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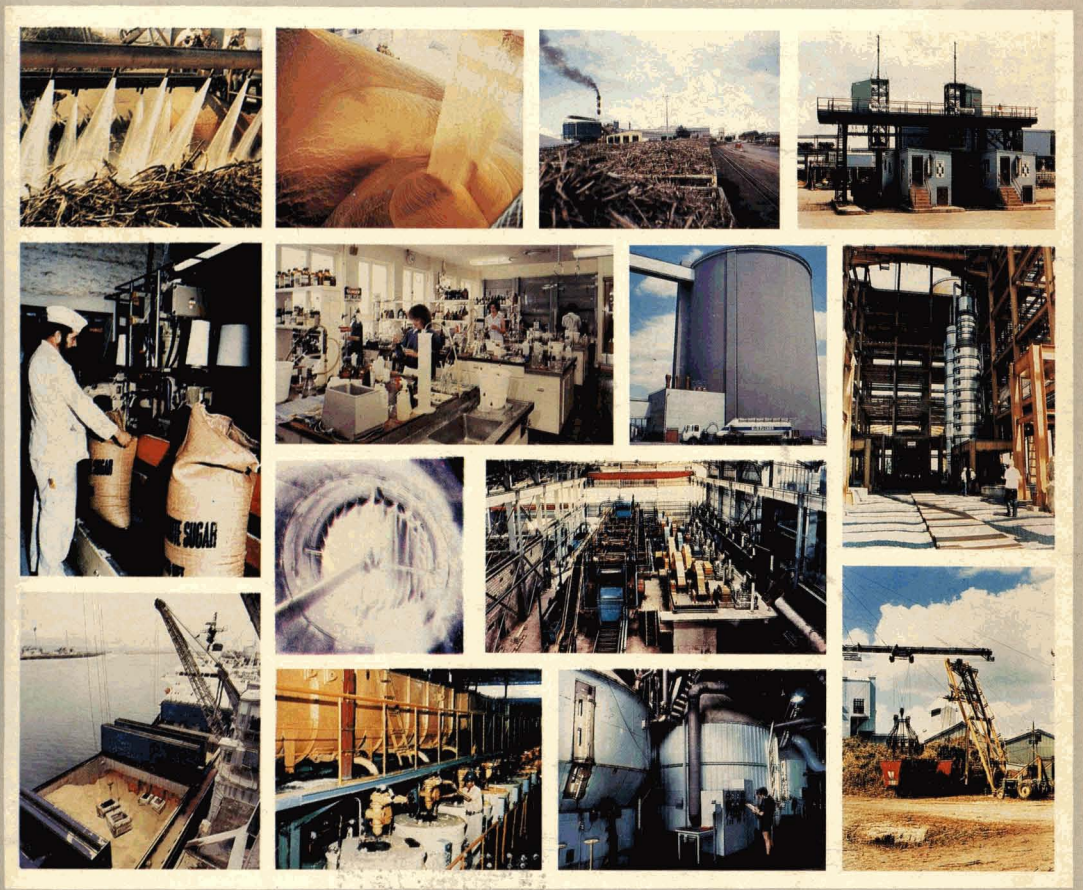

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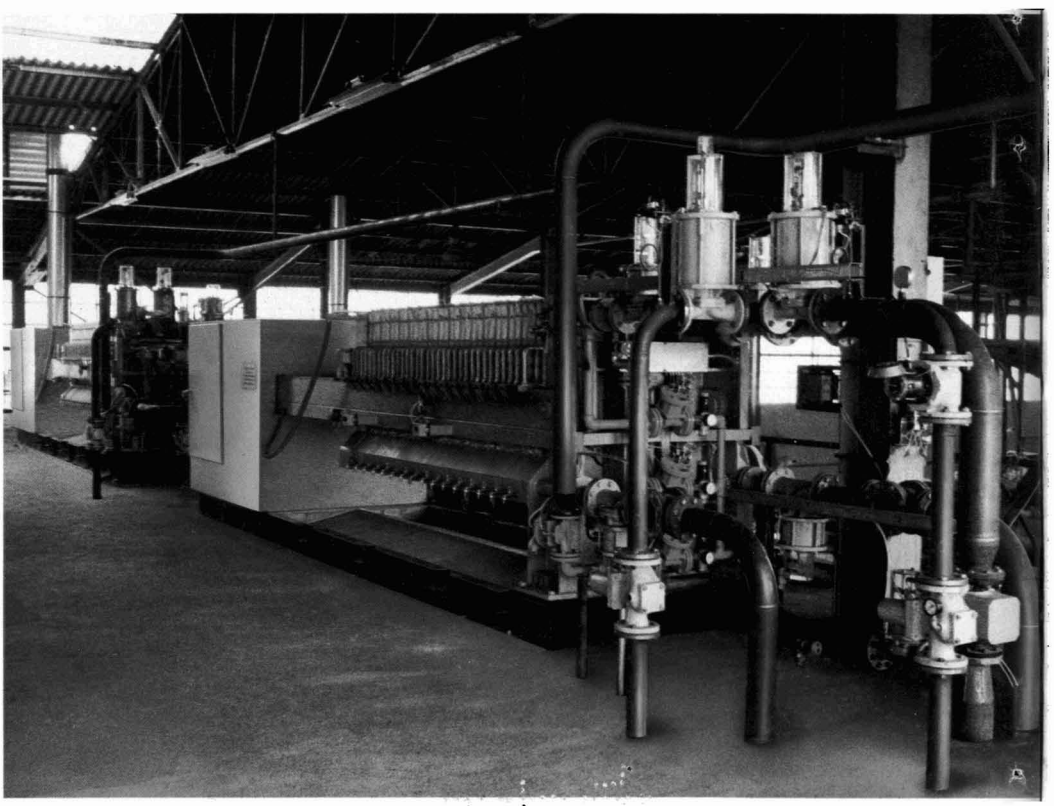

