder of the month, with the LDP falling sharply to end the month at $345.60, only $1 higher than at the start of the month, while the LDP(W) was actually lower, at $384 per tonne.

Pakistan sugar expansion plans[1]

The government's Economic Co-ordination Committee recently discussed sugar policy and decided to allow the setting-up of 25 to 30 cane sugar factories during the next five years, each with an average sugar producing capacity of about 40,000 tonnes a year. It now appears that the government has in mind to add about one million tonnes of sugar, white value, within the next five years, to the current production of 1.8 million tonnes. To fulfil the new scheme will require about 10,000 million rupees, besides 300,000 hectares of land suited to cane growing with the necessary inputs.

The President of the Pakistan Society of Sugar Technologists suggested at its 1988 annual convention that it would be far more economical to concentrate on extending the capacity of existing factories from an average of 2500 t.c.d. to 4000 t.c.d. by 1990 and to 5000 tonnes by 1995.

Sri Lanka sugar industry study

The sugar industry in Sri Lanka has a total installed capacity of 119,000 tonnes of sugar per annum but only produces 35,000 tonnes, about 10% of consumption. The factories are underperforming for a number of reasons, including periodic droughts. Domestic sugar production is subsidized because of lower import prices. Largely because of this and increasing sugar consumption, the government has decided to conduct a study on the industry to examine whether it should be expanded or reassessed in the light of import alternatives and its social and economic impact on farmers and consumers.

A team of consultants with expertise in sugar sector economics, corporate management, privatization, agronomics, field and processing machinery, irrigation engineering and rural credit, will prepare the study for consideration by the government. It is expected to assist the government in examining the economic rationale for improving and investing in domestic sugar production and will also help to determine its comparative advantage in terms of land use, marketability and profitability in relation to rice and other alternative crops.

Australia/USSR sugar sale contract[2]

Australia has secured a 5-year contract covering the sale to the USSR of a total of 1.5 million tonnes of raw sugar. This is the first long-term contract of the USSR with any sugar producer other than Cuba. The deal represents about 10% of Australia's exportable sugar.

Indian cane price and sugar production[3]

The Indian Sugar Mills Association has called for an immediate review of the statutory minimum price of sugar cane for the 1989/90 season. Sugar production for 1988/89 had been initially estimated at more than 10 million tonnes, white value, but production will probably only reach 8.76 million tonnes, 350,000 tonnes less than the 1987/88 output of 9.15 million tonnes. The shortfall is mainly due to large-scale diversion of cane to gur and khandsari manufacture but also to the steep decline in cane yield in most of the major cane-growing states on account of adverse agro-climatic conditions.

The fall in production, coupled with excessive releases of free sale sugar in the initial period have resulted in a very tight supply position. Stocks at the start of the 1989/90 crop year on October 1 are estimated at around 1.2 million tonnes and an output of at least 11 million tonnes will be needed to balance estimated consumption of 10.5 million tonnes and the required working stocks.

In view of the urgent need to maximize production, the commission for agricultural costs and prices appears to be favourably disposed to review cane prices for 1989/90 and to recommend their revision, so that the Association hopes the central government will make an early decision to increase the statutory minimum cane price.

Thailand factories permitted to expand[4]

A ministerial committee has decided that existing sugar factories in Thailand will be allowed to expand their production capacities and also to move to more appropriate locations. This relaxation on the limitations for existing

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 464.
2 *Financial Times*, October 4, 1989
3 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 401.
4 *Czarnikow Sugar Review*, 1989, (1789), 134 - 135.

operations will allow the sugar industry to take advantage of the likelihood of higher world market prices that seem to be in prospect over the next year or two. There have been sharp increases in land prices over recent years in Thailand and a number of cane growers have been encouraged to sell up and move to new locations. As a result there are several cane areas which are now some distance from sugar factories. Some of these have therefore found it difficult as longer haulage distances have increased cane costs and also the risks to the continuity of cane supplies. For these, the benefits of resiting the factory closer to a concentrated cane area can justify the costs of relocation. The Industry and Agriculture Ministers will consider such requests jointly and approval for such relocations will be subject to the condition that there are no existing factories already operating near to the new site.

The existing ban on opening any new sugar factories still remains in effect as there is official concern that if rapid expansion were to go ahead unchecked when export prices showed improvement, it might be difficult to sustain such operations when world prices subsequently fell back. Last August the Industry Ministry proposed to the Cabinet that this ban should be lifted but the idea was rejected and a study group has been set up to examine the situation.

Brazil sugar export arrangements[5]

After more than a decade of pressure the Brazilian Government has finally decided to take responsibility for the export of sugar away from the Sugar and Alcohol Institute (IAA) and give it to the private sector. From the beginning of June the IAA ceased to be responsible for exports, although it will still maintain a close hold on all other aspects of the industry. The removal of the export function from the IAA before rules of procedures were agreed upon for its successors created something of a hiatus and in the circumstances it may be as well that there was not a great deal of sugar which had to be shifted.

A working party, consisting of government and industry representatives, was appointed to establish the procedures to be followed by private sector exporters. The new arrangements were promulgated on September 14 and until then, in theory, no export business could be effected. However, in practice, it is understood that there were some transactions involving international trade houses with the understanding that the contracts would eventually be modified so as to comply with the new regulations when they came into force. It is some of these contracts which may have to be set aside on account of the very small export quota which has been announced.

Under the new system a quota for 1989/90 has been established but exports will not be permitted until the requirements of the domestic market have been assured. The authorities will, however, be prepared to accept a guarantee that these demands will be available when required but need not actually have been produced by the time exports from the crop are made. It has been proposed that a fund for the defence of sugar should be established with producers paying fees into it at times of high prices and being entitled to repayments when they fall.

Another, more controversial proposal is that only producers not in debt to the government will be permitted to export. This has received official approval, despite the fact that most producers in the Northeast region, the origin of most export sugar, are in debt to the government, having borrowed to expand their plants. The steps to liberalize exports should lead to an increase in national revenue; the pity is that there will be so little sugar, by traditional Brazilian standards, to reap the benefits of this.

Cane raws refining in a US beet sugar factory

The US Department of Agriculture has reported[6] that an unnamed California beet sugar factory took advantage of its geographical location, plant technology and high refined sugar prices, to process 70,000 to 80,000 tonnes of imported raw cane sugar during late 1988 and early 1989. The plant was able to operate at capacity when beet supplies were short owing to weather, disease problems and reduced acreage. At the factory, the raw sugar entered the beet juice stream and was co-processed without any need for major additions to the normal processing units. According to industry sources, co-processing of this type could become a regular occurrence, especially when refined sugar prices are high.

World sugar balance

F. O. Licht GmbH recently published their first estimate of the world sugar balance for the crop year September 1989/August 1990[7], and the summary appears below. For the fifth year in a row, world production is expected to fall short of demand and stocks at the end of the period are estimated to fall to about 30.75 million tonnes or a stocks to consumption ratio of 28%, the lowest since 1980/81. The forecast deficit in world sugar output relative to potential demand implies a strong world market, with the possibility of a rapid price rise for sugar.

By the end of 1988/89, however, there were practically no surplus stocks left and any unforeseen production shortfall will have a much stronger impact on demand than on stocks, as there is only limited room for further stocks reduction without disruption of supplies. Accordingly, consumption must be expected to be held back by lack of supply and the estimate is for a modest 1.4% increase in 1989/90 to 109 million tonnes although potential demand is thought to be around 110 million tonnes.

Consumers must be prepared to compete for scarce supplies and the question is to what level are they prepared to bid each other up or alternatively at what price will they leave the race. 1988/89 has already provided valuable insights in this respect; in spite of the

5 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 438 - 439.
6 *USDA Sugar and Sweetener Situation and Outlook Rpt.*, September 1989, 14.
7 *Int. Sugar Rpt.*, 1989, **121**, 467 - 474.

lowest stock:consumption ratio for years, raw sugar prices were unable to breach the 15 cents/lb barrier until November. In contrast to earlier times, most importers now care about prices and prefer to cut domestic demand instead of allocating huge amounts of scarce foreign exchange for sugar imports.

World production is expected to rise by 3.8% from 1988/89, the main contribution being in Eastern Europe where output is forecast to rise by 1 million tonnes. South Africa has embarked on a significant expansion program, the only one on the continent. In North and Central America, production is forecast to rise by 3%, thanks to the higher US crop and smaller increases in Mexico, Dominican Republic, Guatemala and Nicaragua.

A higher figure is set for Brazil, which brings the South American forecast up by 6%; this is because the period covered includes part of the 1990/91 crop in Brazil which is expected to show a healthy rise over the reduced 1989/90 crop which has been affected by the alcohol supply problems in that country. Asia is expected to produce 1 million tonnes more, but there is uncertainty over the Indian government's sugar policy and production in Thailand, China, the Philippines and Indonesia. A fairly secure expansion by 200,000 tonnes is expected in Oceania.

	1989/90	1988/89
	tonnes, raw value	
Initial stocks	30,953,000	33,657,000
Production	108,882,000	104,877,000
Imports	27,811,000	28,995,000
	167,646,000	167,529,000
Consumption	108,930,000	107,423,000
Exports	27,966,000	29,153,000
Final stocks	30,750,000	30,953,000
" "		
% consumption	28.23	28.81

Modern sugar market trading

Sugar technologists are well aware of the advantages for processing of the systems for data handling which have developed over the past 25 years. With the aid of computers and automatic equipment, it is possible for complex calculations and mechanisms to be adapted to save time and labour and to bring about better quality of sugar production, for instance in such diverse applications as pan boiling and the selection of optimum harvest date for individual cane fields.

Such computer-based technology has been applied in the marketing of sugar in recent years and reference was made by the Chairman of the London Futures Market to the new Automated Trading System (ATS) for white sugar in his response to the toast of "The International Sugar Trade" given by the Lord Mayor of London at the recent London Sugar Dinner at the Guildhall. This new system has encouraged expansion of traded volumes substantially and the White Sugar No. 5 Contract has become one of the most sophisticated and reliable automated futures markets in the world.

Consideration is being given to providing a facility to convert US dollar-specified trading into any currency of the EEC, while the London market, through its geographical position, has the advantage of being able to allow trading outside market hours (literally "kerb dealing" at the start of commodity trading and still known by that name) during times when the New York and Tokyo markets are open. Should demand warrant it the ATS can be used for such activities.

India sugar production prospects, 1989/90[8]

Prospects for this season's sugar crop in India are very difficult, according to industry sources. Much will depend on policy for the season, although the cane crop is currently satisfactory and the area under cultivation has risen by 3 - 4%. This is because it cannot be foreseen how much of the crop will be delivered to the sugar factories and how much to the producers of gur and khandsari. The price of gur is 600 rupees per quintal and, at this price, gur producers can afford to pay more for cane than can the sugar factories despite likely sizeable increases in state-advised cane prices. To save the country from an impending disastrous shortage, the government will have to either resort to massive sugar imports or drastically change its sugar policy regarding both production and distribution, according to Indian press reports.

China sugar supply problem[9]

Sugar traders in Tokyo are claiming that China's sugar deficit is fast becoming a crisis after a request from Cuba that it accepts delays in shipments for the rest of calendar 1989. Sugar stocks are reported to be running out and Cuban cargoes have not been arriving since June, in spite of repeated Chinese requests. Cuba asked Japan to accept shipment deferrals in October although this involved only two or four cargoes totalling less than 50,000 tonnes. Cuba's embarrassment is attributed to over-commitment and to delays in harvesting.

China has a government-to-government contract estimated at 700,000 tonnes a year with Cuba although the amount currently involved is nearer 300,000 tonnes. The sugar beet area in China fell this year from the 1988 level and stagnant cane production meant that 1988/89 output was 4.9 million tonnes, only a little above that of 1987/88. As a consequence, China was expected to buy nearly a million tonnes from the world market to meet its needs, but a swollen trade deficit, lack of foreign exchange and higher prices have combined to make this impossible.

Some traders say that the shortage has finally forced China to increase its bidding prices; early this year it was rumoured that China would only buy at below 11 cents/lb but now most Tokyo traders expect China to come in if prices dip below 14 cents.

US sugar import quota[10]

The US Department of Agriculture has raised the 1989/90 import quota by 272,915 tonnes to 2,259,865 tonnes with

8 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 508.
9 *Public Ledger's Commodity Week*, November 4, 1989.
10 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 559 - 560.

effect from November 27. This is about 13.5% above the level of quotas announced on September 12, 1989 and, like that quota, applies to the period January 1, 1989 to September 30, 1990. The increase was necessary in view of unexpectedly low US stocks and production. The quotas for individual countries are as follows:

	tonnes, raw value
Argentina	92,331
Australia	178,221
Barbados	15,031
Belize	23,620
Bolivia	17,178
Brazil	311,350
Canada	23,620
Colombia	51,534
Congo	14,215
Costa Rica	43,900
Dominican Republic	377,915
Ecuador	23,620
Fiji	19,261
Gabon	14,215
Guatemala	103,068
Guyana	25,767
Haiti	14,215
Honduras	41,736
India	17,178
Ivory Coast	14,215
Jamaica	23,620
Madagascar	14,215
Malawi	21,376
Mauritius	25,735
Mexico	14,215
Mozambique	227,914
Panama	30,798
Papua New Guinea	14,215
Paraguay	14,215
Peru	88,037
Philippines	339,265
St. Kitts	14,215
El Salvador	62,843
Swaziland	34,356
Taiwan	25,767
Thailand	30,061
Trinidad	15,031
Uruguay	14,215
Zimbabwe	25,767
	2,258,050

Pakistan sugar production, 1988/89

The cane crushing season finished at the end of June with a production of 1,818,000 tonnes of white sugar and 1.1 million tonnes of molasses. The total cane crop reached 33,631,000 tonnes (33,028,000 tonnes in 1987/88) in spite of destruction by floods in the Punjab; however, only 21,707,000 tonnes (some 64%) was crushed for sugar production while a further 18% was used for making gur and khandsari. The cane was grown on an area of 820,400 hectares (841,600 ha in 1987/88) at a yield of 40.99 tonnes/ha against 39.24 tonnes/ha in 1987/88. The yield of sugar per hectare amounted to 3.43 tonnes, white value, against 3.27 tonnes in the previous crop; this is lower than it might be since local laws require the factories to crush all cane even though at the end of the 1988/89 season the sugar content had fallen to 5.43%. Installed capacity of the factories is 118,700 t.c.d. but actual throughput was 130,258 t.c.d. In the beet campaign which closed at the end of July, 341,377 tonnes of sugar beet were sliced at the four factories which process both crops. This was a quarter less than the 459,155 tonnes processed in 1988 but the output of white sugar was reduced by only some 16%, from 37,843 last year to 31,806 tonnes in 1989, owing to a higher average sugar content of 9.35% *vs.* 8.30%. The 1989 crop was grown on 10,421 hectares, at a yield of only 32.76 tonnes/ha against 33.5 tonnes/ha in 1988. The government is trying to help by providing incentives, including free or subsidized inputs and waiving of excise duty on beet sugar. However, the small crop is attributed to the unfavourable beet price and higher costs of growing beets.

European beet sugar production, 1989/90

F. O. Licht GmbH have recently published[11] their second estimate of beet sugar production in Europe from the 1989/90 campaign. Favourable conditions have generally raised expectations especially in the USSR where an excellent crop appears to have been brought in. Overall production is now expected to reach 32.8 million tonnes, raw value, half a million tonnes more than the first estimate and nearly 2 million tonnes above the 1988/89 figure.

In the EEC dry conditions and high incidence of virus yellows did not reduce yields as expected, and slightly more sugar than last year is expected from the 1989/90 crop.Including cane sugar production in Spain and French Overseas Departments, overall EEC sugar production could reach 15,238,000 tonnes, raw value. Other West European countries are also expected to produce more sugar, significantly so in the case of Turkey, Yugoslavia and Austria.

Early drilling in the USSR and reports of improved yields led to expectations of 9.5 - 9.7 million tonnes last summer. However, bad weather in September/October and transport problems caused Western observers to scale down estimates, prematurely it turned out, since good results were reported and Licht's estimate is for a production of 9.8 million tonnes against 8.9 million in 1988/89.

Estimates for individual countries are as follows:

	1989/90	1988/89
	tonnes, raw value	
Belgium	945,000	1,005,000
Denmark	527,000	549,000
France	4,130,000	4,424,000
Germany, West	3,270,000	3,003,000
Greece	418,000	235,000
Holland	1,228,000	1,075,000
Ireland	225,000	212,000
Italy	1,825,000	1,606,000
Portugal	2,000	1,000
Spain	1,020,000	1,290,000
UK	1,360,000	1,417,000
EEC	*14,950,000*	*14,817,000*
Austria	446,000	357,000
Finland	158,000	145,000
Sweden	408,000	395,000
Switzerland	152,000	150,000
Turkey	1,520,000	1,414,000
Yugoslavia	908,000	653,000
West Europe	18,542,000	17,931,000
Albania	45,000	45,000
Bulgaria	82,000	75,000
Czechoslovakia	755,000	660,000
Germany, East	605,000	550,000
Hungary	576,000	521,000
Poland	1,8560,000	1,824,000
Rumania	560,000	450,000
USSR	9,800,000	8,913,000
East Europe	14,273,000	13,038,000
Total Europe	32,815,000	30,969,000

11 *Int. Sugar Rpt.*, 1989, **121**, 547 - 551.

Product news

Palletizing system for Tate & Lyle Sugars

Medway Packaging Systems have obtained an order from Tate & Lyle Sugars for a palletizing system to be installed on a new packing line at their Greenock refinery, replacing a manual process. The system will palletize eight layers of 25 kg and 50 kg open sacks of granulated sugar on 100 mm × 1200 mm Europallets. The installation will consist of an APR600 fully automatic palletizing machine with a single-row loading system. An unusual feature specified by Tate & Lyle Sugar will be at a remote "diagnostic tower" with a three-sided display to indicate the cause of any fault in the palletizing process. A similar indicator will be fitted to the machine itself. Low in-feed allows good visibility during palletizing. The incoming sacks are first flattened, then turned through 90° on a positive turning device; after being positioned in a single row on a driven roller section they are lifted by a fork-type loading system. The stacking height is automatically detected by a photocell sensor and the loading cycle is controlled by a PLC. The machine is fitted with a bottom sheet dispenser. At the end of the line an accumulator area will hold up to four filled pallets before these are removed by forklift.

Further details:

Medway Packaging Systems,
Medway House, New Hythe Lane,
Larkfield, Maidstone,
Kent ME20 6SH, England.