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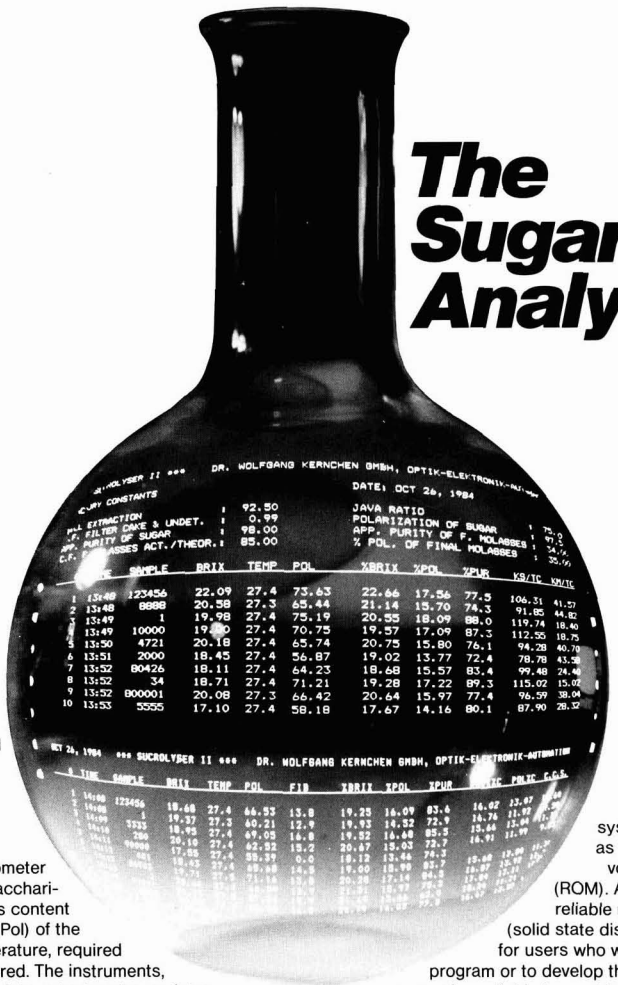

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Notes and comments

World sugar production, 1984/85[1]

In their second estimate of world sugar production for 1984/85, Licht have raised their total from 96.9 to 98 million tonnes, raw value, up 1.7% from 1983/84 and 1.1% higher than at the time of their first estimate in October last. Beet sugar production is now set at 36.9 million tonnes, an increase of 3.4% over 1983/84, largely owing to better weather and larger areas in the EEC and USA, a bumper crop in Yugoslavia and higher forecasts for the USSR and Iran.

The cane sugar total is forecast at 61.1 million tonnes, about 0.8% higher than in 1983/84. Recovery after the previous season's poor crops in South Africa, Australia and Fiji is partly offset by reductions in a number of countries which are reacting to low world market prices. Prospects in Cuba, Brazil and India are very uncertain, however.

High fructose syrup penetration of sugar markets

Use of high fructose syrup as a substitute for sugar began in the United States and has spread to a number of countries. In most of Europe, however, its production has been limited by regulation and it is in North America and Japan that greatest penetration of the sweetener market has taken place, although HFS production facilities operate in Pakistan, Uruguay and elsewhere. The advantage of HFS over sugar is solely that of price; an invert syrup obtained from sugar can be treated in the same way as an isomerized glucose syrup from corn starch to produce a 42% or 55% fructose syrup.

The price of HFS is governed to some extent by the return for the other products of corn milling—the corn oil and gluten feed in particular—and in the US it has been such as to permit undercutting of the high supported sugar price. The same conditions do not apply in the rest of the world, however. Observers have written of HFS as an intruder which would take over an ever-increasing part of the sweetener market yet a recent assessment by McKeany-Flavell Co. Inc., indicates that in the US the substitution will about reach its peak in 1985[2].

Estimates of industrial HFS use by market category (in short tons, dry basis, and % of the market) and the long-term penetration level (%) are tabulated below:

	1985		
Beverages	3,365,000 tons	96.4%	(100%)
Baking & cereals	505,000 tons	25.9%	(25%)
Canning & processed foods	700,000 tons	59.7%	(60-75%)
Dairy products	215,000 tons	34.9%	(35%)
Confectionery	25,000 tons	2.2%	(5%)
Other food & non-food uses	165,000 tons	22.0%	—

Usage in 1985 has received a big boost by the adoption of 100% HFS by the major beverage companies but in other areas the markets are mature and close to long-term penetration levels. The time of massive loss of sugar markets to HFS could therefore now be coming to an end.