Cane mill turbine contracts

Peter Brotherhood Ltd. has announced orders worth around £750,000 for a total of seven sugar factory turbines, including three for Ethiopia in the company's first ever contract for that country. The other four machines are for sugar factories in the Sudan and Pakistan where Brotherhood has a long history of supplying equipment to sugar producers. The Ethiopian order has come via another UK engineering firm, Fletcher Smith plc, which is the main contractor for the modernization of a sugar factory at Shoa in Ethiopia. Brotherhood is to supply three single-stage steam turbines – one rated at 225 kW and two rated at 340 kW – which are due to be delivered later this year for use to drive the cane mills. The other orders include one by Fletcher Smith for a further two single-stage machines for sugar factories at Sennar and Assalaya in the Sudan, one from the Kohinoor sugar factory in Pakistan for a multi-stage 3000 kW turbo alternator set and associated equipment, and a tenth turbine for the Fauji Sugar Mill Company in Pakistan for installation at the factory at Khoski. The machine will generate 2000 kW of electrical power for use on site. Peter Brotherhood supplies turbines with power outputs from 250 kW to 15,000 kW and can provide complete turbo-alternator packages incorporating the turbine, gearbox, generator and a full instrumentation and control system.

Further details:

Peter Brotherhood Ltd.,
Lincoln Road,
Peterborough PE4 6AB,
England.

Accurate microbial analysis

Detection of a wide range of micro-organisms in the food and other industries can now be carried out simply, rapidly and automatically using the new Malthus 2000 equipment from Radiometer Ltd. The time taken to produce a test result is directly related to the initial numbers of organisms present in the sample; the higher the level of contamination the faster a result will be obtained. The Malthus 2000 can detect down to one viable micro-organism, therefore removing the need for costly and time-consuming serial dilutions. Accurate test results are available in hours rather than days and by selecting the appropriate medium a broad spectrum of micro-organisms can be quantified, including aerobic and anaerobic spore-formers, coliforms, yeasts and moulds, etc. The analyser can simultaneously test 480 individual samples over a temperature range of 5° to 56°C. Its versatility allows an extensive range of product types to be tested including clear or turbid liquids and solids. The system is completely automated, with sample handling facilities that minimize sample preparation and manipulation. Designed to operate with a user-defined IBM/AT compatible personal computer, an inbuilt menu-driven program checks to ensure precise analysis 24 hours a day. Data is automatically transferred to hard or floppy disk for storage and reports can by quickly printed or transferred as required.

Further details:

Radiometer Ltd.,
The Manor,
Manor Royal, Crawley,
West Sussex RH10 2PY,
England.

Manville filter aids folder

A new four-page folder shows how Manville's Celite rotary vacuum filter aids offer consistent quality and more efficient filtration than alternative filter aids. In addition to discussing the performance advantages of Manville marine diatomite over fresh water diatomite and perlite, the folder describes how Celite rotary vacuum filter aids provide maximum flow rates and desired clarity while virtually eliminating precoat shifting and cracking. Charts give typical particle size distribution, chemical analyses and physical properties including median pore size and permeability for the various grades. Copies are available from Manville Filtration & Minerals, 1601 23rd Street, Denver, CO 80216, U.S.A.

Bagacillo screens

A bulletin in Spanish describes the advantages of Johnson all-welded bagacillo screens, which includes extended service life, significantly greater capacity than screens with a smaller open area, and low maintenance costs. Copies are available from Johnson Filtration Systems, P.O. Box 64118, St. Paul, MN 55114, U.S.A.

New books

The sugar cane industry: An historical geography from its origins to 1914

J. H. Galloway. 266 pp; 15.0 × 22.8 cm (Cambridge University Press, Shaftesbury Road,, Cambridge CB2 2RU, England). 1989. Price: £30.00.

The author of this book is a Professor in the Department of Geography in Toronto University, Canada, and has assembled information both from his own travels and studies in libraries and elsewhere, to provide an account of the development of sugar cane cultivation and sugar manufacture up to 1914 but with a brief mention of later changes. The book is in three sections, the first describing the origins of sugar cane growing and use in the East, the second is concerned with the bringing of cane and sugar first to the Mediterranean and subsequently across the Atlantic, and the third with the developments in Asia and the Pacific Ocean region from the 18th Century. He examines changes in both agricultural methods and manufacturing techniques, together with a discussion on the social changes brought about. Readers with an interest in historical aspects of the industry will find this a useful and enjoyable work.

Handbook of sugar separation in foods by HPLC

P. E. Shaw. 171 pp; 17.4 × 25.3 cm (CRC Press Inc., 2000 Corporate Blvd. N.W., Boca Raton, FL 33431, U.S.A.) 1988. Price: $110.00.

In a time span of little more than ten years, high performance liquid chromatography has become the method of choice for quantitative analysis of sugars and other carbohydrates in the complex mixtures typified by foods and, for our industry, process liquors, etc., in preference to the inferential methods of the past which relied on polarimetry, reducing sugar reactions, etc., and even the more sophisticated methods such as gas-liquid chromatography which have their own drawbacks. The author has assembled a book of reference to all published HPLC sugar separations in foods up to 1986. He first reviews the types of sugars and polysaccharides to be found in foods and then related carbohydrate fractions such as starch hydrolysates, HFS, browning polymers, etc. He describes the development of HPLC techniques from the early studies; this covers problems encountered, sample preparation, hardware, microbore techniques, detectors, derivatization, quantitative analysis, and computer-assisted separation techniques. The larger part of the book comprises tables of individual carbohydrate separations, a number reprinted from this Journal, in each case with details of the column used (and sometimes its preparation and that of the sample), solvent, conditions and detector, as well as a reference to the original publication and comments on the separation. In almost all cases the chromatogram published is reproduced. The bibliography includes 262 references and there is a substantial index. The book is well printed and bound and will be a useful reference to all chemists employing this modern analytical technique.

Basic calculations for the cane sugar factory

J. M. Goddard. 48 pp; 21.0 × 29.7 cm. (Fletcher Smith Ltd., Norman House, Friar Gate, Derby DE1 1NU, England). 1988. Price: £10.00.

Joseph Eisner's original booklet, of the same name, was published in 1958 with the object of providing practical information to those involved in operating cane sugar factories. This is still the aim of this revised edition which has been expanded to include within its scope some of the developments in equipment which have taken place in the thirty years since the original publication. Units of measurement have been brought into the modern SI system and the quite radical changes in both process philosophy and factory equipment have meant almost complete rewriting of the book. Chapters deal individually with cane preparation, juice extraction, clarification, evaporation, raw sugar and final molasses, boiling systems, steam requirements, power and steam, the energy balance, heating surfaces, and condensers. A final chapter is a commentary on steam and bagasse, flash evaporation, evaporator sizing, superheated process steam and massecuite boiling systems. After postscripts, a flow diagram of the cane sugar factory is presented. The book is very well printed and illustrated, and will undoubtedly meet the aims of its producers. Its low price is such as to ensure considerable demand among sugar companies for the training of their staff and Mr. Goddard is to be congratulated on his work.

By-products of the cane sugar industry. 3rd Edn.

J. M. Paturau. 435 pp; 16.0 × 24.0 cm (Elsevier Science Publishers B.V., P.O. Box 211, 1000 AE Amsterdam, Holland) 1989. Price: Dfl. 285.00

Maurice Paturau is Chairman of the By-products Section of the International Society of Sugar Cane Technologists, a fitting recognition of his preeminence as an expert on the use of sugar and sugar industry materials as a source of additional income for the industry. The first edition of his book was published in 1969 and the second, completely revised edition in 1982. Since that date change in the industry has been extensive as has the improvement of technical knowledge which has transformed the prospects for a number of by-products. As a consequence, much of the text has been rewritten. The general object and presentation of the book follows the earlier pattern but more attention is paid to the production of alcohol from cane juice, applications of biotechnology and co-generation of power and steam, especially in respect of the greater energy economy possible by the use of modern equipment and techniques. Prices and production capacity data have been updated and the book now gives a more comprehensive and balanced view of by-products

continued on page 15

Sugar storage in concrete silos

At the 1988 Technical Conference of British Sugar plc, a series of papers were presented on the theme of bulk storage in the UK and the results of recent studies on silo design and construction were presented. These included model tests carried out in British Sugar and University laboratories, sophisticated mathematical analyses of the results and practical experiments at a full-scale silo. The present article is a distillation of some of the information presented at the Conference. Our thanks are due to British Sugar for assembling the expertise of the participants and our apologies to the various authors for the omission or unavoidable condensation of their work which would otherwise have required publication as a small book.

The papers include "The concrete sugar silo" by A. L. Gilbertson and I. M. Wesley (W. S. Atkins & Partners), "Silo foundation choices and performance related to site investigation data" by P. W. Rowe (Manchester University) and F. V. S. Bayliss (John Laing & Son Ltd.), "Sugar silo behaviour. I. Eccentric discharge tests at Felsted silo No. 2" by S. J. Driver and P. Dawson (Taywood Engineering Ltd.), "Sugar silo behaviour. II. Tests on sugar silo models" by R. E. Hobbs (Imperial College London) and I. H. Reith (Campbell, Reith & Hill); "Sugar silo behaviour. III. Comparison of Felsted silo and model silo" by I. L. Davies (Taywood Engineering Ltd.), "Sugar silo behaviour. IV. Preliminary studies on the use of simple models to predict the behaviour of sugar in a 12,000-tonne silo" by D. Sargent (British Sugar plc), "The quality of sugar for silo storage and the requirements of a silo in order to maintain product quality" by G. Wilson, A. W. Mason and D. Sargent (British Sugar plc), "Silo interactions" by A. L. Gilberston (W. S. Atkins & Partners) and P. W. Rowe (Manchester University); and "Implications for silo operators" by I. L. Davies (Taywood Engineering Ltd.), N. R. Twaite (British Sugar plc) and F. V. S. Bayliss (John Laing & Son Ltd.).

Introduction

White sugar is stored in many ways from bags and small hoppers to large storage compartments. At its simplest, the sugar may be piled on the ground and provided with a shed-type roof while, at its most sophisticated, the sugar may be held in a silo with fully-automated mechanical handling systems. For the detailed design of a particular facility, the operator will balance the benefits of more sophistication against the costs which will include not only first cost but also energy, maintenance, operating/manning costs, etc., and the time and money risks associated with product quality, blockages, breakdowns, etc.

All except two of British Sugar's silos are of the cylindrical prestressed concrete type illustrated in Figure 1. Whilst these have been very successful, the older units are showing their age and a program of inspections and improvements is under way. Nevertheless, it must be emphasized that the silos have been and remain a success for British Sugar, both technically and financially.

Silo design

In recent years it has been increasingly realised that the behaviour of stored materials in silos is more complex than was suggested by early theory. Similarly, full-scale monitoring has shown pressure distributions and

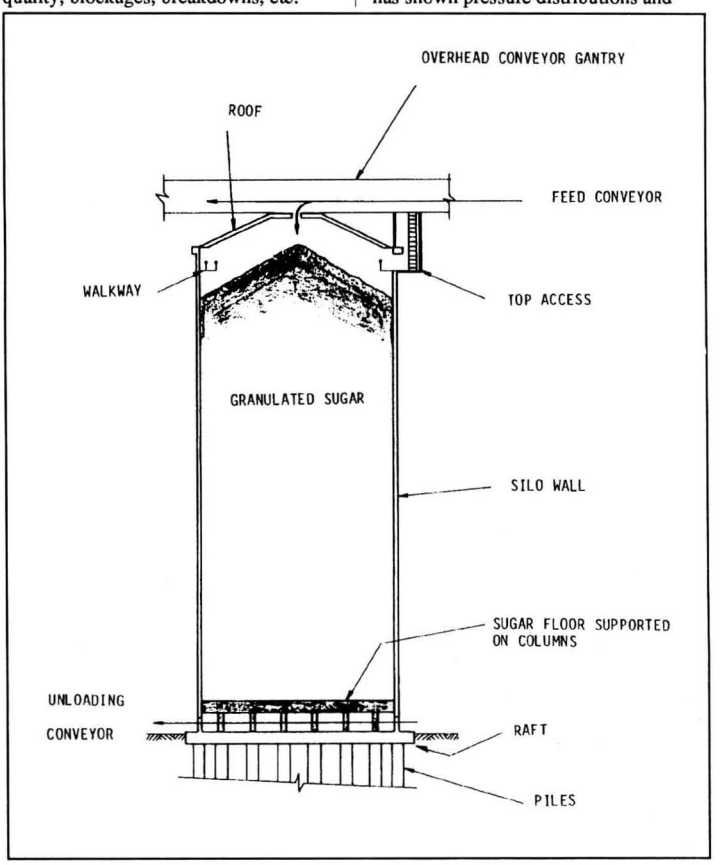


Figure 1. The concrete sugar silo

stresses to be very different from simple theoretical assumptions. The need to reappraise silo design rules has been reinforced by the fact that failures experienced worldwide were statistically more numerous than for other structures.

The silo designer has to try to meet a range of requirements which may be specified directly or in terms of performance, e.g. in terms of volume or tonnage of sugar. In practice, this will not be as simple as it seems; for instance, the usable storage volume will depend on the loading details and whether the sugar surface is left at an angle of repose. Similarly, the minimum density will require to be known in order to calculate how a given tonnage can be stored. Difficulties are normally dealt with on a basis of reason and common sense but, to avoid disputes arising out of differences of opinion, the more explicit the requirements the better.

Provision for loading

When loading the silo, sugar will normally be carried along a conveyor bridge to the centre of the silo and discharged into the storage compartment through a hole in the centre of the roof. More complicated arrangements involving multi-point loading either directly through the roof or from within a loading room below the roof carry the risk that loading will become eccentric if one or more of the loading points ceases to function or the rates of discharge are not even; this can have a significant effect upon the wall of the storage compartment.

While inside the conveyor bridge, the sugar has to be kept in a suitable environment. There will be a need for maintenance of the conveyors and spillages of sugar may occur; these factors should be allowed for in the design of the bridge which, as the main high-level link between the silos, will play a role as a route for services and also as a means of escape. As the silos settle into the ground, they may also tilt and this will be associated with lateral movements at high level. The design of conveyor bridges and their conveyors will therefore need to incorporate suitable joints to cater for such a range of relative movements as can be envisaged.

The storage compartment

The principal role of the storage compartment is to contain the sugar in suitable condition for unloading. The sugar is normally fed in warm and with a small amount of associated free and bound moisture. As it falls into the silo it creates a fine sugar dust which is potentially explosive. For this reason there are no electrical parts inside the compartment and attention is paid to the risk of electrostatic discharge. Management of the residual moisture starts during the discharge as the air in the silo is constantly circulated and conditioned to abstract moisture from the falling sugar.

When the sugar hits the top of the conical pile it rolls outwards towards the walls and the coarser particles roll more easily, leading to some degree of segregation with a finer product near the centre than at the walls. The sugar then continues to lose moisture to the conditioned air which in modern installations is forced up through the sugar from below. As the silo fills up the weight of sugar on the floor and the lateral pressures on the wall increase. By the time the silo is full the pressures on the wall will typically be as shown in Figure 2 by line B. The precise values are a mater of some debate but are less than purely "fluid" pressures (line A) and this arises from the friction of the granular sugar both internally and against the wall.

In a perfect world the pressures at a given level will be uniform around the silo; in actuality this is unlikely and non-

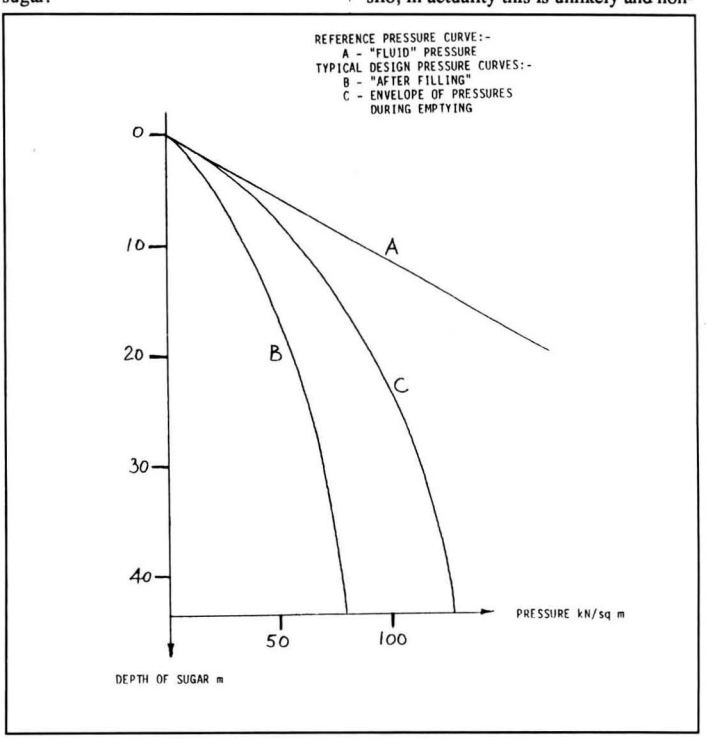


Figure 2. Sugar pressures on the wall of a sugar silo

uniform pressures will occur. If the silo is not filled centrally the pressures are liable to be even more non-uniform. With time the sugar consolidates and the surface level drops a little. The sugar cools but not rapidly because it is a poor conductor.

When the silo is emptied the stress state set up within the sugar during filling is distributed and pressures on the wall can be subject to fluctuations which give rise to uneven pressures around the wall. This again can be a more severe problem if off-centre unloading is involved. The latest silo design codes require not only greater (uniform) design pressures to be taken into account during emptying (line C in Fig. 2), which gives rise to uniform hoop tensions in the silo wall, but also non-uniform pressures which lead to consideration of its capacity to resist bending.

Loads on the silo floor are not normally as great as the weight of the contents, owing to the arching of the sugar as it presses on the silo wall. Indeed, a considerable proportion of the weight passes by friction into the walls, the precise distribution between wall and floor loads being not necessarily constant and influenced by internal movement of the sugar.

Although, like any wall, the silo appears to be massive, many thousands of tonnes of sugar are held and move around inside a relatively thin skin of reinforced concrete. The secret is to ensure that the skin is strong, robust and durable enough to deal with the occasional extreme statistical events which we know from experience will occur. Having decided to build a silo wall, the costs of providing a slightly thicker wall and better reinforcement are, from the aspect of the long-term benefits, an excellent purchase.

Silo unloading

Some operators use mechanical bottom unloading equipment but sugar in British Sugar's silos is discharged by gravity through a pattern of outlets in the flat floor, the centre outlets used initially and the outer ones in the later stages of emptying. Each outlet is conical in shape and, when not in use, is closed with a fabric "sock". If sugar does not flow out well because of crusting within the silo, a steel rod is used to clear the blockage. The sugar from the outlets is carried by mobile conveyors to a fixed conveyor which runs along the centre of the silo and normally under a number of silos.

Large tonnages of sugar pass through the unloading room and it contains a forest of columns to transmit the weight of the stored sugar to the foundations. It is finished to a high standard and may have under-floor heating and air-conditioning.

Maintenance

Maintenance of a silo is a long-term affair; if a 50-year life is aimed at, there will need to be a program of inspection and renovation. There are few materials which do not degenerate with time, and reinforced concrete is subject to a range of potential problems which are only now becoming understood. In particular, the passive protection given by the naturally alkaline concrete is progressively reduced as atmospheric CO_2 neutralizes it; this permits corrosion of the steel reinforcing bars and once these start to rust the concrete cover is "blown off", destroying the structural integrity of the member.

Problems are not necessarily due to material degeneration, however. Progressive distress of heavily stressed parts of the structure may develop over a period of years, or there may be a construction fault as in the case of movement of a jacking rod inside the freshly cast concrete wall which can subsequently lead to the progressive formation of a bulge in the wall.

Ageing itself is less easy to identify but the continual stressing and flexing of the silo walls as the silo "works" and also due to temperature and settlement effects, will also contribute. Once a particular ageing risk has been identified in a family of silos it is necessary not only to repair any immediate damage to allow proper use of the silo to continue, but also to check for the fault generally and to keep watch for it in all future inspections.

Silo foundations

The prime requirements for the foundation are adequate strength and appropriate stiffness. The weight transmitted into the ground by a silo is very large and the volume of soil influenced by a silo is correspondingly great, so that settlement can be a major problem. Careful consideration must be given to both whole-body settlement and also differential settlement, because the silo is not a solid block and its foundations will flex, affecting the structure above. Piling is frequently necessary to carry loads down to good load-bearing strata.

Foundations distribute the gravitational load of silo and their contents into the ground. They are buried and out of sight; if they perform adequately they will also be "out of mind". If the ground is sufficiently strong the silo shell can stand on a shallow raft which serves to spread the load (a) in Figure 3. Alternatively, if soft soils overlie a strong stratum at depth, vertical end-bearing piles can support the raft on this stratum, (b) in Fig. 3. Where the ground becomes stronger with depth without reaching an identified high bearing stratum, a floating pile group can serve this purpose, (c) in Fig. 3.

An adequate foundation is one that permits the silos to be operated as intended; this does not mean that there shall be no movement during construction and first filling, but it does mean that the silos should not (i) fall over, (ii) settle and tilt to an extent that prevents complete filling or mechanical operation of the headhouse or conveyors, or (iii) distort to such an extent as to crack the superstructure and endanger or cause a collapse.

Where the ground at or near the surface is relatively weak, or of variable quality, the foundation engineer will examine the alternative costs of raft and piled foundations. The cost of the latter will be very dependent on the stratific-

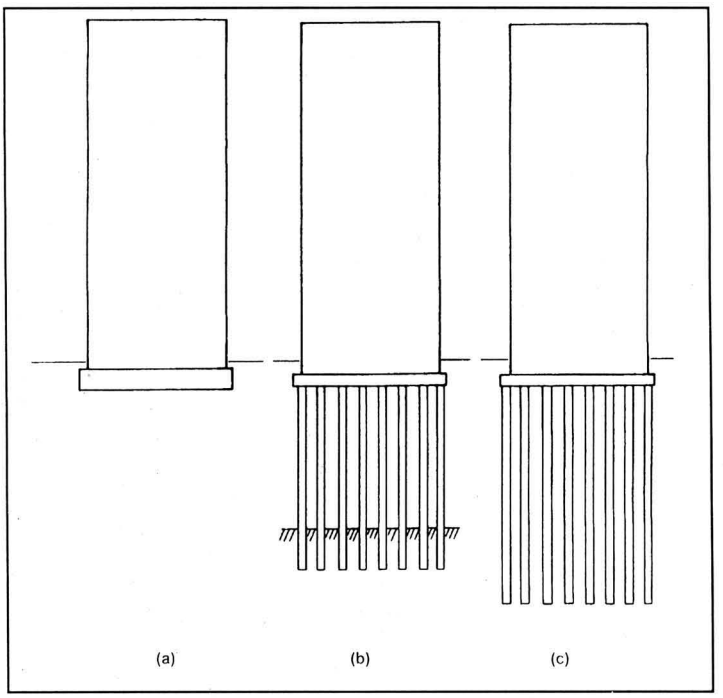


Figure 3. Raft foundations

ation and nature of the ground, more so than is the case with surface rafts.

Concrete piles are by far the most commonly used in Britain and can be as small as 100 mm or as large as 3 metres in diameter. Steel piles can also vary in size over a wide range but, as they can only be installed by pile driving, their application is limited. Concrete piles are installed either by driving or boring. Driven piles, which displace the ground during driving, are limited to the smaller and medium sizes and can be either of precast concrete or formed of wet concrete placed in the hole produced by driving a steel tube into the ground. Bored piles are available through a range of sizes and are installed by a variety of methods.

The sugar silo load regime

A sugar silo imposes a very heavy load upon the ground in relation to its plan area. Furthermore, the load is not evenly distributed; there is a heavy ring load around the perimeter which is due to the frictional forces exerted by the sugar on the silo walls. Within the walls the pressure of the sugar upon the floor is fairly evenly distributed by the columns which support the sugar floor and carry this pressure down to the foundation as a series of point loads.

Depending on the method of sugar extraction the proportion of the total sugar load carried by friction on the walls and by direct pressure on the floor will vary during unloading from the initial static case. It is not known precisely what these proportions are and how they vary and, in designing the foundations, it is desirable to have a degree of excess total pile capacity to deal with the likely extremes of maximum ring load and also of maximum column load, since these maxima occur on different piles at different times.

The ideal arrangement to concentrate support to correspond to the concentrated load, is to have a single ring of large piles under the wall and a single large pile under each sugar floor column. It is not always possible to do this and double rings of piles around the wall and small groups of piles under each column are common. These still require a system of load spreading which may be individual concrete blocks or pile caps for the columns and a concrete ring beam for the wall. Alternatively, it may be a concrete slab of more less uniform thickness covering the whole foundation area, and similar to a raft foundation.

Account must be taken of the fact that, when piles are loaded, they and the surrounding soils compress, leading to what is known as settlement, greater loads leading to greater settlement. Differential settlement will occur between the settlements of piles supporting the silo wall and those supporting the floor columns. This can be limited by ensuring load carrying capacity well in excess of what is needed, or by use of a stiff load-spreading raft. Alternatively, the two groups of piles can be isolated from one another.

Silo deflection during discharge

A series of four tests were carried out on a 12,000-tonne sugar silo at British Sugar's closed factory at Felsted during 1985/87 to investigate the deflection of the silo under various discharge regimes. In three of the tests sugar was discharged at ports with progressively increasing eccentricities; in the other test, deliberately crusted sugar was discharged from a range of ports generally within the radius defined in the silo's recommended operating instructions.

Measurements of the settlement of the silo base slab were made throughout the tests and during the intervals between them. By comparing the displaced shapes of the base slab and the silo shell, the deflections of the silo were related to the quantity of sugar in the silo, in the adjacent silo, and to the particular discharge regimes.

ISJ Abstracts

Cane sugar manufacture

Control systems of the SRI continuous high-grade pan at Maryborough

L. W. Davies, J. F. Knight and D. J. O'Loughlin. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 162 - 167.

Details are given of the automatic controls on the pan described by Broadfoot *et al.*[1]. A Bailey Network 90 distributed process control system used also controls three out of eight batch pans and can be connected to a system for control of milling and one of two boilers. During trials conducted in 1988, all the systems were found to perform satisfactorily, early difficulties with contactless probes being largely overcome by installing improved versions, although further development work is needed on conductivity control which could be replaced by mobility sensing. In general, the various types of valve used in the pan have operated successfully.

An evaluation of several sensors for feed control of vacuum pans

K. F. Miller and N. G. Skippen. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 175 - 183.

Tests were conducted on a standard single-probe conductivity electrode, a Foxboro electrodeless conductivity probe, a SRI resistance-measuring contactless probe and a K-Patents pan refractometer as means of pan feed control. The advantages and disadvantages of each type are listed and their performances in *B*-massecuite boiling discussed. While all the sensors tested would be suitable for high-grade massecuite boiling control, the SRI contactless probe would be preferable provided the zero and span settings were properly adjusted following installation. Although the pan refractometer gave a very good indication of mother liquor Brix, it would be unsuitable for control purposes because of its high cost and slowness in detecting any changes when the set point was altered to higher values; however, it could be of use in monitoring and optimizing the graining point conductivity set point.

The estimation of massecuite flow changes resulting from alterations in raw sugar purity

P. G. Wright. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 184 - 190.

The SRI Panflo mass flow program developed for a typical 3-massecuite boiling scheme as used in Australia was modified to take account of the rise in high-grade molasses purity when washing in the centrifugals is used to raise the sugar purity to very high levels. The program was then applied to calculation of the changes in low-grade massecuite flow and in the total high-grade massecuite flow with alterations to the specified product sugar purity. The results are discussed with the aid of diagrams. The procedure used is considered of potential value in indicating the cost and capacity implications of changes in the specification of raw sugar to be supplied.

Pilot-scale evaporator design and operation for the evaluation of antiscalants

S. J. Clarke. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 191 - 198.

A system is described in which a tube evaporator and a plate evaporator containing removable elements were used to concentrate clarified juice at Raceland factory in Louisiana in a study of scale formation and of the performances of anti-scale agents. Each evaporator could be operated separately. Copper tubes and copper and stainless steel plates were used. The equipment worked well but it was not possible to maintain constant feed rates so that the evapor-ation rates could not be monitored continuously; installation of positive displacement pumps on each of the juice feed lines will overcome this problem. The composition of the scale on the plates is discussed and electron micrographs of treated and untreated scale on copper are presented. Of the anti-scale agents tested (Polystabil UZ, Acriflow 241C, Fabcon I-12 and Taloscale), only Taloscale reduced scale formation while most of the others increased scale thickness; the chemicals also caused the scale to become amorphous (rather than, at least partially, crystalline) and increased the silica content.

Substitution of evaporator supply juice (ESJ) for process water at North Eton mill

R. G. Attard. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 199 - 206.

Water was replaced with clarified juice for: pan calandria washing, the sugar arrestor spray system on the granulator, dilution of high-grade *A*- and *B*-molasses, *C*-sugar dilution and remelting, washing of sugar in the *A*- and *B*-centrifugals and dilution of clarification flocculants. The effects on each of the process stations involved are discussed. Replacement of a total of 27.4 tonnes of process water per hour with ESJ increased clarified juice throughput by 7.1% which contributed to an increase in the average crushing rate from 335 to 364 tch with minimal capital outlay and saved 3.3% of the mean boiler steam output. Sugar colour, pol and reducing sugars:ash ratio were not appreciably affected by the use of ESJ for centrifugal washing but the purities of *A*- and *B*-molasses rose by an average of 0.05 and 0.35 units, respectively.

Sugar losses in lime saccharate formation

M. B. Stringer, M. L. Clarke, C. D. Doyle and E. A. Sumpter. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 207 - 214.

Because of the very high pH to which syrup is exposed during lime saccharate preparation, there is some reducing sugars degradation and an increase in the organic acids concentration as well as alkaline degradation of sucrose. When the pH is adjusted and the syrup is

returned to the juice stream, the reducing sugars level in the juice falls and the organic acid (and hence ash) content rises. An investigation of the effects of change in the milk-of-lime concentration (1.5, 3.0 and 4.5M) and temperature (50, 60 and 70°C) in a laboratory-scale lime saccharate tank operated under simulated factory conditions at a syrup:milk-of-lime ratio of 3:1 showed no change in sucrose concentration, but a substantial degradation of reducing sugars at a rate that was proportional to temperature and milk-of-lime concentration and a major change in the C_6-saccharinic acids and lactic acid concentrations (but not in aconitic acid) that did not account for the total amount of reducing sugars decomposed. Calculation of the costs of lime saccharate preparation in terms of sugar loss and lime consumption minus the value of the increased molasses for a typical factory showed 50°C to be better than 70°C and a milk-of-lime concentration of 4.5M to be preferable to the normally used 3.0M.

The modified feed SRI subsider at Rocky Point mill

D. J. Hale, W. J. Walker and A. L. Bressow. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 215 - 219.

With the conventional 2- point, 3-point and 4-point feed systems on the SRI clarifier (for diameters of <7 m, 7 - 10 m and >10 m, respectively) juice enters the combined annular feed launder/feed well tangentially via opposed feed chutes and flows in the same direction as the scrapers. When a Sargeants multi-tray clarifier was altered to the SRI design at Rocky Point, it was decided to incorporate a 2-point radial feed system. The juice, split into two equal streams by the distributor, flows to two internal feed pots where flocculant is added and then flows up the pots to be discharged radially into the feed launder where it is split so that half of the flow is co-current with the direction of rotation of the two sand scrapers and the other half is counter-current. Tests showed good flocculation and excellent juice clarity with no sand accumulation in the feed launder. The chief advantages of the feed system are the simplification of fabrication, installation, operation and supervision. Tests on a simulated single-point feed system that would have even greater advantages than the 2-point system gave encouraging results.

Development of a test technique to evaluate mill brass lubricant performance

D. J. Hargreaves. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 220 - 225.

Results of standard ASTM (American Society for Testing Materials) tests for lubricants may fail to indicate performance under normal operating conditions. An apparatus is described for evaluation of the performances of cane mill brass lubricants. Details are given of the test procedure used and results of preliminary tests are discussed. Possible modifications are indicated; they include an improved lubricant feed system, a bearing pressure closer to that employed under normal factory conditions and a wear assessment technique employing a Talyrond (normally used to determine the roundness of circular shafts and bushes) coupled to a personal computer.

Design and operational aspects of Macknade's sugar dryer station

J. C. Baird and R. M. Beatts. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 237 - 245.

Details are given of a raw sugar drum dryer/cooler with a rated capacity of 100 tonnes/hr and a nominal speed of 4 rpm; it is inclined at 2.5° to the horizontal to provide an adequate residence time (nominally 8 min) and contains 24 serrated double-sided flights which have an optimum included angle of 105° for a sugar angle of repose of 40 - 55°. On-line near infrared reflectance is used to measure sugar moisture and pol; a calibration check over a 2-week period showed a long-term correlation coefficient for moisture that was better than 0.95 (with daily coefficients >0.98) in the range 0.1 - 0.6%, while pol accuracy is generally better than 0.1°S. Instrumentation for sugar and air temperature and moisture content at feed and discharge is listed.

Cusum charts as an aid to monitoring factory performance

G. F. Longden and R. N. Cullen. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 253 - 257.

Cusum values are calculated as the continuous cumulating deviations from a normal or target value. Charts plotted from a series of values are of particular value in indicating trends from short- and long-term changes in process means and hence in providing a more accurate assessment of process efficiency. Examples presented and discussed compare true and target bagasse moisture contents over a crushing period at one factory and compare the pol in open cells, No.1 mill bagasse moisture and final molasses approach to expected purity at three Bundaberg factories.

Availability of natural gas in India and its use in sugar factories for cogeneration and bagasse fibre saving for the paper industry

D. P. Sharma. *Indian Sugar*, 1989, **38**, 951 - 955.

Following the discovery of large reserves of natural gas in various regions of India, the author examines the case for using the gas to fuel boilers and thus release more bagasse for use in paper making. The gas and steam requirements are calculated for a 2500 tcd factory as well as the economics.

Preparation Index and mill extraction in Indian sugar factories *vs.* sugar factories in Australia and South Africa

P. J. M. Rao. *Bharatiya Sugar*, 1989, **14**, (6), 11, 13, 15, 17, 19 - 20, 25, 27, 29, 31 - 33.

See *I.S.J.*, 1989, **91**, 90A.

Beet sugar manufacture

Sugar screening and screens

P. Wodzinski. *Gaz. Cukr.*, 1989, **97**, 31 - 35 *(Polish)*.

Aspects of sugar screening are briefly discussed and a survey is presented of screening equipment and sugar feeders.

Buckling of the circumferential surface of centrifugal baskets provided with reinforcing rings

H. Houben. *Zuckerind.*, 1989, **114**, 295 - 302, 305 *(German)*.

While, once they have been welded, cylindrical centrifugal baskets with shrunk-on reinforcing rings do not need any further mechanical treatment in their manufacture (of advantage as regards production costs), it is important to ensure that every care is taken in their production. However, slight dents or protuberances are unavoidable in the longitudinal welds so that imperfections occur in the curvature. Analysis of this deviation from the desired geometry and calculation of the stress distribution in a buckled area show that the stresses will be below the level of metal fatigue for both side sheet and reinforcing rings provided the spread of the buckle does not exceed 5% of the basket circumference. Comparison of measured and calculated tangential stresses in reinforcing rings showed good agreement.

Practical use of Filtermat filters for the sugar industry

F. G. A. de Vreede, A. P. M. Backx and A. Timmermans. *Zuckerind.*, 1989, **114**, 331 - 332.

The Filtermat filter is a horizontal self-cleaning unit containing a cylindrical woven mesh wire screen protected on the inside by a coarse screen that collects random large particles; juice or water flows from the inside to the outside of the screen. Backwashing in a special rinsing cycle is used when sufficient cake has accumulated on the screen to cause a differential pressure, while a rotary tubular dirt collector sweeps the screen. A Filtermat battery of five units at Dinteloord factory is used to filter 70 - 74°Bx thick juice at 90 - 95°C and a throughput of 130 - 140 m³/h. The screen has a mesh of 50 μm; operating pressure is 2 bar and the rinsing cycle with thin juice starts at a differential pressure of 0.8 bar, during which only one unit at a time is treated while the others continue to filter. In 1987 the average insolubles content was reduced from 1400 to 11.2 mg/litre.

Comments on: Optimization of diffuser draft and sugar loss

G. V. Genie. *Zuckerind.*, 1989, **114**, 333 - 334.

The nature of the characteristic plant curve described by Andersen[1] relating pulp losses to diffuser draft is discussed. Curves are drawn of the relationship for different values of N, the number of transfer units which is a measure of diffuser efficiency and which has tended to decrease over the years with increase in pressed pulp dry solids content. A mathematical model of diffusion[2] is mentioned and its use to determine the pattern of the characteristic plant curve of a tower diffuser demonstrated.

Current problems in the Polish sugar industry

S. Urban. *Zuckerind.*, 1989, **114**, 340 - 341 *(German)*.

The current status of the Polish sugar industry, with 78 existing sugar factories and one planned, is examined and the structure of the industry described. Difficulties associated with full implementation of an economic reform program included the restriction on rapid increase in sugar production imposed by the level of beet production and factory capacity and the inability to make the industry financially independent because that would have entailed raising the price of sugar to a prohibitive level, although in 1985 the price was increased sufficiently to guarantee profitability and allow the discontinuance of monetary aid. Further measures are listed as well as changes in organization and administration and steps to improve the motivation of factory and field workers.

Computer-assisted analysis of an RT2 diffuser station at a beet sugar factory. I. Modelling and simulation of the station

T. Bounahmidi, A. Haida, M. Kaab and R. Salim. *Sucr. Maghrebine*, 1988, (37), 3 - 11 *(French)*.

A physico-chemical model has been developed to simulate the steady-state operation of one of two RT2 rotary diffusers (plus prescalder) operated in parallel at Sidi Bennour factory in Morocco; the parameters of the model, which allows for the transient nature of the process and for non-ideal flow within the diffuser, were obtained experimentally and with the aid of correlations found in the literature. The simulation technique used is described. Comparison with measurements taken at Doukkala sugar factory showed that, while the model was reliable in calculating juice Brix and flow and pulp losses, it did not allow for possible sucrose degradation by infection and/or inversion (although the model is currently being revised to include this). Prediction of juice non-sugars content was also considered reasonable, subject to comparison with very precise measurements of non-sugars in different compartments.