US sugar quota period extended

In order to correct imbalance in the supply of sugar in the US, the Secretary of Agriculture decided to extend the period for which the fiscal 1985 quota applies from 12 to 14 months, i.e. to November 30 instead of September 30. The action was necessary because of greater than expected imports of blended sugars from Canada and an initial quota set higher than requirements. Rather than cut individual countries' quotas the same effect has been obtained by spreading the same supplies over a longer period. The announcement on January 10 brought about an improvement in the spot and future prices, and a threatened interim fee increase was avoided.

Indian sugar supplies[3]

It had been expected that in the run-up to the recent general election in India the pace of internal sugar releases would be maintained. However, the release of 390,000 tonnes of free sale sugar in January shows that the basic trend is being continued after the election and there appears little sign so far that the impressive rate of consumption might be limited by the new government. In the first four months of the 1984/85 crop year releases of both free and levy sugar have together totalled 2,848,000 tonnes of white sugar which, on an annual basis, indicates a usage of some 8.54 million tonnes of white sugar.

Reports of current crop production prospects vary widely. Although statistics for the first few months show an improvement over the same period in 1983/84, Czarnikow's news from India is that final output is unlikely to exceed the 5,889,000 tonnes of whites produced last season and may well be lower. On the assumption that by the end of the 1983/84 crop year some 300,000 tonnes of sugar imports had arrived and had passed into the supply chain, the following picture emerges:

	1983/84	1982/83
	tonnes, tel quel	
Initial stocks	4,605,000	3,296,000
Production	5,889,000	8,230,000
Imports	300,000	0
	10,794,000	11,526,000
Consumption	7,753,000	6,480,000
Exports	648,000	425,000
Adjustments	18,000	16,000
Closing stock	2,375,000	4,605,000

The outlook for the current season indicates that, unless official policy is changed to limit the rate of internal offtake or production prospects show a marked improvement from current indications, imports will need to be substantial. It may be possible to make a further reduction in stock levels but, with world prices now so depressed, there would be little point in running reserves down to the absolute minimum.

EEC farm price proposals for 1985/86

The EEC Commission's proposals for farm prices for the year from July 1985 have now been released and, as had been expected, include prices either unchanged or increased only slightly, while in a few cases it has been proposed that there should even be price reductions. In respect of sugar it is proposed that the price for beet should be unchanged, although an increase is suggested in the intervention prices for white and raw sugar of 1.33% and 1.15%, respectively, to allow for the 20% rise in fuel costs between the autumn of 1983 and a year later. It is also proposed, however, that the storage refund should be unchanged while the levy which finances it should be cut; this the Commission believes would maintain an unchanged white sugar price for the consumer. As might be expected, the farmers' organizations in member countries denounced the proposals as unacceptable and inadequate; they had been looking for increases in prices and considered that the proposals would reduce farmers' incomes to those of earlier years. Consumer organizations, on the other hand, welcomed the proposals but considered that they did not go far enough to reduce the production of surpluses and consequent commitment to exports subsidized by the taxpayers of the Community. The proposals will be considered by the Council of Ministers in due course.

World sugar prices

Very little in the way of solid news and developments occurred during February and the London Daily Prices for raw and white sugar declined slowly during the first half of the month from $117 and $143, respectively, to reach minima of $106 and $134, largely owing to bearish forecasts of higher than expected sugar production in the USSR and elsewhere. Thereafter, news of likely reduction in Philippine sugar production and confirmation of Indian purchasing intentions strengthened the market. In addition Cuba purchased sugar and the prices rose and after a further short dip ended the month at $115 and $137, respectively.

USSR sugar beet crop, 1984/85

Recent publication of Soviet sugar beet production figures for 1984/85 shows that it reached 85.3 million tonnes, which compares with 81.8 million tonnes in 1983/84 when sugar output reached nearly 8.8 million tonnes, raw value[4]. They show that estimates for 1984/85 sugar production by most Western observers, which have been as low as 7.7 million tonnes, have been seriously below the likely outturn. Over the past three years the state has purchased roughly 90% of the total crop for sugar production; on such a basis, and assuming the extraction rate to be 11.36%, the average for the past six years, total 1984/85 beet sugar production would be 8.7 million tonnes, raw value.

C. Czarnikow Ltd. note[5], however, that "Analysts can harbour no illusions that they will soon be able to include precise Soviet production statistics in their calculations, however, for these will have a considerable bearing on that country's import needs and it cannot be expected that an official assessment of production will be released in the near future".

World sugar balance, 1984/85

Recently, estimates of sugar production and consumption have been published by F. O. Licht[6] and by *World Sugar Journal*[7]. Their bases are not the same and the figures show quite a different picture. Licht sets production in the period September 1983/August 1984 at a total of 97,896,000 tonnes, raw value, against a consumption of 96,629,000 tonnes, giving a surplus of 1,267,000 tonnes. For 1984/85 he sets production at 97,424,000 tonnes and consumption at 97,337,000 tonnes, giving a further small surplus of 87,000 tonnes. *World Sugar Journal* set production and consumption in 1983/84 at 95,040,000 and 95,600,000 tonnes, respectively, indicating a deficit of 560,000 tonnes, while for 1984/85 the corresponding figures are 95,970,000 tonnes and 97,260,000 tonnes, providing a deficit of 1,290,000 tonnes. Only time will tell which of these estimates is nearer actuality. As a consequence of their differences, estimates of closing stocks are considerably apart, yet in both cases, show a burdensome surplus.