Evaluation of losses by respirometric measurements

D. Destombes and B. Noe. *Sucr. Franç.*, 1989, **130**, 85 - 86 *(French)*.

Respirometry revealed daily sugar losses in stored beets that were 9% greater in beets that had been cleaned at the field clamp before transport to the factory than in dirty beets (140 *vs.* 128 g/tonne of beet). Measurements also compared the effects of using a bladed topper and a Garford rotary skew bar topper on storage losses. Under normal conditions, sugar losses were the same, but oper-

1 *I.S.J.*, 1989, **91**, 108A.
2 *ibid.*, 1986, **88**, 127A.

ation of the Garford type at greater pressure to improve the topping quality increased losses. The bladed system gave a much greater proportion of untopped beets and, because of this and the rapid blunting observed, is considered of little value; however, the Garford system gave a considerable proportion of beets that were topped at an angle and caused numerous crevices that were quickly invaded by mould.

Attempts to optimize sulphitation

P. Bourlet and J. P. Lescure. *Sucr. Franç.*, 1989, **130**, 117 - 126 *(French)*.

Investigations showed that, despite a correlation between the SO_2 content in sugar and that in thin juice (and hence the sulphitation dosage) and a correlation between sugar SO_2 and colour content, the relationship between sugar colour and the SO_2 dosage in sulphitation is too weak to be used for optimization of sulphitation, so that the dosage rate must still be decided largely on an empirical basis. The main obstacle lies in the considerable variability in juice composition which is probably linked to beet quality and the initial stages of the manufacturing process.

Dialogue between operation and control. Cheops and Cleopatra systems

M. Baudot, J. P. Delannoy, A. Deleurence and G. Windal. *Sucr. Franç.*, 1989, **130**, 129 - 132 *(French)*.

The Cheops software system is designed to provide hierarchic supervisory control of boiling house operations while Cleopatra is a data management system. The two can now be integrated in a network and used on microcomputers as at Chevrières sugar factory where a shared database permits dialogue between them for control of the 1st strike (involving two standard liquor tanks, four batch pans, two mixers and five batch centrifugals). A Modumat 800 digital controller reads the data supplied by Cleopatra (Brix, pressure, flow, level, etc.) every 5 minutes; the required calculations are carried out simultaneously and an hourly average determined and stored in the Cleopatra database. The computer using the Cheops program is connected to the control network and to the Modumat 800; some of the information is used directly by the Cheops system and other data are sent to Cleopatra which also stores data from Rameses, the evaporator computer system. Since some of the thick juice is stored (under Cheops control), boiling house operations are not governed by syrup feed but by the maximum possible production of a given massecuite. The benefits of the system are discussed.

Industrial efficiencies of optimum evaporator operation. Rameses system

G. Windal, B. Portales and P. Crevits. *Sucr. Franç.*, 1989, **130**, 137 - 140 *(French)*.

After satisfactory results were obtained in automatic evaporator control using the Rameses system at Lillers factory in 1987, some improvements were made with the aim of regularizing the steam supply from the boiler or reducing the marked fluctuations due particularly to changes in the processing rate at the front end of the factory and to periodical washing of the evaporator entrainment separators. The system as used in 1988 includes four modules for monitoring the pressure in the 1st effect (on which depends the use or not of recompression), juice flow adjustment before the evaporator, Brix stabilization during evaporation and final juice Brix control. The modified system allows Brix to be maintained at ± 1 - 1.5° when thin juice flow does not vary by more than 15 m^3/hr from a nominal of 400 m^3/hr.

Heat transfer during evaporation of technical sucrose solutions in falling-film evaporators

S. Kurudis and W. Mauch. *Zuckerind.*, 1989, **114**, 385 - 391 *(German)*.

A method is described for calculation of steam- and juice-side heat transfer coefficients in a falling-film evaporator; the method makes use of an empirical equation with which the overall heat transfer coefficient k can be found from the mean kinematic viscosity. Examination of the effects of various process parameters on heat transfer shows that Brix has the greatest influence; changes in tube length and coverage by the juice (m^3/hr/m) had negligible effect.

Investigations of the bulk density of sugar with regard to storage conditions in silos

M. Kaminski. *Zuckerind.*, 1989, **114**, 392 - 394 *(German)*.

The bulk density of sugar was determined by feeding it through a sieve down into a cylindrical vessel with and without shaking down and applying vertical pressure of 0.01 - 0.784 mPa, and by feeding the sugar from varying heights in the range 0.1 - 3.0 m. The sugar had a crystal size in the range 0.06 - 2.00 mm; 10% measured <0.5 mm, 12% measured >1.0 mm and the rest 0.5 - 1.0 mm. The bulk density was highest for the entire crystal size range where the sugar was shaken down, while the lowest was for sugar of 0.75 - 2.00 mm that was loosely fed without shaking down. Change in the height from which sugar was fed in the range 0.1 - 0.5 m had little effect on bulk density, which however gradually increased with rising height above 0.5 m, particularly at 1- 2 m, after which the increase became smaller with greater height. Where pressure was applied to the sugar, the greatest rise in bulk density occurred with small vertical loads, after which the changes were directly proportional to the changes in pressure. The maximum bulk density for loosely fed sugar to which pressure was applied was lower than that for sugar shaken down and not subjected to pressure; in the overall crystal size range, application of 0.280 mPa pressure to shaken sugar gave the highest bulk density of all (9.43 kN/m^3), and it is suggested that silo loads should be based on bulk densities in the range 9.0 - 9.5 kN/m^3.

Energy saving in modified carbonatation - experimental and practical results

W. Lekawski, J. Serafin and K. Urbaniec. *Zuckerind.*, 1989, **114**, 401 - 404.

Investigations are reported on the two methods described earlier[3,4]. In one set of experiments, carbonatation was conducted at a pressure of 0.10 - 0.35 MPa (abs.) with dry, cold gas at a feed temperature of 26°C, while in another set the gas (used at the same pressure) was saturated with hot water to approx. 100% R.H. and a feed temperature of 70 - 72°C. The CO_2 utilization rate was 65 - 80% with the cold gas and 68 - 88% with the hot gas. The ratio of heat loss to enthalpy flow in juice at the tank inlet with the hot gas was about half of that for the cold gas at atmospheric pressure but was only about one-third of it when the pressure was raised to 0.15 MPa. In 1987, 1st carbonatation was carried out (not under pressure) at Olmedo sugar factory in Spain with gas heated by condensate at 88°C in a scrubber provided with plastic Raschig rings; at a gas feed temperature of 73°C the CO_2 utilization rate was 82.2% compared with 76.8% where dry, cold gas was used at a feed temperature of 37°C, while the juice temperature drop was 2.6°C compared with 4.4°C, corresponding to a reduction in heat loss of about 40%. At Wozuczyn factory in Poland, condensate at 96°C was used as heating medium. Depending on factory conditions and carbonatation parameters, a steam saving of 0.8 - 1.6 kg/100 kg beet is attainable; however, conducting carbonatation under pressure involves extra capital and running costs.

Low cost - high quality: British Sugar's recipe for staying ahead in the nineties

M. Branch. *British Sugar Beet Rev.*, 1989, **57**, (2), 41 - 45.

Aspects of the British Sugar investment program aimed at increased efficiency and quality control are outlined, including the continued construction of flat pads for beet storage, measures to reduce fuel consumption and lime usage and the introduction of modern automatic control systems.

Anti-foam agents in sugar manufacture

S. Bertuzzi. *Ind. Sacc. Ital.*, 1989, **82**, 51 - 54 *(Italian)*.

The effect of saponins and protein on foam formation in flume water and factory processes is discussed and the anti-foam effect of 0.1% CaO addition to flume water to maintain a pH >10.5 at which saponins do not solubilize indicated. Desirable properties of anti-foam agents and conditions responsible for loss of their efficiency are described. Advice is given on addition of anti-foam agents in diffusion. No special measures are normally needed in juice purification provided the equipment (particularly pumps) is operated properly, but juice entering the settlers must be properly deaerated; if anti-foam agents are used, it must be remembered that 40% of the quantity used will pass via thin juice to thick juice. Controlled foam formation in the 1st evaporator effect is of benefit in promoting heat transfer. In boiling, although foam that forms in the vapour bubbles reduces heat flow, heat transfer can only be accomplished with the formation of bubbles, so that controlled foaming is essential. General use of continuous centrifugals has led to an increase in air entrapment in high-viscosity run-offs; molasses viscosity rises steadily with air content while air in *B*-massecuite causes particular problems in cooling where this is preceded by centrifugalling.

Colour of thick juice in relation to the use of ammonium bisulphite in diffusion

B. Carlesso. *Ind. Sacc. Ital.*, 1989, **82**, 55 - 59 *(Italian)*.

The continuous dosing of ammonium bisulphite (equivalent to a raw juice SO_2 content of 240 - 250 ppm) at the head and of calcium bisulphite at the tail of the DDS diffuser as pulp pressing aids and disinfectants at Mezzano white sugar factory reduced the colour of thin and thick juices by 30 - 35% by comparison with the levels at two neighbouring sugar factories not adding the bisulphites. There was a 80% drop in colour per unit non-sugars between thick juice and molasses and the white sugar colour was also lower. Because it caused corrosion in the diffuser and pulp conveyor, Ca bisulphite was subsequently replaced by Ca sulphate. (See also Vaccari *et al.*: *I.S.J.*, 1987, **89**, 25A.)

Hairline cracks in circular welds between the top, bottom and outer shell of centrifugal baskets

H. Houben. *Zuckerind.*, 1989, **114**, 457 - 463 *(German)*.

Calculation of stress concentrations at hairline cracks in circular welds between the top, bottom and outer shell of centrifugal baskets showed that repairs may be carried out by simple machine grinding provided care is taken in choosing the correct geometry of the groove. Advice is given on how to avoid hairline cracks caused by corrosion below the weld.

Energy reduction by vapour compression

K. Bøggild and K. Andersen. *Zuckerind.*, 1989, **114**, 478 - 481.

A Sulzer Escher Wyss single-stage turbo-compressor was installed at Nakskov sugar factory in 1986 for recompression of 2nd effect vapour which is then introduced into the two bodies making up the1st effect together with exhaust steam. A bypass valve is used during start-up and when the compression requirement is below the minimum compressor output. The system is provided with pressure control in the 1st effect and a microcomputer-based surge control. Fuel consumption in 1986 (when the total heating surface of the evaporator was also increased) was 2.51% *vs.* 2.83 - 2.92% in 1982/5.

3 Lekawski & Urbaniec: *I.S.J.*, 1986, **88**, 69A.
4 Bogumil: *ibid.*, 1987, **89**, 27A.

Sugar refining

Computer control of flow through a resin station consisting of sixteen cells arranged in three batteries

J. A. Fitzpatrick. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 14 pp.

The resin plant at Thames refinery in London is housed in two separate buildings about 50 m apart, one for decolorization of filtered liquor and the other for resin regeneration; all operations, including transfer of resin between the buildings, are controlled by computer. One operator is responsible for the entire resin station as well as the evaporator station (which is not computer-controlled). Liquor from the Sweetland filter-presses is decolorized in three stages, the first two comprising five cells each arranged in parallel and filled with acrylic resin while the third stage consists of six cells in parallel filled with styrene resin. Details are given of operation of the decolorization section and of flow control, including tabulated flow rates extracted from routine reports. Reactions of the system to plant failures are also described. Flow control through the resin station has been entirely satisfactory since commissioning in 1985.

Statistical process control and quality improvement. Practical aspects

T. E. Wilson. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 9 pp.

The potential value of statistical process and quality control in refining is discussed with sugar drying at Colonial Sugars Inc. as example. The sugar from three granulators, one per white sugar pan, forms one stream which is fed to the silo where warm, dry air is blown up through the sugar to help provide a final moisture content of 0.03%. Common causes of day-to-day fluctuations in the moisture content are predictable and include changes in the level of sugar in the silo, while special unpredictable causes include a drop below the minimum level at which the moisture level may exceed 0.03% and equipment failures. The approaches adopted for both types of cause are indicated, particularly the elimination of special causes.

Experiences with starch and dextran in a refinery

T. P. Johnson. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 14 pp.

Experiences with high levels of dextran and starch in raw sugar and associated filtration and throughput problems at Gramercy refinery in Louisiana are discussed. The starch and dextran levels in raw sugar from 12 Louisiana sugar factories and possible causes are examined. Although starch hydrolysis by amylase is one means of dealing with the problem, the refinery blends various raw sugars to obtain a low starch content. All incoming raw sugar is analysed for dextran by the haze method and the Roberts copper method; the two techniques are compared.

Continuous vacuum pan operation at Colonial Sugars Inc.

E. O. Betancourt, J. L. de Chazal and J. D. McCulla. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 21 pp.

The Langreney continuous vacuum pan installed at Colonial Sugars Inc. in 1987 for high remelt boiling was the first continuous pan to be installed in North America. The construction, operation, automatic controls and performance of the pan are discussed and comparison made with batch boiling. The pan is used for high remelt boiling, circuit C1 being fed with a mixture of concentrated sweetwater and affination syrup of 83 purity which is boiled at 92°Bx, circuit C2 receiving a liquor of 62 purity which combines the separated wash portion from the high remelt centrifugals with repurged crystallizer sugar and is boiled at 93°Bx, while circuit C3 boils back the 51 purity syrup from the remelt strike at 95 - 96.5°Bx and possibly 98°Bx; the purity of the feed liquors may vary by ±3 units. Before installation of the pan, a 2- or 3-boiling system was used with high remelts (some 85% of which were of 72 purity and the rest of about 83 purity) and low remelts of about 62 purity; use of the pan has allowed elimination of the 83 purity remelts. The desired grain size is simple to attain by adjustment of the seed:steam ratio, and a mean aperture of 0.66 mm has been easily achieved, although the target size is normally 0.40 mm. In the first quarter of 1989, the C.V. averaged 26.8. Exhaustion in the high remelt station has increased by 11% and the quantity of wash water in the centrifugals reduced. Performance data are also given for Marle sugar factory in France which is equipped with an earlier type of Langreney pan.

Modelling of the crystallization sector

P. Dauvois, D. Depeyre, A. Isambert and H. Chraibi. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 18 pp.

Modelling of the boiling processes at Marseilles refinery and beet sugar factories operated by Générale Sucrière S.A. in France is described. Details are given of the software selected, method of calculation used, configuration and application of a mass balance model aimed at improving molasses exhaustion and reducing the amount of massecuite boiled; a scheme based on the model that would meet the requirements is shown alongside the existing system. A dynamic model was also developed which allowed various methods of boiling control to be tested and their effects on the granulometry assessed; the strategy selected was based on supersaturation control based on the steam flow rate. Tabulated data and diagrams are presented.

An overview of operations at Amstar Sugar Corporation's Chalmette refinery

F. Goodrow. *Sugar y Azúcar*, 1989, **84**, (5), 33 - 34, 36.

See *I.S.J.*, 1989, **91**, 85 - 87.

Starch based sweeteners

Prospects of obtaining sugar products from rye flour by enzymatic hydrolysis

V. V. Galkin, E. V. Lyashenko, N. V. Ostashenkova, I. S. Shub and S. E. Traubenberg. *Dokl. Vses. Nauch.-Tekhn. Konf. Razrab. Protsessov Poluch. Kombinir. Produktov Pitaniya*, 1988, 68; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (7), Abs. 7 R1520.

Work on production of sugar products from rye is reported. In content, chemical structure and physical properties, starch from rye is similar to starch from other cereals but differs in the greater rapidity with which it is saccharified by amylolytic enzymes, which facilitates obtaining sugar products. Dosage rates of enzymic preparations and conditions under which hydrolysis is carried out were determined; it was found that preactivation (heat treatment in the presence of maltose, Ca^{++}, Zn^{++}, etc. as stabilizers) intensified hydrolysis by increasing the activity of the enzymes by 20 - 30%. The potential of using rye starch as a source of sugar products has been demonstrated.

Enzymatic conversion of starch in food processing

G. Richter and G. Tegge. *Proc. Int. Symp. Biotechnol. & Food Ind.*, 1987, 401 - 423; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (7), Abs. 7 R1524.

Methods for production of high-fructose syrup from starch are presented. Enzymatic treatment of starch commences with the action of bacterial α-amylase. For liquefaction of the starch, α-amylases from *Bacillus subtilis* are used, while a new thermostable type from *Bacillus licheniformis* is currently being used at an optimum temperature of 88 - 90°C and a pH of 5.2. The substrate, containing oligosaccharides and a small number of maltodextrins, is saccharified using glucoamylase preparations. Exoamylases hydrolyse the α-1,4-glycosidic linkages, giving hydrolysates containing 95 - 96% glucose. Enzymatic isomerization is carried out using immobilized glucoisomerase preparations. The characteristics are given of Optisweet, a new preparation which produces 46.5% isomerization. The final product is a HFS containing 42 - 55% fructose.

Glucose isomerase: a widely used enzyme

H. Wribs and H. Sic. *Procestechn.*, 1989, **44**, (3), 37 - 44; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (11), Abs. 11 R1633.

Data are given on natural sweeteners, their properties and their application. Schemes for production from starch of glucose-fructose syrups of varying fructose content are reviewed, with particular attention focused on applicable enzymes, especially glucose isomerase. The advantages of using immobilized enzymes are noted and factors affecting enzyme activity are analysed. The mechanism by which enzymes act is investigated.

Glucose syrups

A. Fioretti. *Ind. Alimentari*, 1989, **28**, 702 - 705 *(Italian)*.

A review is presented of glucose syrups obtained by starch hydrolysis, with details of their chief properties (including an explanation of dextrose equivalent) and composition according to the type of conversion used. Typical syrup applications are indicated and advances made in the use of enzymes surveyed.

Combined enzymatic starch hydrolysis

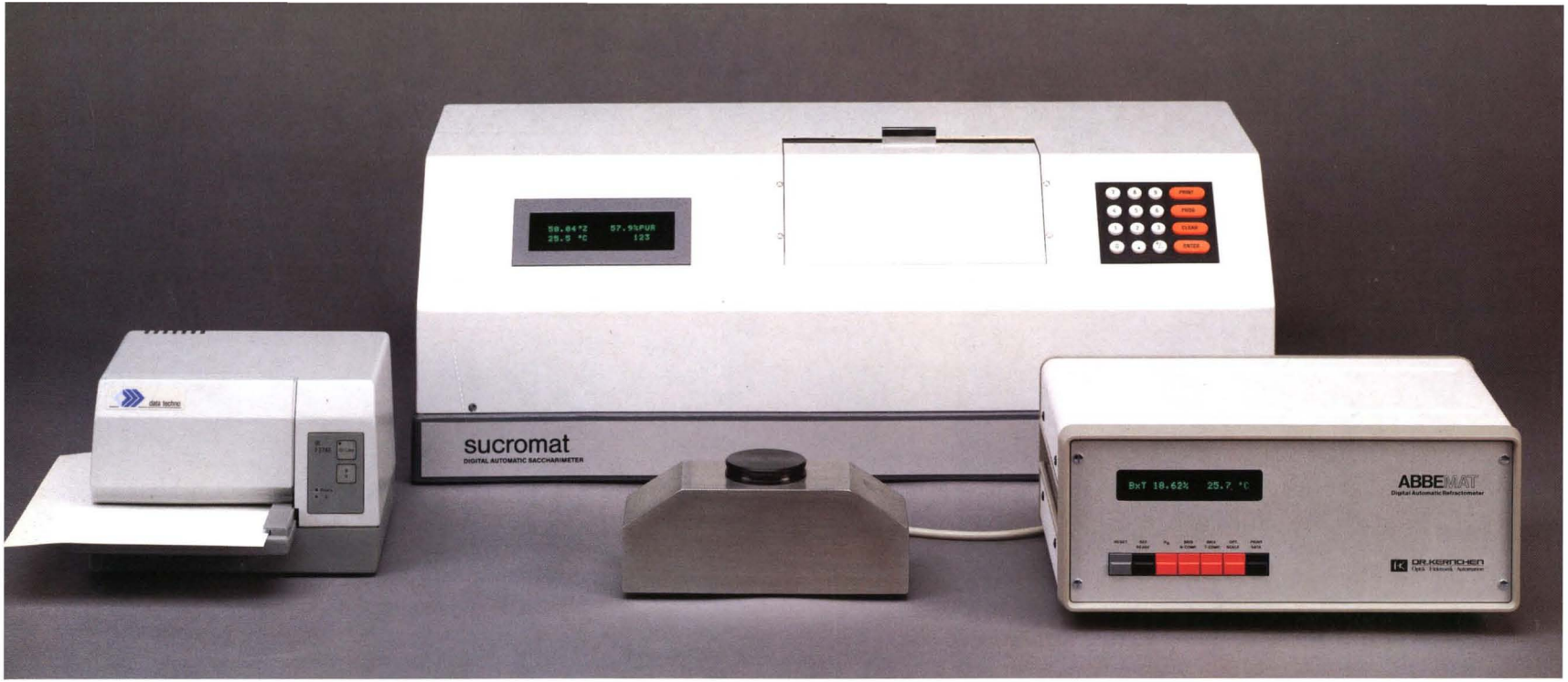
E. Nebesny. *Starch/Stärke*, 1989, **41**, 266 - 270 *(German)*.

Investigations, in which AMG 300 L glucoamylase and Promozyme 200 L pullulanase were used together in quantities approximating those in Dextrozyme 225/75 L Novo, demonstrated the ability of pullulanase to facilitate the work of the glucoamylase and accelerate starch saccharification; by reducing the quantity of glucoamylase and increasing that of pullulanase, only 48 hours was needed to give a glucose syrup of up to 98 DE. Chromatographic analysis showed that the pullulanase performed best when it was added simultaneously with the glucoamylase, since it hydrolysed the α-1,6 linkages in low-molecular dextrins more easily than in the G_5 - G_7 oligosaccharides formed by the glucoamylase. At an optimum glucoamylase + pullulanase ratio to liquefied starch, no iso-sugars, oligosaccharides higher than G_5 or dextrins were present after 8 hours' hydrolysis.

Isolation and characterization of starch-iodine positive material formed during saccharification of corn starch

P. J. Brümm, R. E. Hebeda and W. M. Teague. *Starch/Stärke*, 1989, **41**, 343 - 348.

Customers have been putting pressure on corn wet-millers to improve the quality of glucose and corn syrups, including provision of a product that contains no free starch that turns blue or green in the presence of iodine. However, investigations at a number of corn starch plants showed that liquefied corn starch may be free of starch and yet react positively to the iodine test after saccharification. Such hydrolysates are difficult to treat and often fail to meet customer requirements. The problem has been traced to small particles (measuring 0.2 - 1.0 μm) present in the original starch. Comparison of enzymatic degradation of the particles with the same treatment of gelatinized and non-gelatinized starch and of lipid-amylose complexes showed that the behaviour of the particles most closely resembled that of non-gelatinized starch. Extended liquefaction was found to reduce the problem but not eliminate it. Addition of cellulase, hemicellulase, α-amylase and protease to normal glucose amylase products failed to assist in hydrolysis of the particles under saccharification conditions. However, the particles may be completely removed by microporous filtration of the liquefied product or of the hydrolysate.



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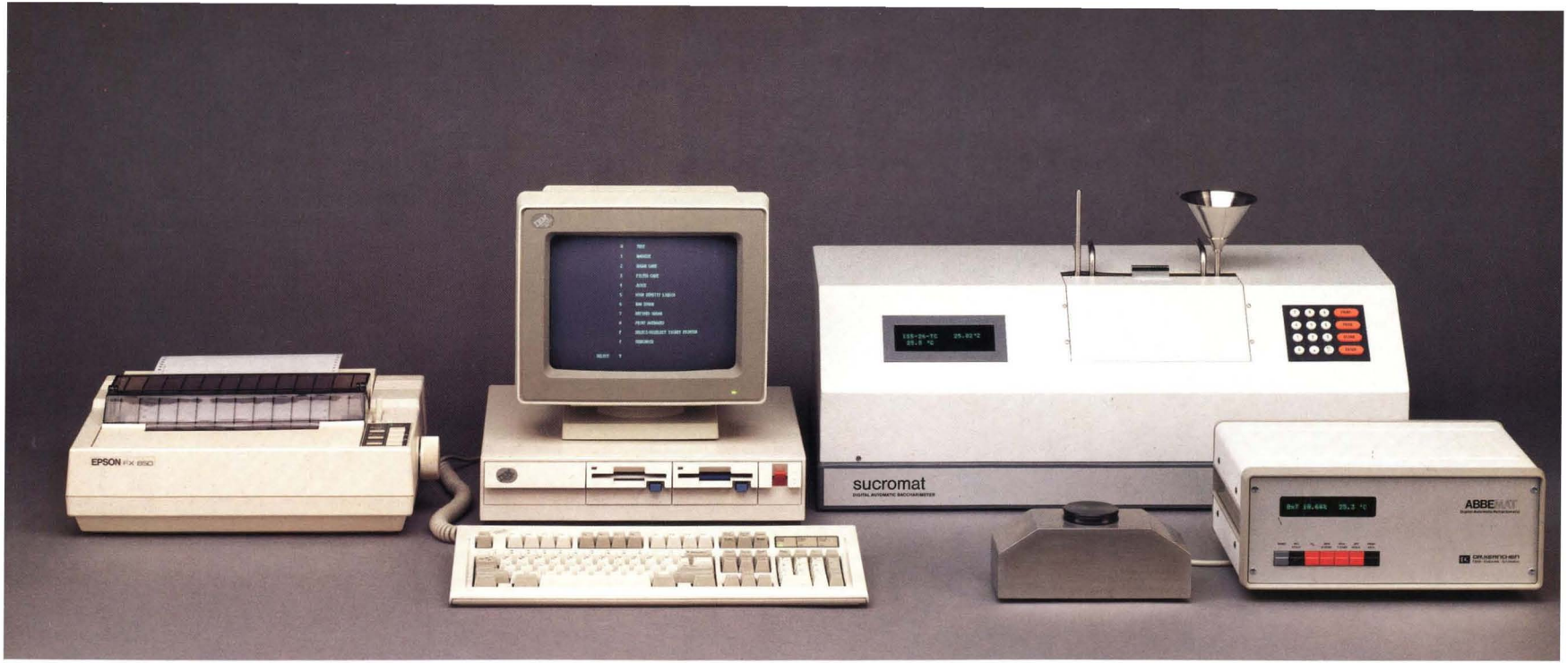

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Laboratory studies

Replacement of lead salts in polarimetric analysis

M. A. Clarke and B. L. Legendre. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 26 pp.

Regulations on the use and disposal of lead in the US are outlined and the quantities of lead subacetate waste at cane sugar factories and refineries indicated. Analytical methods that do not require the use of lead salts for sample preparation are discussed, and particular mention made of an infrared polarimeter widely used in the beet sugar industry (but requiring a clear solution) and of near-infrared techniques. In a polarimetric method investigated, 2 g of Ca hydroxide powder was added to 200 ml of juice in a 400-ml beaker and stirred for 1 min, followed by addition of 4 g Al chloride powder and about 15 seconds' stirring; 1 g of Analytical Grade filter-aid was added and the contents stirred for 30 sec to ensure that all the reagents were completely dispersed. The solution was filtered through RA grade 226 filter paper, the first 10 ml discarded and about 50 ml collected for polarimetry in a 100-mm tube. The procedure gave satisfactory clarification with fresh juices and with some partially deteriorated juices, including those from cane samples taken 18 days after a moderate frost; however, the filtration time was much longer than with lead subacetate clarification (9.3 *vs.* 3.7 min), although with batches of juice samples the time could be managed so that it was greater only for the first batch. The coefficient of variation was very low. The test is sufficiently simple and rapid and its reproducibility and repeatability acceptable for use in sugar factory laboratories; correlation with results given by the lead subacetate method was excellent. The clarification method is not suitable for raw sugar analysis without dilution of the sample and does not remove much dextran.

Search for a method of estimating sugar degradation in diffusion by measuring various metabolites

G. Deruy, J. P. Ducatillon and J. P. Lescure. *Sucr. Franç.*, 1989, **130**, 96 - 100 *(French)*.

Sugar losses in 19 raw juice samples were determined by polarimetry (without correction for reducing sugars), by an enzymatic method of Devillers *et al.* and by ion chromatography of organic acids (lactic, acetic + formic, propionic, malic and citric acids) formed from pyruvic acid by metabolic pathways after sucrose hydrolysis and glycolysis of the resulting reducing sugars to pyruvic acid; butyric acid was not found. Formulae were then derived for partial losses in terms of glucose (assuming that fructose represented 33% of the weight of glucose and that the two sugars had a molecular weight of 180) and of the metabolites, and the values given by the formulae then added together. Comparison showed marked discrepancies between the values obtained by the three methods. A linear regression ($r = 0.95$) was found between the enzymatically determined losses and the calculated losses whereby the former were 1.8 times greater; the regression formula was used to calculate total sugar losses and partial calculated losses in six different types of diffuser, showing a loss <0.2% in French factories.

Applications of infrared spectroscopy to white sugar contaminant complaints

D. E. Rearick. *Zuckerind.*, 1989, **114**, 405 - 408.

A number of examples are cited in which infrared (IR) spectroscopy has been used to characterize white sugar contaminants such as rubber and other polymeric materials (determined as pyrolysis products). For contaminants present in only very small quantities, e.g. small rubber particles, a modern Fourier transform instrument is applicable. IR spectroscopy is also of value in identification of inorganic contaminants such as sulphates, sulphites and oxalates characterizing particles of pan scale that are too small for wet chemical analysis. Mention is made of the identification of sodium borate in bagged sugar that had been accidentally added at the customer's home.

Utilization of enzymic reactions for determination of glucose and sucrose on chromatograms

J. Maslowska and J. Leszczynska. *Chem. Anal.* (Poland), 1988, **33**, (1), 141 - 147; through *Anal. Abs.*, 1989, **51**, Abs. 6C16.

Whatman No.1 paper and thin layers of cellulose, alumina and silica gel were used in a study on separation and detection of maltose (I), lactose (II), sucrose (III), glucose (IV) and fructose (V) by chromatographic techniques. For the detection of spots, 0.1M glucose oxidase (A), 0.1M β-fructofuranosidase (B) and 0.1M peroxidase (C) were used. The chromatograms were developed with (i) 2:1:1 butanol:acetic acid:water or (ii) 10:1:2 butanol:ethanol:water by the descending technique for 4 hours, then the chromatograms were dried at 20°C for 2 hours. The conditions for the application of enzymic reactions were studied by using acetate buffer solution (pH 4.8), phosphate buffer solutions (pH 7.0 or 7.2) and various temperatures. The results obtained, which are tabulated, indicate the usefulness of enzymic reactions in the detection of (III) and (IV) after their separation on paper or cellulose layers. The optimum results were achieved in the detection of (IV) with (A) after its separation with (ii) or with (A) and (C) after its separation with (i). In the detection of (III), the use of (A) and (B) is preferred; (I) interferes. In the detection of (I), (II) and (V), the enzymic methods failed. The detectability of (IV) was 30 times better and of (III) was 10 times better by enzymic than by chemical methods.

Isotachophoretic determination of 4-methylimidazole in colouring matter

F. Kvasnicka. *Listy Cukr.*, 1989, **105**, 104 - 106 *(Czech)*.

Capillary isotachophoresis was used to

determine 4-methylimidazole in samples of colouring matter formed when sugar is heated in the presence of ammonia or ammonium salts. A ZKI 001 analyser was used with a pre-separation capillary measuring 170 × 0.8 mm, a separation capillary measuring 180 × 0.3 mm and a conductivity detector. Two systems were tested: (I) with 10mM KOH + 30mM acetic acid (AA) + 0.1% polyvinyl-pyrrolidone (PVP) as leading electrolyte in the pre-separation capillary and 2mM KOH + 8mM AA + 0.1% PVP in the separation capillary, and 10mM TRIS + 5mM AA as terminating electrolyte; the pH of the leading electrolyte was 4.5. (II) in which the leading electrolyte was 5mM KOH + 20mM N-2-hydroxyethyl-piperazin-N'-2-ethane sulphonic acid (HEPES) + 0.1% PVP in the pre-separation capillary and 1mM KOH + 4mM HEPES + 0.1% PVP in the separation capillary, and 10mM TRIS + 5mM AA as terminating electrolyte; the pH of the leading electrolyte was 7. (I) required 25 minutes for analysis and (II) 15 minutes; the operating current was 250 μA and 200 μA in the pre-separation capillaries of (I) and (II) and 10 μA and 5 μA in the corresponding separation capillaries. The detection limit at a colour sample concentration of 2 g/50 ml was 5 ppm at a paper feed rate of 6 cm/min or 2 ppm at 15 cm/min, which was well within the permissible limit of 200 ppm. The method has the advantage over chromatographic techniques of requiring no sample preparation.

Application of near infrared reflectance (NIR) spectroscopy to the analysis of sugar cane in clonal evaluation trials

N. Berding, G. A. Brotherton, D. G. LeBrocq and J. C. Skinner. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 8 - 15.

Tests were conducted on the application of NIR spectroscopy (using a Technicon 450R 19-filter spectroscope) to analysis of fibrated whole-stalk cane and of expressed juice for Brix, c.c.s., conductivity, fibre content, moisture content, pol and purity. Results for the cane showed moderately high correlation (r = 0.891 - 0.955) between NIR values and routine laboratory data for all components except conductivity and purity (NIR analysis was not expected to be satisfactory for prediction of conductivity because of its inorganic basis). There was an appreciable reduction in error with a greater number of readings, particularly at lower sampling levels; it is suggested that increasing the number of readings per sample is preferable to a greater number of samples. Improvement in sample preparation would also improve the results, since the Jeffco cutter/grinder used gives heterogeneous samples varying in particle size and origin. High correlation between NIR results and laboratory values was obtained for Brix, c.c.s. and pol of expressed juice. Despite some problems in juice analysis, the technique is considered promising.

The use of a robot for juice analysis

P. G. Everitt, J. Smit and V. Mason. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 26 - 33.

Trials were conducted at North Eton factory on the use of a Kawasaki PH560 robot to measure the pol and Brix of 1st expressed juice. Details are given of modifications to the mechanical operations normally undertaken by laboratory chemists to conform to the limitations of the robot. The beakers had no pouring spout so that their orientation was not important. The operations included lead acetate dispensing and mixing (using a standard laboratory stirrer), folding and fitting filter papers into the funnels using a specially devised compressed air system, weighing by electronic balance, juice sampling, disposal of filter paper and waste, dispensing of Herles' reagent, feeding of the juice to the Brix meter and polarimeter, and washing and drying of vessels. The scheduling procedure is described and the performance of the system compared with that of the factory laboratory. No significant difference in average juice pol was found between the factory and robot laboratory but the latter gave a Brix reading that averaged 0.13 units lower than the factory laboratory value. The robot was able to carry out all the required procedures, but at a rate of 7.6 samples per hour that was below the 12 per hour originally specified, although it is thought that a rate of about 8.6 per hour could be achieved with minor layout and operational changes; 12 samples/hour might be possible if the washing and filter paper folding operations were automated, but this would increase the cost and complexity of the system.

Control of sugar polarization and moisture using near infrared reflectance analysis

R. V. Ames, S. W. Norton and H. H. Nguyen. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 246 - 252.

NIR calibrations developed for eight raw sugar parameters were used to predict the analysis of a separate set of sugar samples. Results for moisture content and pol were satisfactory for factory control purposes where the speed of analysis is of advantage but not where the results were to be used as basis for payment. Reasonably high correlation was also obtained for ash and reducing sugars, while colour measurement by reflectance spectroscopy was moderately successful when wavelengths in the visible region were used but not in the infrared range. Correlation for parameters relating to physical aspects such as crystal size, shape and variation was unsatisfactory. An InfraAlyser 400 reflectance spectrophotometer provided with 20 standard filters was installed at Invicta factory. Comparison of values for pol and moisture content obtained by NIR analysis with average results obtained by manual measurement in the previous four years demonstrated the benefits of the new technique in helping to maintain a consistent raw sugar quality over relatively short periods, although a systematic bias that occurs over a longer period needs correcting.

By-products

Recent developments in chemical and microbial products from sucrose

M. A. Clarke. *Sugar y Azúcar*, 1989, **84**, (3), 24, 26, 28, 30, 32 - 34.

See *I.S.J.*, 1989, **91**, 11A.

Fluid lime in the West Midlands

T. Breay and I. Briggs. *British Sugar Beet Rev.*, 1989, **57**, (1), 60 - 61.

An account is given of the system used to fluidize semi-dry lime recovered from settling ponds at two British Sugar factories and deliver it in road tankers to farms for spraying on the land.

The effect of Trilon B on citric acid biosynthesis with *Aspergillus niger*

A. A. Avtandilova and F. A. Bekoeva. *Dokl. Sev.-Oset. Gos. Univ.* (Ordzhonikidze), 1988, 12 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (5), Abs. 5 R1517.

Molasses properties and chemical treatment methods to improve the quality of citric acid at a Soviet plant were investigated and the optimum dosage rates established for two components that modify the mineral composition of the medium: Trilon B (ethylene diamine tetraacetic acid) and potassium ferrocyanide. The preliminary stage in preparation of the molasses solutions for fermentation was carried out under laboratory conditions with both control and test variants, the result being the average of 20 tests in a 4-variant arrangement. The optimum ratio of the two components for 300 g molasses was 1 g EDTA to 14 g $K_4(CN)_6$, at which the growth rate of the mass rose to 29%.

Inversion of sucrose solutions by immobilized yeast cells. I. Theoretical. II. Laboratory investigation. III. Pilot plant investigation

I. J. Smolík. *Listy Cukr.*, 1988, **104**, 265 - 272. **II.** J. Smolík, L. Fassatiová and M. Stenglová. *ibid.*, 1989, **105**, 13 - 19. **III.** J. Smolík and M. Stenglová. *ibid.*, 36 - 43 *(Czech)*.