E. D. & F. Man recently observed[8]: "The initial indications for 1985/86 are that some reductions are planned in Thailand, the Philippines and Argentina. The EEC beet area is expected to be marginally lower. However, these on their own will probably not be big enough to provoke a deficit of sufficient size to alter fundamentally the perception of the market held by all involved, producers, importers, traders and speculators. Further cuts will be necessary for the market to stage a significant recovery. Eventually they will happen as the futility of producing and exporting sugar at 4 or 5 cents per lb is brought home to even the most optimistic exporters. Those countries whose ratio of world market exports to domestic market (plus preferential market sales—Ed.) are highest are clearly the most vulnerable in the coming months." While so many producers sell large amounts of sugar profitably in the home market and to preferential markets such as the US and EEC, their losses on the world market (in total less than 15% of world production) will be accepted and the vulnerable exporters will continue to suffer.

1 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 45-54.
2 *MF Sweetener News*, January 14, 1985.
3 C. Czarnikow Ltd., *Sugar Review*, 1985, (1734), 3.
4 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 78.
5 *Sugar Review*, 1985, (1735), 27.
6 *International Sugar Rpt.*, 1985, **117**, 67.
7 1985, **7**, (7), 12-13.
8 *The Sugar Situation*, 1985, (405).

HPLC analysis of reaction mixtures containing monosaccharides and alditols

By M. Makkee, A. P. G. Kieboom, and H. van Bekkum

(Delft University of Technology, Laboratory of Organic Chemistry, Julianalaan 136, 2628 BL Delft, Holland)

Continued from page 58

At higher temperatures, the efficiency picture of these mutarotating monosaccharides shows more resemblance to that of the other polyhydroxy compounds, as is demonstrated by Fig. 4. This is clearly due to the increased rate of mutarotation.

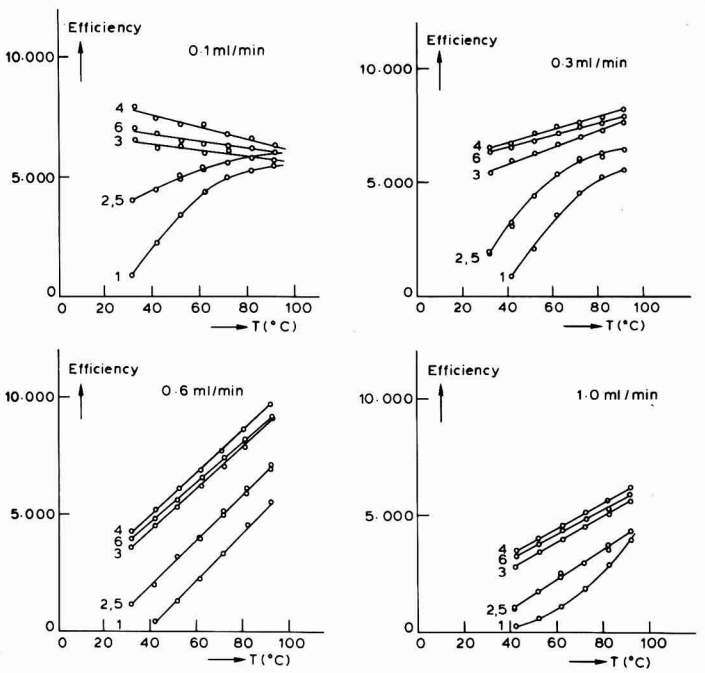


Fig. 4. The influence of the temperature on the efficiency of D-glucose (1), D-fructose (2), D-mannitol (3), D-glucitol (4), D-mannose (5), and myo-inositol (6) at different flow rates. Chromatographic conditions: column (30 cm × 7.0 mm i.d.); stationary phase: sulphonated polystyrene-divinylbenzene resin; Aminex A 7 in the Ca(II) form (7-11 μm); eluent: H_2O.

In this respect, we already mentioned that Angyal *et al.*[6] and Verhaar & Kuster[14] have applied 0.001M triethylamine (TEA) in water as the eluent. In this way a much better resolution (a higher capacity factor) and efficiency were obtained for D-glucose, D-fructose and D-mannose at lower temperature, which is due to the amine-catalysed mutarotation. Unfortunately, TEA from the eluent gradually displaces Ca(II) from the cation exchanger, resulting in a decrease of retention times and separation efficiency in due course. Immobilization of TEA (e.g. in the form of a weak base ion exchanger) might overcome this disadvantage. Another possibility is a partly exchanged cation exchange resin, where free sulphonic acid groups might catalyse the rate of mutarotation.

It has to be noted that a complete understanding of the chromatographic behaviour (Fig. 3 and Fig. 4) requires a detailed description of the various diffusion and mass transfer processes (van Deemter equation[18]). This, however, falls beyond the objective of this paper.

Practical chromatographic conditions chosen

The results mentioned above have enabled us to select chromatographic conditions for the almost base-line separation of D-glucose, D-mannose, D-fructose, D-mannitol, D-glucitol, D-tagatose, and D-psicose as given in Fig. 5. The system proved to be stable for 12 months (6500 analysis runs) with respect to retention time, peak width and column efficiency without any need for regeneration. This permitted us to use the chromatographic system with an autoinjector overnight and at weekends, thus overcoming the objection of the somewhat longer time of analysis (45 min).

The retention times and the capacity factors of a number of mono- and disaccharides and sugar alcohols are summarized in Table II.

For the enzymatic isomerization of D-glucose the only reaction products are D-glucose and D-fructose, whereas the hydrogenation of D-glucose, D-fructose and invert sugar (D-glucose: D-fructose = 1:1) under mild conditions leads to a mixture of D-glucose, D-fructose, D-mannitol, and D-glucitol. In these cases a very rapid and quantitative analysis of the reaction mixture is obtained within 6 min over an HPLC column (25 cm × 4.0 mm i.d.) containing Aminex A 7 in the Ca(II) form at higher temperature (85°C) and with a flow rate of 0.5 ml/min as given in Fig. 6. The method is suitable for automation and operates with water as the eluent and RI detection.

Summary

In connexion with the investigation of a new combined process for the preparation of D-mannitol from invert sugar (involving a dual heterogeneous catalytic system consisting of immobilized glucose isomerase and a copper hydrogenation catalyst) a quantitative HPLC analysis technique has been developed (using RI detection). Sulphonated polystyrene-divinylbenzene resin in the Ca(II) form as the stationary phase with water at 65°C as the eluent gives an almost base-line separation of sucrose, D-glucose, D-mannose, D-psicose, D-mannitol and D-glucitol. Retention

Table II. Retention times (min) and capacity factors for a number of carbohydrates[a,b]

Carbohydrate	t_r	k′	Carbohydrate	t_r	k′
Raffinose	12.48	0.121	Methyl α-D-glucopyranoside	17.66	0.587
Cellobiose	13.80	0.240	3-O-Methyl-D-glucose	16.20	0.455
Sucrose	13.92	0.251	2-Deoxy-D-glucose	18.20	0.635
Maltose	14.31	0.286	6-Deoxy-D-glucose	18.62	0.673
Isomaltulose	14.62	0.313	2-Deoxy-D-galactose	20.64	0.854
Lactose	14.86	0.335	6-Deoxy-D-galactose	22.14	0.989
Lactulose	16.62	0.493	6-Deoxy-D-mannose	20.07	0.803
6-O-α-D-Glucopyranosyl-D-mannitol	18.66	0.676	D-Xylose	14.00	0.707
			D-Arabinose	22.47	1.019
Lactitol	20.21	0.816	D-Lyxose	23.40	1.102
6-O-α-D-Glucopyranosyl-D-glucitol	22.04	0.980	D-Ribose	39.10	2.513
			2-Deoxy-D-ribose	23.13	1.078
D-Glucose	17.03	0.530	D-Xylulose	22.56	1.027
D-Galactose	19.38	0.741	D-Ribulose	36.46	2.276
D-Mannose	20.03	0.800	myo-Inositol	22.13	0.988
D-Altrose	20.43	0.835	D-Mannitol	29.79	1.676
D-Allose	27.35	1.457	D-Talitol	30.13	1.707
D-Talose	36.09	2.242	Galactitol	35.57	2.196
L-Sorbose	19.49	0.751	D-Glucitol	37.33	2.354
D-Fructose	22.51	1.022	Ribitol	24.47	1.198
D-Tagatose	27.11	1.436	D-Arabinitol	30.05	1.700
D-Psicose	34.70	2.117	Xylitol	39.05	2.508
			Pentaerythritol	24.60	1.210
			Erythritol	25.64	1.304

[a]Chromatographic conditions: column (30 cm × 7.0 mm i.d.); Aminex A 7 in Ca(II) form (7–11 μm); eluent: H_2O; temperature: 62°C; flow rate: 0.3 ml/min.
[b]Unretained $Ca(ClO_4)_2$: t_0 = 11.13 min.

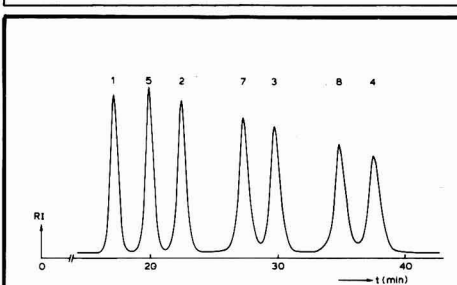


Fig. 5. HPLC analysis of an aqueous mixture of D-glucose (1), D-fructose (2), D-mannitol (3), D-glucitol (4), D-mannose (5), D-tagatose (7), and D-psicose (8).
Chromatographic conditions: column (30 cm × 7.0 mm i.d.); stationary phase: sulphonated polystyrene-divinylbenzene resin; Aminex A 7 in the Ca(II) form (7-11 μm); eluent: H_2O; temperature: 62°C; flow rate: 0.3 ml/min.