I. Inversion of sucrose solutions is discussed, particularly using invertase as catalyst. A survey of the literature (46 references) covers invertase properties, determination of its activity, its use for invert syrup manufacture and various aspects of its immobilization, including entrapment by various polymeric materials, suitable types of support and cell aggregation.
II. A heterogeneous biocatalyst having invertase activity was prepared from *Saccharomyces cerevisiae* in the form of commercial baker's yeast and suspended in sugar solution to hydrolyse it. The immobilized yeast, which had a specific activity of 200 - 300 μmoles of glucose/min/g dry solids, was active at a relatively high temperature (up to 75°C) and at a sugar concentration of up to 70%. The biocatalyst could be employed for repeat hydrolysis of sugar solutions containing high quantities of non-sugars for which acid hydrolysis would not be suitable.
III. A sugar liquor of 66°Bx was subjected to inversion in a stirred batch vessel; for a batch of 235 kg, a reaction time of 2 - 3 hr was required to give a 75°Bx syrup which was a 1:1 mixture of invert sugar and sucrose suitable for use in non-alcoholic beverages.

A brief note on available technologies for effluent treatment

B. B. Gunjal and S. V. Arbatti. *Bharatiya Sugar*, 1989, **14**, (4), 29, 31 - 32, 54.

Details are given of nine effluent treatment processes applicable to vinasse with an indication of their average performance and the number of Indian distilleries currently using the systems or installing them.

Treatment of effluent from straw board/mill board plants

-. Jamaluddin and J. Ahmad. *Bharatiya Sugar*, 1989, **14**, (4), 47, 49 - 50.

The effluent at a plant producing board from a mixture of rice straw, paddy straw and bagasse contains 500 - 1000 mg/litre solids and about 300 mg/litre BOD, has a pH of approx. 8 and is slightly brown (as a result of the lignin content); 9000 litres/hr (about half of the total) needs to be treated by sedimentation, filtration, aeration, pH stabilization, degreasing and dilution before re-utilization. After treatment, the BOD is approx. 20 mg/litre and the suspended solids content 80 mg/litre. The pH and colour are unchanged.

Beet pulp microstructure and mechanism of internal moisture transfer

G. E. Trokoz and Yu. P. Lutsik. *Izv. Vuzov, Pishch. Tekh.*, 1988, (6), 70 - 72 *(Russian)*.

A study of beet pulp as a porous colloidal body revealed that a rise in its temperature caused a reduction in the size distribution and equivalent size of the micropores. Intense internal moisture transfer was observed as a consequence of effusion and thermal effusion in the form of vapour. A rise in temperature from 25° to 70°C caused increase in the moisture effusion coefficient by a unit order of magnitude.

Alternative production possibilities based on agricultural raw materials

U. Tegtmeier. *Zuckerind.*, 1989, **114**, 204 - 209 *(German)*.

A survey is presented of sucrose as a raw material for the production by fermentation of ethanol, fodder and food yeast and 2,3-butanediol. Descriptions and flow diagrams are given of the processes.

Utilization of sugar cane bagasse

A. Muhammad, M. Yaqub, M. Iqbal and F. Azam. *Pakistan Sugar J.*, 1989, **3**, (1), 11 - 14.

The changes in the chemical composition of bagasse composted over a period of 174 days in a polyethylene-lined pit at an initial moisture content of 60% are discussed.

Continuous fermentation of ethanol using immobilized growing yeast cells

M. C. Hsie. *Rpt. Taiwan Sugar Research Inst.*, 1988, (119), 17 - 31 *(Chinese).*

Yeast cells were immobilized by entrapment in Ca alginate gel and employed for alcohol production from cane molasses. The characteristics of the immobilized yeast were examined. The immobilized cell preparation formed from the Hualien strain exhibited highest specific productivity compared with five other strains tested. No significant modification of ethanol productivity occurred within the range of alginate concentration assayed. The variation in bead diameter below 3 mm had little effect on ethanol productivity. In an investigation of optimum operating conditions, dilution rate and initial pH of the mash were found to be significant factors. Continuous fermentation studies showed that an ethanol productivity in the range 6 - 8 g/litre/hr could be achieved at a dilution rate <0.12/hr; this was 4 - 5 times greater than with conventional batch fermentation. The immobilized cell system was operated continuously under steady state conditions with a high ethanol concentration in the effluent over a period of 360 hr, after which time the concentration of ethanol produced gradually fell with increasing concentration of residual sugar. Under steady state conditions, the ethanol concentration in the effluent was 8.2 - 8.5% v/v, which was 75 - 78% of the theoretical value. The decrease in ethanol-producing activity was attributable to the loss of cell viability; aeration improved viability considerably, as a result of which the length of stable operation time was doubled by comparison with continuous fermentation without air supplement.

Kinetic characterization of product inhibition in alcohol fermentation

C. Y. Chang and L. H. Wang. *Rpt. Taiwan Sugar Research Inst.*, 1988, (119), 33 - 40 *(Chinese).*

The inhibitory effect of ethanol on the specific growth rate μ and ethanol production rate v was studied for Hualien alcohol yeast (the industrial strain) in batch or continuous alcohol fermentation with cane molasses or raw sugar used as culture medium. Based on the results and the Lineweaver-Burk plot, a non-competitive type of product inhibition was found. The kinetic constants of ethanol inhibition of the specific growth rate and ethanol fermentation were calculated according to the models shown as follows:

$$\mu_m/\mu_o = 1 - (P/P_{max})^{0.5} \text{ (for growth)}$$

$$v_m/v_o = 1 - (P/P_{max})^{0.5} \text{ (for ethanol production).}$$

When raw sugar culture medium was used in continuous fermentation, the maximum allowable ethanol concentration above which cells do not grow was found to be 98 g/litre, and the ethanol-producing capability of the cells was completely inhibited at 102 g/litre.

Evaluation of factors in batch fermentation of molasses

L. D. Il'ina *et al. Khim. i Tekhnol. Pishch. Prod.*, 1988, 84 - 89; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (8), Abs. 8 R1466.

A new method is proposed for evaluation of factors in batch fermentation of molasses by different strains of yeast with the aim of selecting industrial strains. The main criteria for evaluation of strains by the method are: mass of the target product; percentage of synthesized biomass in the cumulative product; and the overall economics of synthesizing the mass of the cumulative product with reference to the initial and utilized sugar. The method has allowed a more precise differentiation of the properties of different strains in selection work.

Utilization of concentrated molasses vinasse in fodder yeast technology

A. G. Zabrodskii. *Khim. i Tekhnol. Pishch. Prod.*, 1988, 113 - 120; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (7), Abs. 8 R1473.

The possibility is demonstrated of utilizing concentrated molasses vinasse as antistatic in the drying of fodder yeasts, as bonding agent for granulation of yeasts and fodders, as yeast growth stimulant and in the production of vinassed pulp.

Reflexions on the economical utilization of pulp as fodder

F. Kozaczka. *Gaz. Cukr.*, 1989, **97**, 14 - 15, 17 *(Polish).*

The importance of beet pulp drying to produce a material suitable for ensilage and having good nutritional properties is discussed; at present, drying is practised only on a very small scale in Poland and the dry solids content of pressed pulp is often so low that mostly what is transported is water, while the pulp is of low feed value. The technology and energy aspects of drying are considered.

Rumen microbial degradation of beet root pulps. Application of infrared spectroscopy to the study of protein and pectin

P. Robert, C. Bertin and D. Bertrand. *J. Agric. Food Chem.*, 1989, **37**, 624 - 627.

Beet pulp samples were microbially degraded in the rumens of fistulated goats by the nylon bag technique and then analysed for protein and pectic substances (measured as galacturonic acid) as well as subjected to I.R. spectroscopy at a wavenumber in the range 1400 - 2000/cm where proteins and pectins present characteristic absorption bands; the percentage dry matter degradation was determined gravimetrically. A decrease in the absorption band of normalized spectra at 1740/cm demonstrated the high digestibility of pectins, while an amide II band characteristic of proteins and present in the area with its centre at 1530/cm showed an increase in the protein concentration when the pulp was degraded which could have been due to poor digestibility or to microbial growth.

The two silos at Felsted are about 20 metres internal diameter and 50 m high, and were constructed in 1974. The slabs are 1.35 m thick and of 23 m diameter, carried on 76 piles of 750 mm diameter and 30 m long, bored into London clay. The concrete shells are 230 mm thick and are prestressed with unbonded hoop tendons anchored on four pilasters. The layout is shown in Figure 4.

Radial displacements of the shell of silo No. 2 were measured using a precise optical plumb set up over datum points scribed on brass plates screwed to the silo base slab. The plumb was used to sight onto graduated radial targets mounted at five levels around the outside of the silo shell. The measurements were subject to errors in setting up the optical plumb and also to reading errors; however, accuracy was generally within ±0.5 mm at Level E (Figure 5), increasing to about ± 2 mm at Level A.

Base slab levels were measured at 11 sockets embedded in the silo wall, approx. 0.5 m above the base slab, using a precise optical level and staff; accuracy was generally within ± 0.2 mm

Eccentric and crusted sugar discharge tests

A set of datum readings was taken when the silo contained 700 tonnes of sugar and readings of both sets of instrumentation were taken at intervals as the silo was filled to its 12,000 tonnes capacity. During the first test, using mildly eccentric discharge, 1850 tonnes of normally conditioned sugar was discharged via emptying port F5, 4.3 m from the centre of the silo and near the periphery of the normal discharge zone which encloses the most central 36 of the 127 sugar emptying ports (Figure 6). Radial displacements were monitored at 3-hourly intervals during continuous discharge at about 20 tonnes/hr.

The silo was refilled and Test 2 carried out using moderately eccentric discharge through port F3, 6.7 metres from the centre, about half the sugar being discharged during 5 days and transferred to Silo No. 1. Radial displacements were read at 3-hourly intervals and one of the base slab movements on the 7th day. The silo was refilled for Test 3 and covered with a 600 mm thick crust of caked sugar formed by topping the silo with damp sugar and allowing it to dry out. About 1200 tonnes of sugar was discharged from various ports mostly within the central radius. Radial displacements were measured as before.

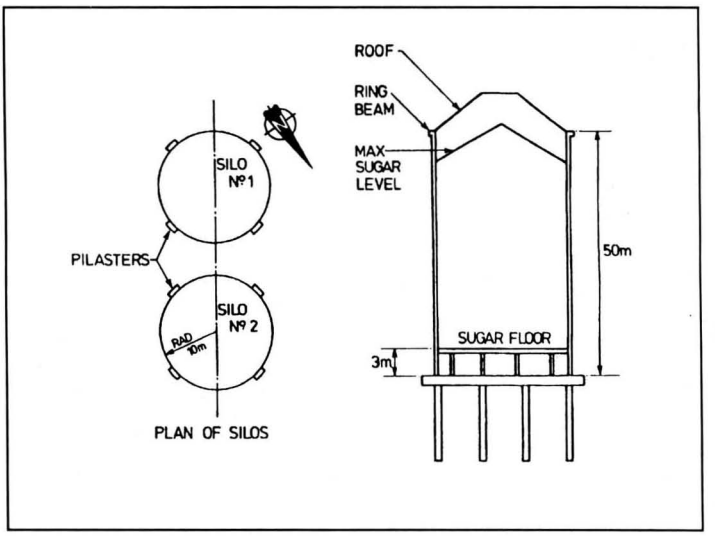


Figure 4. Layout and details of Felsted silos

Test 4 was carried out after refilling, with more severely eccentric discharge through ports F1 and E16 at diametrically opposed locations; the test was carried out only in daylight so that direct observations of the silo could be

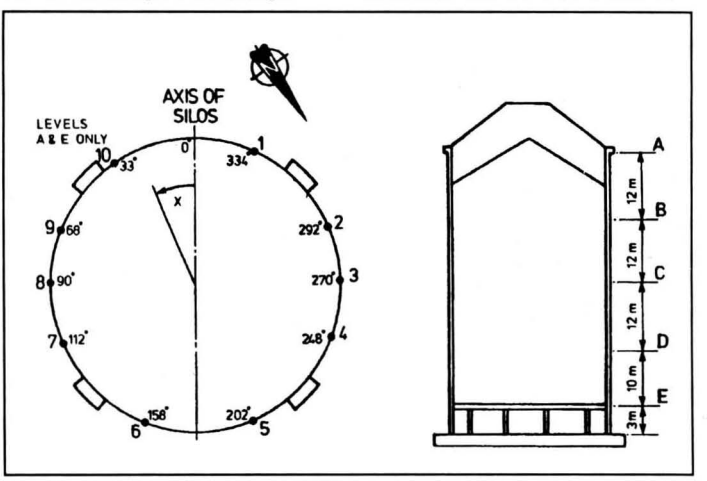


Figure 5. Locations of radial displacement measurements

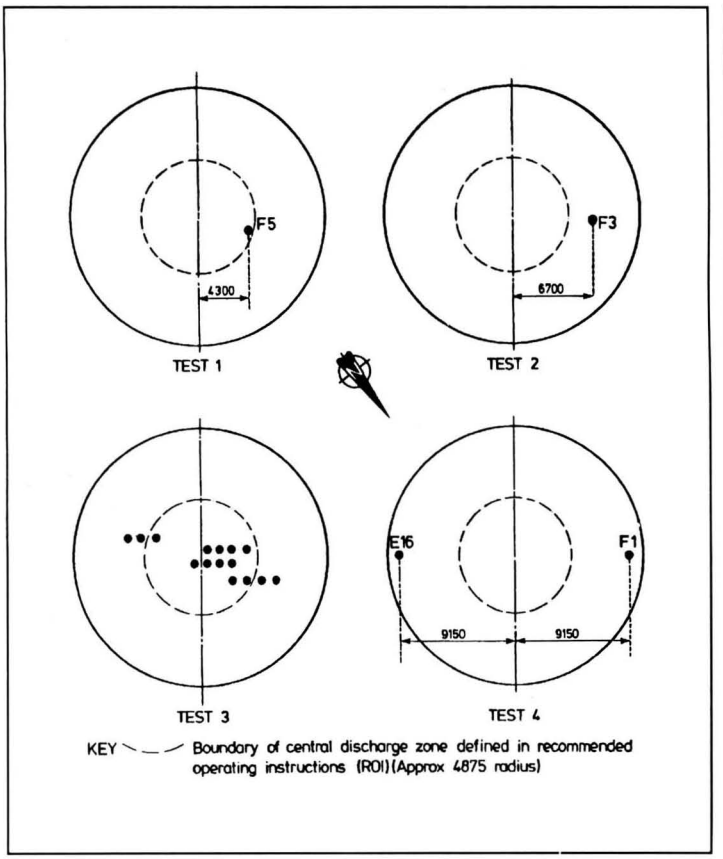


Figure 6. Locations of discharge ports

made to cut the risk of excessive deflections developing. Readings of radial displacements and base levels were made at 3-hourly intervals during both day and night. Between the tests, slab level measurements were made at 2-week intervals, and also radial displacements between Tests 1 and 2 and between Tests 2 and 3. After Test 4 the silo was emptied and final readings made.

Test results analysis

The analysis of the radial displacements of the silo shell was carried out by fitting a curve through the measurements at each level using a Fourier expression which allows a complex curve to be reduced to simpler components (harmonics), each of which may be given a physical interpretation. The expression used was a third order formula.

The analysis of results from Tests 1 and 2 generally indicated that Silo 2 was able to tolerate discharge of sugar from eccentric ports without suffering unacceptable distress. The extent to which the silo "ovalled" during these tests, and particularly the development of a significant third harmonic shape was sufficient, however, to indicate that any level of eccentric discharge from a full silo should be avoided if possible. No significant influence was found on the response of the silo shell to discharge of severely crusted sugar.

Through Test 4, the closely monitored measurements showed that the silo did not suffer any significant permanent damage, and the outside of the shell did not reveal any cause for alarm. However, observations from the walkway on the inside of the silo just below ring beam level identified a series of vertical cracks, generally coincident with locations where the silo was tending to flex inwards relative to its datum circular position. The analysis showed during bending stresses up to 4 N/mm^2 at Level C and close inspection of the surface, if it had been possible, might have shown similar cracks there. These would not mean that the silo was in a dangerous condition, but there is ample evidence that repeated application of loading of concrete structures into the cracking zone causes faster deterioration of the structure and reduced working life.

Although the silo appears to have survived Test 4 satisfactorily, the extent of the distortions which were indicated and the possibility of associated cracking are more than sufficient to justify the discharge restrictions imposed by the Recommended Operating Instructions.

Test conclusions

The gross behaviour of Silo 2 during the tests was characterized by tilting towards Silo 1 and ovalling of the shell and warping of the base slab along the common axis between the silos. Vertical displacements varied in proportion to the amount of sugar contained, although a degree of permanent settlement remained when the silo was emptied at the end of the test period. The maximum tilt at the top of the silo was 12 mm, the maximum ovalling half-way up the shell was 9 mm, the maximum warping of the base slab was 1 mm and the maximum vertical displacement (downwards) was 14 mm.

Structure/foundation interaction between the two silos was demonstrated by the tilting of Silo 2 towards Silo 1

when the latter was filled with sugar before Test 1 and between Tests 1 and 2. Measurements were consistent with a hypothesis that interaction occurs between the pressure bulbs under the base slabs of adjacent silos.

Sugar quality and silo storage

The primary objective in storing sugar should be that quality of the product removed from storage meets an agreed specification which ensures the ability of the Company to meet customer requirements. An equally important objective is that the physical properties are not so affected that difficulties are experienced in recovering sugar from the silo. Such changes may not only make the sugar unsaleable but may also place strains on the storage structure and those which do occur should not produce strains in excess of those for which the silo was designed.

Another objective is that during storage the chemical, physical and microbiological parameters should not get worse and should preferably improve. Where deterioration does occur the rate of change should be known and it should be under control.

The most important parameter to be considered for good storage is water, or rather its absence. Water can get into the storage environment in four ways: (a) associated with the sugar, (b) as a result of sugar degradation, (c) from the air within the silo, and (d) from leaks into the silo.

Water in the sugar

Water in sugar includes inherent water i.e. in the form of syrup trapped inside the crystal lattice; this normally takes no part in any function of the crystal unless it is dissolved or fractured as it would be if ground for icing sugar. Another form is bound water – trapped in some way when the sugar is first dried. A heavily supersaturated solution is formed as a glass or candy which prevents the escape of water trapped within but, during up to a week after crystallization and drying the candy surface undergoes crystallization and a genuine syrup film forms on the crystal surface, the water becoming free water, able to take part in any surface effect. Following the recognition of this phenomenon in the 1960's the use of pan stirrers in white sugar boiling has reduced bound water to the point where it is difficult to detect.

The remaining type of water associated with sugar is the free water in the form of syrup on the surface and is detectable by a loss on drying. Experience with a range of white sugar produced within British Sugar has shown that a level of up to 0.03% free surface water would not significantly affect flow characteristics within a silo. This assumes an ash content of less than 0.015% and reducing sugars at the time of manufacture below 0.005%.