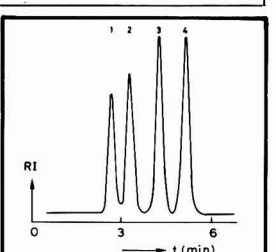


Fig. 6. HPLC analysis of an aqueous mixture of D-glucose (1), D-fructose (2), D-mannitol (3), and D-glucitol (4).
Chromatographic conditions: (25 cm × 4.0 mm i.d.); stationary phase: sulphonated polystyrene-divinylbenzene resin; Aminex A 7 in the Ca(II) form 7-11 μm); eluent: H_2O; temperature: 85°C; flow rate: 0.5 ml/min.

times and capacity factors have been determined for 44 mono-, di- and trisaccharides and alditols. The HPLC system proved to be stable for 12 months (6500 analysis runs) without any need for regeneration. This allowed the use of an autoinjector overnight and at weekends. Dependent on the complexity of the carbohydrate mixture, analysis times vary from 6 to 60 minutes.

Acknowledgement

The technical assistance of Dr. F. van Rantwijk and Dr. C. Olieman is acknowledged.

Analyses par HPLC de mélanges reactionnels renfermant des monosaccharides et des alditols

En connection avec la recherche d'un nouveau procédé combiné pour la préparation de D-mannitol au départ de sucre inverti (faisant appel à un système double hétérogène catalytique et consistant de glucose-isomerose immobilisé et d'un catalyseur d'hydrogénation, à base de cuivre), on a développé une technique d'analyse HPLC quantitative utilisant la détection RI. La phase stationnaire consiste de résines polystyrene-divinylbenzene sulphoné en forme Ca(II). L'éluant est de l'eau à 65°C. Ainsi on obtient une séparation pratiquement parfaite du saccharose, D-glucose, D-mannose, D-psicose, D-mannitol et du D-glucitol. Les temps de rétention et les facteurs de capacité ont été déterminés pour 44 mono-, di-, trisaccharides et alditols. Le système HPLC s'est montré stable pour 12 mois (6500 séries d'analyses), sans besoin de régénération. Cela rendait possible l'utilisation d'un injecteur automatique durant la nuit et pendant les week-ends. En fonction de la complexité du mélange d'hydrates de carbone, la durée de l'analyse varie entre 6 et 60 minutes.

HPLC-Analyse von Monosaccharide und Aldite enthaltenden Reaktions-gemischen

In Verbindung mit der Untersuchung eines neuen kombinierten Prozesses zur Herstellung von D-mannitol aus Invertzucker (bestehend aus doppelten Katalyse mit immobilisierter Glucoseisomerase und einem Kupfer-Hydrierungs-Katalysator) wurde eine quantitative HPLC-Analysentechnik entwickelt (unter Verwendung des Brechungsindexes). Sulphonierte Polystyrol-Divinylbenzol-Harze in der Ca(II)-Form als stationäre Phase und Wasser von 65°C als Elutionsmittel ergeben eine fast vollständige Trennung von Saccharose, D-Glucose, D-Mannose, D-Psicose, D-Mannitol und D-Glucitol. Retentionszeiten und Kapazitätsfaktoren wurden für 44 Mono-, Di- und Trisaccharide sowie Aldite bestimmt. Das HPLC-System erwies sich für über 12 Monate (6500 Analysen) stabil ohne regeneriert werden zu müssen. Dies erlaubte die Verwendung eines Autoinjektors über Nacht und am Wochenende. Abhängig von der Komplexität des Analysen-gemisches betrug die Analysenzeit zwischen 6 und 60 Minuten.

Análysis por HPLC de mezclas que contienen monosacáridos y alditoles

En conexión con la investigación de un nuevo proceso combinado para la elaboración de D-manitol de azúcar invertido (que invuelve un sistema doble de catálisis heterogéneo que consiste de glucosa-isomerasa inmovilizada y un catalizador para hidrogenación basado en cobre) se ha desarrollado una técnica de análisis cuantitativa por HPLC utilizando detección por indice de refracción. El fase estacionario consiste de résina polistirena-divinilobenzena sulfonada en la forma Ca(II), y para elución se emplea agua a 65°C. Se obtiene una separación casi perfecta de sacarosa, D-glucosa, D-manosa, D-psicosa, D-manitol y D-glucitol. Tiempos de retención y factores de capacidad se han determinado para 44 mono-, di- y trisacáridos y alditoles. El sistema HPLC resulta estable para 12 meses (6500 corridas de análisis) sin necesidad de regeneración. Esto permite el uso de un auto-inyector durante la noche y el fin de semana. Dependiente del complejidad de la mezcla de carbohidratos, el tiempo de análisis varie entre 6 y 60 minutos.

1984 Conference on Sugar Processing Research

The 1984 Conference on Sugar Processing Research, sponsored jointly by Sugar Processing Research Inc. (SPRI), and the Agricultural Research Service of the US Department of Agriculture, was held during October 16-18, 1984, in New Orleans, Louisiana. One hundred and ten delegates, representing the major sugar companies of the world, from a dozen countries, gathered to hear about recent developments in the forefront of sugar processing technology.

Two guest speakers presented overviews of areas of importance to sugar production in the future. Dr. Michael Ladisch, of the Laboratory of Renewable Resources Engineering, Purdue University, talked about the manufacture of fermentable sugars from cellulosic materials, such as bagasse, showed some pilot-plant designs now in operation and discussed analytical methodology important in following these processes. Dr. Robert F. Hutton described liquid chromatographic processes used on an industrial scale for the separation and purification of chemicals; this sort of process is used for molasses purification and fructose production at the Finnish Sugar Company.

Two important papers on sugar cane polysaccharides were presented: Earl J. Roberts (SPRI) described the isolation and identification of a newly discovered polysaccharide from sugar cane, a glucan, found in fresh cane of all ages; it is rather similar to amylopectin but much more soluble and may be a type of plant glycogen. Dr. Frederick W. Parrish (Southern Regional Research Center) reported the observation of very small starch granules, of about 1μm diameter, in raw sugars of various origins. These do not gelatinize under normal conditions for starch solubilization, and may be retrograded or protected by lipid compounds.

Several papers on colour and flavour in sugars were of interest: Dr. John Williams (Tate and Lyle) presented data on pilot plant studies of anion decolorization and listed factors responsible for resin fouling. Mary An Godshall (SPRI) discussed in detail the sensory analysis of brown sugar flavours, and the correlation of taste panel results with chemical measurements; she listed the names of flavour compounds which can be determined by chromatographic procedures, and their relative importance to flavour. Dr. Margaret A. Clarke (SPRI) described a series of simple tests to determine the types of colorant in a raw sugar and predict the behaviour of that raw under refining processes.

Stanley Bichsel (American Crystal Sugar Co.) evoked great interest with his presentation on his Dark Solution Polarimeter which, through use of a laser light source, can measure pol in dark syrups and juices and thereby eliminates the need for clarification with lead acetate.

Several speakers discussed chromatographic techniques: Pamela Morel du Boil (Sugar Milling Research Institute) described the use of gas liquid chromatograpy to measure sugars in juices and molasses from South African factories, and discussed process observations and control measures derived from these measurements. Dr. Charles W. S. Tsang (SPRI) talked about his use of HPLC for analysis of sugars and organic acids in cane juices from experimental trials, and also for measurement of sucrose decomposition products. Trevor Chorn (Sugar Milling Research Institute) compared results on sugars in molasses by gas liquid chromatography and HPLC, and showed ways to improve HPLC techniques.

Dr. Eivind Lillehoj (Southern Regional Research Center) outlined studies on the nature and occurrence of dextran-producing organisms in a raw sugar factory and confirmed that *L. mesenteroides* was the major, but not the only, dextran former. Dr. Ben L. Legendre (US Sugarcane Field Station) also referred to dextran levels in his

study of freeze damage to several cane varieties, where he found variety-related differences in overall deterioration and dextran formation.

Dr. Stephen A. Brooks (Barbados Sugar Producers' Association) discussed problems that arise from the diversity of analytical methods available today, and used calcium analysis in sugar factories as an example of different results given by different techniques. Dr. Richard Riffer (California and Hawaiian Sugar) gave a comprehensive discussion on the importance of iron compounds in sugar manufacture, their incidence, potential problems (and solutions) and analytical methods; his paper is a significant contribution to sugar chemistry literature.

A series of four papers on press filtration created an informal symposium on filtrability. Robert J. McCowage (CSR Ltd.) described identification of the quantitative effect of raw sugar components on carbonatated liquor filtrability: phosphate, silicate, magnesium and aluminium salts and high molecular weight polysaccharides were the major offenders. James A. Devereux (SPRI) also found polysaccharides a major factor in filtration impedance as are field soil traces and all suspended solids. Nicholas Nenadkevich (Amstar Corp.) described a filtration bomb test that gives good correlation with refinery performance, and Clifford W. Cain, Jr. (Manville Corporation) described work on particle size of filtration-impeding raw sugar components and particle interaction with filter aids of different pore sizes.

Among the social functions for delegates was a banquet where highlights were a talk by Henry G. Gerstner (and an introduction by the inimitable F. A. Graugnard of St. James) on the history of the Louisiana sugar industry, and a presentation to Dr. Frank G. Carpenter upon his retirement after 36 years service to the sugar industry.

The micro-computer applied to beet reception

By R. D. Robins and P. R. Leaton

Continued from page 54

System hardware

Using a 16-bit architecture, the function required in each station micro is provided by a combination of 7 in × 9 in printed circuit boards. The Central Processing Unit (CPU) board receives its power from an enclosed power supply board via a back panel. Communications between the CPU and other printed circuit boards also proceed via this back panel. The function achieved by each of the component boards is as follows:

The board layout within a micro chassis is illustrated in Figure 11 whilst the total tarehouse package (including station micros and communication micro housed in Tallboy cabinets) is shown in Figure 12.

A positive attempt has been made to house the equipment in a clean environment to combat the high humidity levels and the occasional ingress of hydrogen sulphide which are features of tarehouses.

Automatic data entry at every

Board	*Function*
MP100 CPU	Processing capacity and control over other boards.
EPROM MEMORY	Accommodates EPROM chips containing application and operating software.
CMOS MEMORY	Battery backed-up memory board which stores transaction data.
DIGITAL I/O	Handles inputs and outputs to control operator panels; also "digitize request" signal for scale devices.
MULTIPLEXOR	Asynchronous data channels for communications with station equipment and inter-micro communications.