Water by sucrose degradation

Water can result when sugar is degraded chemically by heat or acid conversion but the conditions for these are not normally met in silo storage. Water also results from microbiological attack, particularly by yeasts and moulds, and this tends to be self-sustaining as some of the metabolic by-products such as reducing sugars, water, alcohol, etc., make conditions more favourable to further attack. However, the wort agar yeasts and moulds cannot grow in the dry conditions normally found in crystal sugar, and the growth of osmophilic yeasts and moulds almost stops when the water activity or Equilibrium Relative Humidity (ERH) of the syrup on the crystals is less than 65%. Growth of osmophiles is relatively slow but it is this growth which determines the length of time, normally measured in months, for which sugar can be stored. Generally speaking, the presence of bacteria on sugar is as a result of contamination. They do not tend to grow and, in fact, numbers emerging from silo storage tend to be fewer than those entering.

The ERH of the syrup film, and therefore of the sugar, is influenced by impurities which are present. At any given ERH value, the corresponding loss on drying reduces as the amount of impurities also reduces. This means that, to maintain sugar at a given ERH in order to prevent water pick-up and to prevent the growth of osmophiles, the very pure white sugars have to be dried more than the less pure semi-white sugars. Sugars which are less pure, having higher ash contents and higher levels of reducing sugars, require less drying to prevent the growth of osmophiles. Such conditions, however, affect the flowability of the sugar and therefore the ability to extract it from the silo.

The ERH of the sugar is dependent on temperature. When sugar with a given loss on drying is cooled, the ERH will fall. Water in the air which can no longer be supported will enter the syrup layer on the surface of the crystal, thus increasing the loss on drying and the ERH, to re-establish a balance. However, the air in contact with the sugar will also be cooling and this will increase the relative humidity; in order to remain in balance with the ERH of the sugar, more water must pass to the sugar from the air. This assumes there to be no mechanism to remove surplus water from the air. Air conditioning through the sugar removes this surplus and its importance can be seen not only during the time following initial filling of the silo but also subsequently whenever the sugar might be subject to temperature variations. If warm sugar cools as described above without air conditioning, the water entering the syrup will dissolve more sugar. If the sugar is subsequently reheated, for whatever reason, crystallization will occur, leading to crystals cementing together.

It is well known that the growth of osmophiles can also be severely reduced, if not stopped altogether, by maintaining pH conditions in excess of 8.0, and preferably over 8.5. If the sugar was originally boiled from a syrup having pH well in excess of 8.0, the growth of osmophiles will be significantly reduced as a consequence. Another consequence of boiling at this pH will be to prevent acid floc forming in sugar solutions which means that this

is doubly beneficial.

From the above it will be seen that if there is a brief interval during the storage of white sugar when it becomes accidentally wetted for whatever reason, even for a short period and even if it is promptly dried, the effect can be far-reaching. If wort agar yeasts grow in the diluted syrup they will produce acid, reducing the pH of the syrup film, so that when the sugar is subsequently dried the pH effect can no longer retard the growth of osmophiles. Their resultant increased rate of growth will then produce more water and more acid, significantly reducing the time for which the sugar can be stored.

Additionally, if yeast growth occurs and is then subsequently arrested by the removal of growth conditions, the spores and invertase remain and, when water subsequently becomes available, degradation begins sooner. The induction time from inoculation of concentrated sugar syrups with osmophiles to the establishment of fermentation can normally be measured in weeks; when sugar has been contaminated previously, fermentation can start in a few days. The resultant sticky and viscous reducing sugars affect the flowability of the sugar; furthermore, the fructose element is hygroscopic and tends to absorb water from the immediate surroundings, which causes nearby sugar to dry out and so form lumps.

It is recommended that the ERH of the syrup film on the sugar be reduced to 65% or below. Whilst sugar at the time of drying will meet this, because of the supersaturated film on the surface, this figure will be exceeded as the sugar conditions unless more water is removed in the first week after drying. This can be done externally to the silo in conditioning bins while in the future alternatively methods of drying might render it unnecessary. In British Sugar, the water is generally removed in the silo by blowing air through it. The flow rate and relative humidity of the air should be such as to remove any bound water as it is released and to reduce the loss on drying to a level which roughly equates to the sum of ash and reducing sugars within one week of producing the sugar.

The recommended loss on drying figure, after conditioning, of between 0.01 and 0.02% is below that considered above to be acceptable and so supersedes it as a criterion.

Approximately 40% of the volume occupied by crystal sugar is in fact air. Given the right conditions, sugar can remove water from the air and *vice-versa*. The amount of water entering the silo with the air will depend on its R.H. and this should be maintained at 65% or below if the ERH of the sugar is to be kept below this level. The drying capacity of the air passing through the sugar immediately after production needs to be higher than at a later stage. It also must be available on a continuing basis for at least one week after sugar has ceased to be passed to the silo.

The temperature conditions of the sugar, air and the silo itself, particularly the walls, should be such that the relative humidity of the air is not increased above 65%, even for short periods of time or in small areas of the silo. This area of consideration is complex and significant time and thought needs to be given to each individual installation; the dangers of not doing so are clear from the above. Also obvious is the need to prevent ingress of water into the silo through leaks.

Flowability and lump formation

Many customer specifications state that the sugar shall be free flowing but this is a property of sugar which is not easy to define in absolute terms. Lump formation is even more difficult to define. Sugar can stick together as a result of a sticky viscous syrup film or alternatively can cement together as a result of two wet surfaces coming together and subsequently drying. Such joints can be very tenuous, giving the sugar a slight crust or can be severe, giving lumps which are almost impossible to break.

The influence of water has been discussed above; reducing sugars are also a factor but levels in sugar are generally below 0.005% and have no effect on flowability unless additional amounts are produced by deterioration. Flowability is affected by the number of points of contact between crystals; finer sugars have more such points and, as the coefficient of variation increases, the number will increase as the very fine crystals pack into the interspaces. The potential for lump formation is similarly affected by the number of points of contact, e.g. where they may cement together to form bridges. Good storage therefore requires a high mean aperture and a low coefficient of variation.

Customer requirements have to be borne in mind, however. Retail customers tend to want a finer sugar, as do some industrial customers, but generally the latter prefer a coarser grain. The sugar manufacturer must therefore balance these requirements, ensuring the mean aperture required by customers and the presence of sufficient fine sugar which can be removed by screening. The result may not be ideal for storage.

Dust

Whilst dust is an associated factor, it does need special consideration other than its contribution to the coefficient of variation. As sugar is placed into silos, dust can be seen in the air and this either falls onto and is mixed into the sugar or is removed by the dust extraction equipment. When filling is complete dust can settle on top of the sugar and produce a distinct layer. The quality of the sugar within this dust layer is generally very low and, despite the fact that it is a very thin layer, it can have a significant effect and the sugar can discolour considerably.

In order to avoid the formation of such layers, the filling of silos should be continuous for as long as possible and conditioning air should be maintained through the sugar for several days after the inflow of sugar has stopped. Where dust is produced, effective dust extraction should be provided.

Colour

This is an important quality parameter to many customers. Typically, within the UK, sugar is deemed acceptable to many if it has a colour less than 30 ICUMSA units, but a significant number of customers require colour below 20 ICU. The sugar manufacturer must ensure that when sugar is removed from silo storage, perhaps after one year, it will still meet the requirements of the customer. Should the possibility exist that the colour will increase during storage, he must take steps to prevent or at least reduce such deterioration. Alternatively, he can consider producing the sugar at a lower colour such that when it is removed it is still within specifications. This alternative is not to be recommended as it is difficult to control.

Colour can increase in storage only as a result of segregation or degradation. Finer sugar will have a relatively higher level of colour and segregation will bring about other quality problems such as particle size variation, and this must be avoided by careful filling and emptying of silos. Segregation in sugar handling to and from silos must also be avoided.

Degradation causing an increase in colour can occur as a result of microbiological attack, discussed above, or as a result of heat. Generally the latter is not significant if the sugar is placed in storage at a temperature below 30°C. Above this temperature the possibility of increase exists and becomes significant if the temperature is allowed to exceed 35°C.

Implications for silo operators

A prestressed concrete silo gives the impression of a massive, immensely strong structure which can withstand any abuse to which it might be subjected during operation. Similarly, inside an empty silo, the impression is one of permanence and great strength. However, the wall thickness to diameter ratio is about the same as for a can of soft drink which is well known to be easy to crush! Although most of the non-symmetric loads in the silo would tend to cause it to burst instead of collapsing inwards like the can (the prestressing is the resistance to bursting), bending in the silo shell can be similarly damaging and must be avoided or dealt with very carefully in the design of the system if failure is to be prevented.

Of major significance is the ratio of the maximum "live load" (the capacity of the silo) to the "dead load" (the weight of the silo itself. For a silo of the type at Felsted, a capacity of 12,000 tonnes and a "dead weight" of about 4000 tonnes, the ground loading increases by a factor of 4 between the empty and full silo states. This introduces very large variations in the ground stresses and any tilting as a consequence of variation in ground state variations may result in significant movements at the top of the silo to complicate support arrangements of and impose thrust loads on the sugar loading gantry.

The effect of these silo loads upon the ground extends outside the foundation slabs and may, depending on the separation distance between silos, modify the ground stress state below adjacent silos. This again leads to tilting and movements at the top, and frequently, to prevent excessive movements, the difference in the loads in adjacent silos must be limited.

A watch will need to be kept on the support arrangements for the sugar feed-ing gantry since, depending on the way it is fixed to the silo roof structure, load-ing may develop which may produce thrusts into the top ring beam of the silo shell. Of importance to the structure but of far greater significance to the operator is the possibility that such movements at the top of the silo may damage the water proofing arrangements there and allow rain water to reach the ensiled sugar.

New books – *continued from page 6*

utilization. No less than 491 references are given to the literature with a bibliography for each chapter and section. Thus, readers in the industry, in research and other areas will have a solid basis for further study, perhaps in the former case with the object of examining the feasibility of adoption of a new outlet for a waste material.

Sugar Research Council Research and Development Program 1989-90

Anon. 16pp; 17.5 × 25 cm. (Australian Government Publishing Service, Canberra, ACT, Australia) 1989.

A total expenditure of $Aus 3.1 million is proposed for the 61 projects to be funded by the Council in 1989/90, and this booklet provides a report on its activities in 1988/89 and details of the program for the current year, to be funded by a levy on the Australian sugar industry. Last year the Council conducted workshops on harvesting and infield cane transport, cane quality assessment, and nitrogen and water management; as a result of these, appropriate research projects have been proposed and will be supported in 1989/90. "On-farm" projects cover an extremely wide range of research isues, particularly in relation to cane breeding, soil preservation and usage, new cropping systems, and disease and pest control. Because of the relatively high proportion of growers' costs involved in harvesting and transport, there has been a significant increase in funds for projects in these areas. For the first time, projects are being proposed in respect of research into cane quality assessment and alternative products and by-products. Projects to be supported will be carried out by the Bureau of Sugar Experiment Stations (36), CSIRO (8), CSR Limited and Sugar Research Institute (5 each), the University of Queensland (3), the Queensland Dept. of Agriculture and Bundaberg Sugar Co. (2 each), etc.

On-line monitoring of colour and turbidity in sugar process liquors

By R. W. Plews*, A. N. Mead* and J. Day**

Ever since 1878, when Henry Tate first built a refinery on the banks of the Thames to manufacture sugar cubes, Tate & Lyle has been a world leader in sugar production. Nowadays sugar cubes are out of vogue but, whilst ships from Mauritius, Fiji and Afro-Caribbean countries deliver more than 20,000 tonnes of raw sugar a week, the Thames site maintains its position as the largest cane sugar refinery in the world.

However, the company is not just ahead by virtue of its throughput. Tate & Lyle has always led the field with innovative refining technology; and has exported techniques and personnel throughout the world.

A recent development is the automation of various analytical procedures, most notably the unique introduction of on-line monitoring of both sugar colour and turbidity of pressed sugar liquor by means of a single photometric analyser. This is a technique devised by Ron Plews (the Refinery Chemist) and Alan Mead (Production Measurements Technologist) with instrumentation and technical assistance from Du Pont's Process Instruments Division.

According to Mr. Plews, "Automated analytical techniques being applied at Tate & Lyle Sugars are unique and pioneering." For a number of years the company had been trying to automate analytical methods in a number of areas with only limited success. Now, with the emergence of sophisticated computers, new microprocessor-based instruments and, with respect to colour, the technical help of Du Pont, the company has taken large steps forward.

A photometric analyser that would measure sugar colour automatically at full weight had to meet several technical criteria:–

(a) It must be robust enough to endure the harsh environmental conditions it would experience in use in the refinery.

(b) It must tolerate the way in which the material was presented to the colour cell. Sugar solutions are very difficult to handle – subject to aeration, changes in concentration, viscous, hot and with high pH.

(c) Maintenance must be minimal.

There was only one instrument found with the potential to meet all these requirements – a Du Pont 400 Photometric Analyser.

Says Mr. Plews: "We looked at a number of instruments and put them through the same conditions. The Du Pont instrument stood head and shoulders above the rest."

The 400 analyser works on a split-beam technique, measuring the difference in absorption, by a sample, of light at two wavelengths in the UV-visible region. In practice, radiation from a selected light source, usually a metal-vapour discharge lamp, is passed through a sample cell and into the photometer where it is split, by a semi-transparent mirror into two beams.

The measured beam is filtered to exclude all wavelengths except that absorbed strongly by the sample constituents under analysis. The reference beam is filtered to a wavelength which the sample absorbs weakly, if at all. In each beam, a vacuum photodiode produces an electrical current proportional to the light intensity; and a logarithmic amplifier, in turn, provides a voltage proportional to the negative logarithm of the phototube current. The amplifiers then subtract one output and, in accordance with Beer's Law, provide a single output linearly proportional to the concentration of the constituent under test.

The beauty of the split-beam technique is that it is inherently accurate and interference-free because the wavelengths are examined simultaneously. In addition, because adverse sample conditions (e.g. particulate matter, turbidity and fluctuations in light intensity) produce an equal effect on the intensity of

* Tate & Lyle Sugars plc.
** Du Pont (UK) Ltd.

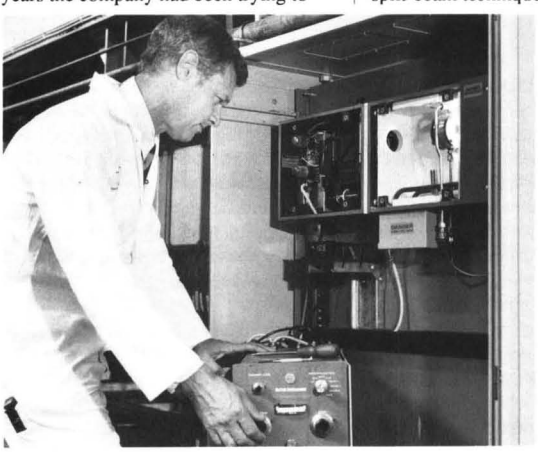


Figure 1. Alan Mead calibrating a Du Pont photometric analyser on-line

Figure 2. Ron Plews and Alan Mead examine results

Figure 3. A control room Tate & Lyle's Thames refinery

Figure 4. The pan floor at Thames refinery

the energy at both wavelengths, they cancel each other out without affecting the basic measurement.

Even by sugar refining standards, a pressed liquor stream is a difficult material to examine, displaying high pH, high temperature, variable colour and sometimes turbidity. With assistance from Du Pont, Mr. Mead calibrated the photometer for white sugar colour by measuring absorption at 420 nm, after filtering through a 0.45 μm membrane. This was accomplished most successfully and without apparent deterioration of response.

In operation, the analyser was set up so that its two photoelectric cells would read at 546 nm (for reference) and at 436 nm (measurement). The difference between readings was proportional to the change in sugar colour.

But of possibly greater interest to the scientists at Tate & Lyle was the fact that, not only was the photometer detecting colour changes in the sugar stream, there was also the potential for it to detect turbidity at the same time.

Turbidity in process solutions can be high, especially in pressed liquors, owing to the presence of traces of calcium carbonate and silica particles which are invisible to the naked eye. This turbidity will be picked up by the instrument but, in normal operation, its presence would affect both reference and measuring channels equally and hence be cancelled out by design. Colour measurement would continue unaffected.

Indeed, in essence, the reference channel checks aeration/striation; the light obscuration by suspended particles; and light intensity fluctuations from the instrument's light source. But Mr. Plews and Mr. Mead knew that in their application, the light from the source remained constant and there was no aeration. Because the only suspended solids were primarily particles of chalk, this was all that the reference channel was picking up.

They therefore reasoned that if the instrument could be modified so that the output of both the reference and measuring channels were read directly (unlike in the instrument's normal use where the only output is the difference in reading between the two channels), then not only would they have a means of monitoring on-line sugar colour but it ought to monitor sugar turbidity, too. This they tested by adding chalk to sugar passing through the analyser. When put on-line, it continued to monitor the turbidity level, besides sugar colour.

They also discovered that, occasionally, when a new press was put on line a transient peak is observed equivalent to up to several hundred ppm. The automated instrument gave instant indications of changes taking place, and the benefit of instant notification if a filter assembly was not working correctly.

Tate & Lyle put its first Du Pont analyser on line in a pressed liquor stream in February 1985. The intention was to run it for a short trial period, but the process operators found it so useful that it has never been taken out. During operation it has never broken down.

They have gone on to install four more Du Pont 400 photometric analysers – monitoring the sugar stream after it has passed through acrylic and styrene resin and two CAL decolorization steps. Plans are advanced to place additional instruments in the liquid sugar production lines.

All five analysers are part of an

Analytical Information Management System (AIMS) – linked to a Laboratory Information Management System with data going directly into a statistical computer database. Part of the Quality Control Laboratory's weekly operation is to produce information for a sugar balance for the statistics department. This they can achieve easily and quickly, using a program especially written by Tate & Lyle to meet their exact needs. The LIMS is based on Hewlett-Packard computers, but all software is generated by Tate & Lyle.

Mr. Plews and Mr. Mead have insisted on using Du Pont analysers, mainly because they had to have the confidence that results would be reliable; and they were not convinced that this reliability could be obtained from other products. Nor was the competitive equipment tested robust enough to withstand the rigours of the sugar industry.

Some instruments have to be directly connected to the sugar stream on-line. With the Du Pont 400, samples are bypassed to the instrument so that, if necessary, access can be gained without having to close the production stream.

Says John Day, from Du Pont: "It's this type of innovative thinking, mixed with a demand for high quality standards, that has kept Tate & Lyle a world leader for more than 100 years; and should ensure that they stay ahead in years to come."

Acknowledgement

The authors acknowledged the permission of Tate & Lyle plc to publish this article.

Facts and figures

ISSCT 20th Congress, 1989

The 20th Congress of the International Society of Sugar Cane Technologists was held in São Paulo, Brazil, as featured in our special issue of October 1989. Just over 900 members participated and it is hoped that Proceedings will be available within a few weeks. This volume will be available from the Secretariat, Caixa Postal 532, Piracicaba, SP, Brazil 13400, at a price of $130.00. The post-Congress visit to Colombia was cancelled because of the turbulent conditions in that country which, it was feared, might put the safety of members at risk.

Inter-American Sugar Cane Seminar, 1989

The 1989 Inter-American Sugar Cane Seminar was held as usual in Miami during September 20 - 22. It was the tenth in the series and marked a point for celebration and reflection. The celebration was of the way in which workers in the sugar cane industry from very many countries had been brought together to describe and discuss work being done in agronomy, weed control, breeding, pests and diseases control, irrigation and soil science, etc. It provided an occasion in which workers were able to bring up to date their reports of experience over the past ten years. The seminar presentations were made at the James L. Knight Convention Centre of the University of Miami, where the opening ceremonies were held on the morning of September 20 in the presence of representatives of the Sponsors and Co-sponsors. Seminar President Mr. Diego Suarez referred to the 26 papers on cane diseases presented in 1980; the 1989 program inclcuded 51 papers although in some cases these were not able to be presented where, e.g. authors from Puerto Rico were unable to leave their island because of hurricane damage. He expressed his appreciation of the efforts of all those involved in the organization of the seminars, the interval between which is to be extended to 2 years so that the next will be held in 1991.

British Society of Sugar Cane Technologists

The Autumn 1989 meeting of the BSSCT was held at the rooms of the Linnean Society in Burlington House, London, on November 21. This was later than usual, in order that speakers could deliver their impressions of the October 1989 Congress of the International Society in Brazil. The agricultural aspects of the Congress were summarized by David Marland, while Bob Gray provided an account of the processing, engineering and by-products papers. Additional comments were made by members who had been able to go to São Paulo, including the Chairman, Simon Winn, who also referred to the pre-Congress tours in the São Paulo sugar industry. Papers were then presented by David Evans (on behalf of David Eastwood) on the disease Ramu stunt and its near disastrous effect on the sugar industry of Papua New Guinea, and by Patrick Watson on experience in Malawi on the production of fuel alcohol. It is expected that these will be published in *Sugar Cane* and *International Sugar Journal*, respectively, in due course.

PERSONAL NOTES

Rufus J. Herring, who retired from Savannah Foods & Industries Inc. in 1978 after 39 years of service to the company, died in June. Rufus first worked at the Savannah sugar refinery as a student attending Georgia Institute of Technology and joined the company on graduation in 1939. Between 1942 and 1946 he served in the US Army but returned to the refinery holding numerous positions including Assistant Superintendent, Chief Chemist and, from 1973, Director of Quality Control. He served on the Board of the Cane Sugar Refining Research Project Inc. (now Sugar Processing Research Inc.) and was President of Sugar Industry Technologists in 1967.

Pakistan sugar statistics, 1988[1]

	1988	1987
	tonnes, raw value	
Initial stocks	828,687	990,454
Production	1,942,857	1,425,000
Imports		
Brazil	8,831	26,954
Bulgaria	0	3,703
China	12,576	229,499
Czechoslovakia	2,467	17,120
EEC	41,625	80,235
Germany, East	0	13,524
Malaysia	0	16,065
Poland	26,757	15,983
Switzerland	0	2,509
Thailand	0	12,641
Unknown	3,304	0
Total	95,560	418,233
less		
Consumption	1,978,055	2,005,000
Exports		
Bangladesh	33,691	0
Final stocks	855,358	828,687

New alcohol plant in Nigeria

The Nigerian News Agency reports that a new distillation plant for the production of alcohol from sugar cane has started production. The location of the plant, although not specified, is believed to be in Enugu in eastern Nigeria.

Rumanian sugar ration increased[2]

In view of the "rich harvest" of sugar beet, the sugar ration for Rumanian citizens was increased on September 21 from 1 kg to 1.7 kg per month.

Contamination risk for white sugar

White sugar transportation from one country to another is often in paper sacks in container vessels. All general-purpose shipping containers, whether of steel aluminium or wood, are fitted with plywood floors, some of plywood and others of glue-laminated timbers or planks. An Australian study[3] has shown that the wood can be contaminated with chlorophenols either applied as preservatives or, for example, from a cargo of hides. If the container were then used to carry sugar, the chlorophenols could impart off-flavours or taints to the sugar if it were packed in plain paper sacks. This risk, although slight, can be avoided by the use of more robust sacks, lined with polyethylene or polypropylene to act as a barrie. to contamination of the sugar.

US sugar support prices

The US Department of Agriculture has announced that the fiscal 1990 market stabilization price for raw cane sugar will be 21.95 cents per pound, raw value, slightly up from the 1989 level of 21.80 cents/lb. This price represents that at or above which producers would be more likely to sell their sugar in the market place than forfeit it to the Commodity Credit Corporation, and is the sum of the price support loan rate for raw cane sugar (18 cents/lb), the adjusted average transportation cost (3.04 cents), interest cost of repaying a price support loan at full maturity (0.71 cents) plus 0.2 cents/lb. The procedure for calculating the price is specified in the Code of Federal Regulations. The price support loan rate for beet sugar has been announced as 21.54 cents/lb, white value, and, like the cane sugar price, is the minimum which must be paid to growers by a processor participating in the price support loan program.

Chile sugar imports, 1988[4]

	1988	1987
	tonnes, raw value	
Argentina	10,141	13,494
Bolivia	44,536	2,000
Brazil	2,702	6,308
Colombia	842	0
EEC	15,160	1,930
Mexico	5,400	0
Paraguay	0	109
Uruguay	5,400	3,587
	44,181	27,428

UK investment in Polish sugar factories[5]

Beresford International plc's Bristar Division has signed a $10 million joint venture deal to take control of two Polish sugar factories at Unislaw and Ostrowite. Profits on the investment will arise from a share of the hard currency export sales of sugar from the factories. Beresford, which owns British Sugar, will hold 51% of the joint venture with Polish interests holding the balance. The investment, to be made over three years, will take the form of expertise and equipment from the West. Polish producers are to be enabled to achieve better beet yields and more efficient processing of the crop. Moreover, efforts are to be made to achieve more effective use of fuel and to improve the factories' environmental record.

Opposition to HFS production in Thailand[6]

Cane farmers in Thailand have mounted a fresh campaign to halt the introduction of new high fructose syrup (HFS) facilities and limit any further expansion in existing plants. Their concern follows reports that a soft drinks producer has submitted an application for a new soft drink formula which includes HFS derived from cassava roots as the starch source. Over two years ago the government authorized the construction of a new HFS plant but this was followed by strong protests from the sugar sector which urged that any further development of HFS should be halted.

Malawi sugar expansion aim[7]

The Malawi government wishes to increase sugar output and has been examining ways which include the controversial proposal; to bring in another international company. However, there is little room to improve yields and suitable vacant land is lacking. There are two sugar estates in Malawi – Sucoma and Dwangwa – occupying 9200 and 5200 hectares, respectively, and sugar production in 1989/90 is estimated at 178,000 tonnes.

1 *I.S.O. Stat. Bull.*, 1989, **48**, (8), 2.13
2 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 479.
3 Whitfield *et al.*:*Chem. & Ind.*, July 17, 1989.
4 *I.S.O. Stat. Bull.*, 1989, **48**, (8), 2.3 - 2.4.
5 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 490.
6 *Czarnikow Sugar Review*, 1989, (1789), 135.
7 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 494 - 495.

Fuel alcohol is also produced, the 12 million litres/year saving $4.7 million in reduced oil imports. Sugar exports from the 187,000 tonnes output in 1988/89 amounted to 78,000 tonnes; Malawi has an EEC quota of 21,500 tonnes and a US quota of 18,500 tonnes.

East Germany sugar production, 1988/89[8]

Sugar production from beets in the 1988/89 campaign amounted to 502,000 tonnes, white value (546,000 tonnes, raw value), and total production, including the refining of imported raws, amounted to 791,000 tonnes. The average beet yield was 23.4 tonnes/hectare and the crop processed was 4,625,000 tonnes, the worst harvest for many years. The beet area for 1989 was expanded by 8% to 215,800 ha but beet yield is estimated at below 30 tonnes/ha and sugar production from beets at somewhat more than 600,000 tonnes.

Czechoslovakia sugar exports, 1988[9]

	1988	1987
	tonnes, raw value	
Algeria	0	28,380
Austria	0	317
EEC	0	5,349
Egypt	3,942	27,500
Lebanon	0	6,780
Pakistan	14,951	26,392
Saudi Arabia	101,626	113,513
Sri Lanka	0	12,540
Syria	12,789	0
USSR	0	6,600
Yemen, North	0	13,200
Unknown	0	32
	133,308	240,603

Rhizomania discovery in the UK

Two outbreaks of rhizomania, a serious disease of sugar beet, have been discovered in Norfolk. Strict quarantine conditions have been imposed to ensure that the infection is contained. Both outbreaks have been discovered as a result of the very extensive annual survey that is carried out by the UK Ministry of Agriculture. The only other outbreak in Britain was that found at a farm in Suffolk in August 1987 in soil which had been brought into the country from Holland. No source of the current outbreaks has been declared.

New Venezuela sugar factory[10]

Accelerated plans for the installation of a sugar factory in Cojedes state were announced by the President of the legislative assembly recently. In its final phase the cane area will reach 18,000 hectares and should yield 1.4 million tonnes of cane, to be processed during a 180-day season. The project is to be carried out by the regional governor, who would seek financing from the central government.

Mexico sugar industry privatization

The Mexican news agency Notimex has reported that, according to the Director of Azúcar S.A., all sugar factories in Mexico will have been privatized by the end of 1990. Twenty of the factories have already been sold to private owners and a further 8 will be sold soon, leaving 20 more which will be privatized in 1990.

Cuban cane area expansion

According to Prensa Latina, the Cuban news agency, the Cuban Sugar Minister has said that the cane area for the 1989/90 crop will be 2 million hectares, 48,000 ha more than for the previous crop. He called for increased efficiency, even though 72% of the cane will be cut by mechanical harvesters.

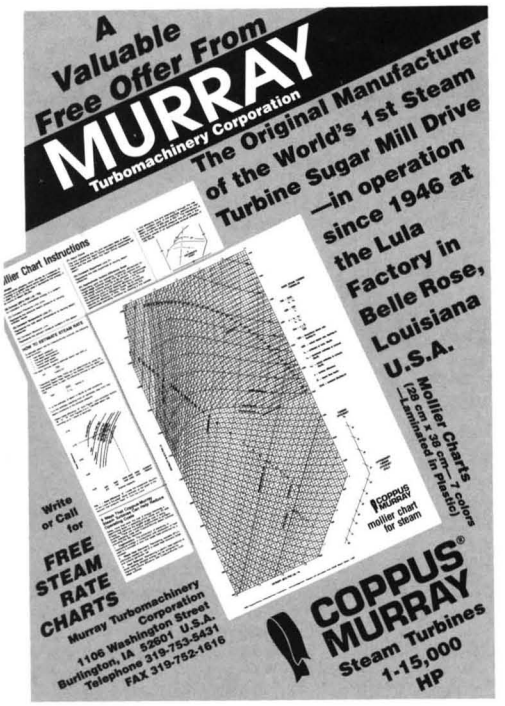
Uganda sugar factory reopening[11]

The Kakira sugar factory, reported earlier to be due for reopening in early 1989[12], is now said to have resumed production in October. It is intended that the factory will produce 90,000 tonnes of sugar a year by 1992. The plant has lain idle since 1984.

8 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 505.
9 *I.S.O. Stat. Bull.*, 1989, **48**, (8), 2.5.
10 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 526.
11 *Czarnikow Sugar Review*, 1989, (1790), 157.
12 *I.S.J.*, 1988, **90**, 223.

CITS workshop on carbohydrate utilization

The Commission Internationale Technique de Sucrerie, in conjunction with the Technische Hochschule, Darmstadt, is to hold a 2-day Workshop on "Progress and prospects in the use of carbohydrates as organic raw materials", to be held during April 11/12 next at the Kékulé Auditorium of the Technische Hochschule. The official language will be English and, because the Workshop is being sponsored by Süddeutsche Zucker-AG, there will be no registration fee. Presentations will be made by H. van Bekkum on "Studies on selective carbohydrate oxidation", by J. N. BeMiller on "Cyclic ethers from carbohydrates", by K. Buchholz on "Enzymatic sucrose modification and saccharide synthesis", by J. Daub on "From carbohydrates to pigments: an exercise in molecular material science and material transformation", by G. Greber on "Reactive sucrose derivatives", by L. Hough on "Applications of the chemistry of sucrose", by M. Kunz on "Hydrophilic building blocks based on sucrose: intermediates for surfactants and polymers", by F. W. Lichtenthaler on "Large-scale adaptable routes from monosaccharides to versatile six-carbon building blocks", by H. Röper on "Selective oxidation of low molecular weight carbohydrates and polyols: chiral intermediates for industrial utilization", by H. Schiweck on "New developments in the use of sucrose as an industrial bulk chemical", and by D. Schwengers on "Leucrose - a ketodisaccharide of industrial design: properties, synthesis, modification". Details of the workshop and a Hotel Reservation Card may be obtained from Prof. Dr. F. W. Lichtenthaler, Institut für Organische Chemie, Technische Hochschule Darmstadt, Petersenstrasse 22, D-6100 Darmstadt, W. Germany (Tel.: +49-6151-162376).



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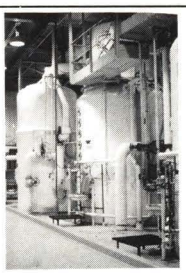

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(2) 37" × 30" W.S. Continuous
(1) 54" × 49" W.S. Auto Batch
(8) 49" × 44" ASEA Weibull Auto Batch
(7) 40" × 30" Western States

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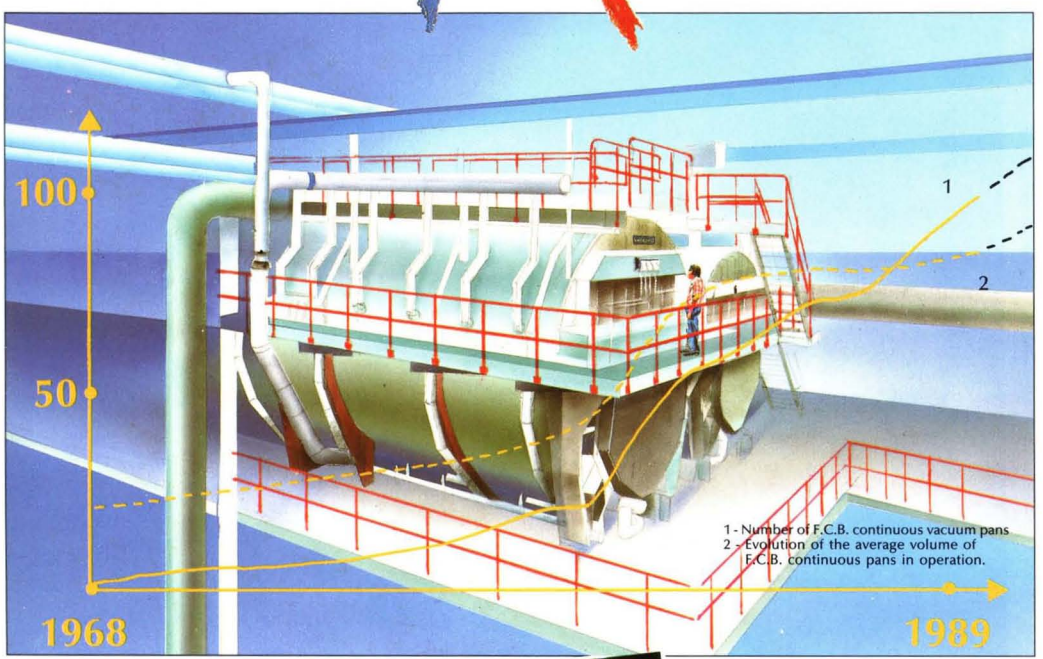

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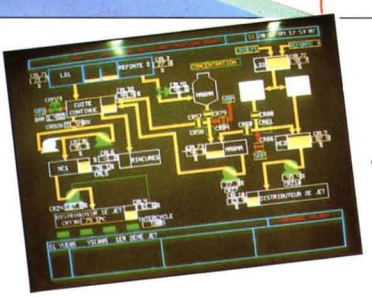

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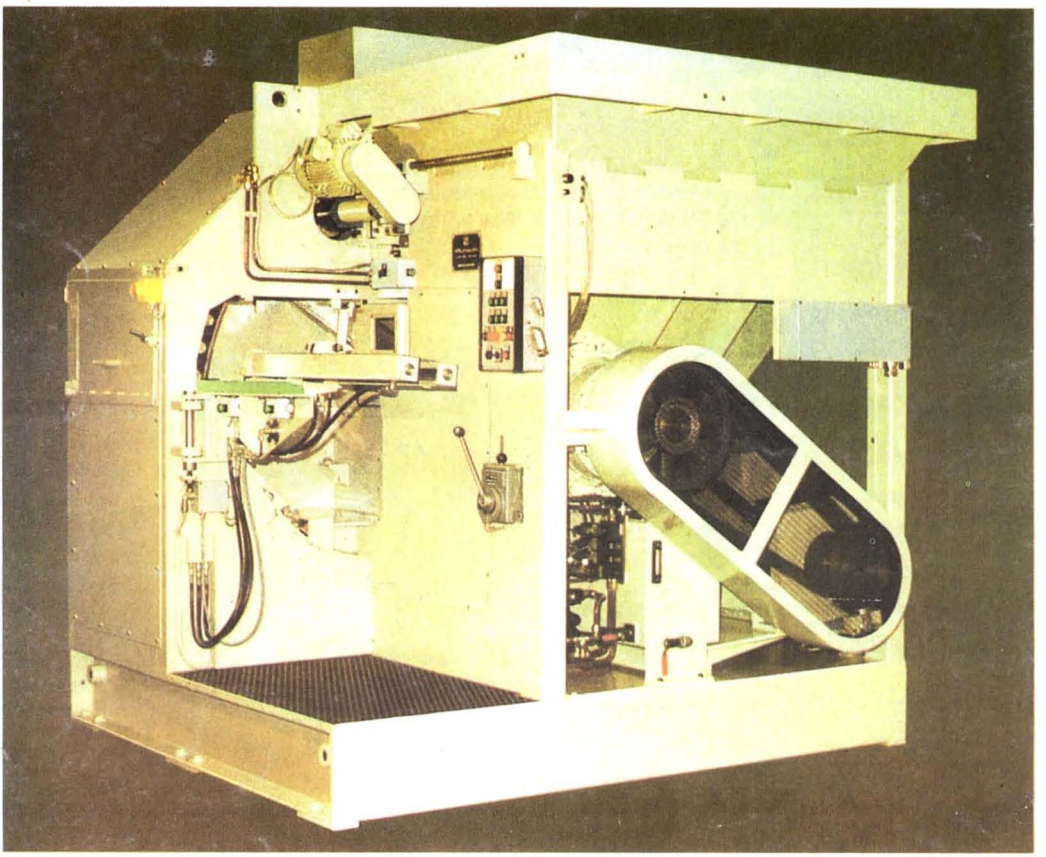

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