Fig. 11. MP100 Micro

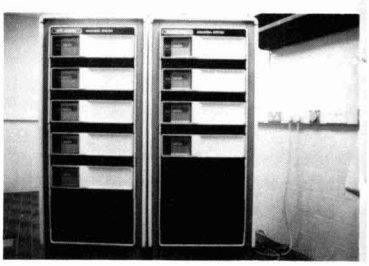


Fig. 12. Tarehouse Micro Cabinets

station is achieved using the optical bar code reader terminal, this having been incorporated into a waterproof terminal box. Apart from weighbridges, where a VDU is used, operator control of any station is achieved by means of an appropriate number of push-button lights mounted on the facia of the box. The control box is sited remotely from the station micro in the more hostile tarehouse environment. The arrangement at the Clean Station is illustrated in Figure 7. For the saccharimeter/amino-nitrogen station (Fig. 8) a smaller light box is mounted remotely from the control box. Data cables from station devices pass to the micro via these control boxes.

Because of the method which British Sugar employs to interface micros to weighing equipment within the weighbridge a further requirement of the Department of Trade standards has resulted in the installation of a fibre optic communication link between weighbridge micros and the communication micro. This is the first installation of a fibre optic system within British Sugar.

A diskette-based micro system is used to achieve communications both locally with station micros and remotely with the commercial system located in the factory office. Multiplexors slotted into the micro chassis handle asynchronous communications with station micros whilst a synchronous controller board achieves communications with the commercial system.

A mini computer system dedicated to the beet data system was installed at King's Lynn for the 1983/84 campaign. Two data communication loops were installed for system users. One loop was laid to the tarehouse to feed a tarehouse logging printer and VDU terminal for the Beet Receptionist. A second loop installed in the factory office provided access to the mini computer for the Beet Office and management users.

System software

The station micros run under the manufacturer's standard micro-computer operating system. This system supports the real-time multi-tasking environment required by the system, with application programs written in Assembler.

Each station is connected to the communication micro by an asynchronous point-to-point line. The line is driven by standard READ/WRITE software at the link level, but data integrity and synchronization are affected by the use of a message block check protocol which effectively prevents loss of data from the system.

The communication micro operates under an advanced operating system which is capable of supporting multiple programs running concurrently in a time-sharing environment.

Software for the weighbridge and tarehouse system was written by and is supported by the manufacturers' System Division.

The link between micro and commercial systems is achieved using standard System Network Architecture (SNA) software products.

The commercial system is fully supported within British Sugar by its own Computer Services Department.

System operation developments

A significant development regarding weighbridge operations has been the concept of a remote document reader (see Figure 13).

As factory beet deliveries increased over the years to match increases in factory slice capacity, document conveyors were introduced to maximize the weighing rates achieved by weighbridges. The benefit of the conveyors was that the drive-on and drive-off time for lorries was used by the weighbridge operator for permit validation and keyboard entry. The disadvantages of the conveyors were the noise, draughts and increasing maintenance costs both during the campaign and off-season.

At the "in" weighbridge remote reader, as illustrated in Figure 5, the haulier draws the delivery document through the slot device of the bar code reader. The micro, which may also be carrying out the weighing transaction for a lorry on the weighbridge platform, carries out the communication micro grower-file search in a multi-tasking environment. As soon as the operator has completed a transaction the details of the next lorry pulling on to the platform are displayed.

At the "out" weighbridge a reader is also sited prior to the platform and the haulier draws through it the "C" suffix weighbridge stub card. The "out" weighbridge micro then collects a record of the "in" weighbridge details from the communication micro and automatically displays them on the operator's VDU.

At the automatic beet sampler units operator control boxes have been interfaced to the sampler control units. For each sample taken the stub card

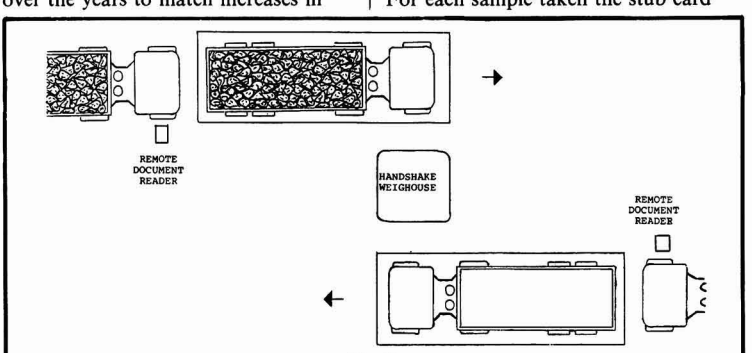


Fig. 13

number is recorded along with the sample position and the sampler number. Dirt tare comparisons are then obtained for different units and sampling positions.

Development and commissioning

System development

At the outset of the project a 42-week development program was identified. This highlighted the fact that software development was critical from the first day, in order to achieve a commissioning date in September 1983. Rather than postpone system commissioning until 1984, the decision was taken to install the equipment for the 1983 campaign and accept an element of risk of delays in software development.

Statutory regulations

The tests carried out on weighbridge equipment were known to be very stringent and included power supply interruptions and variations, static discharges to 6 kV, and resistance to various levels of radio frequency. The Department of Trade were involved at an early stage to ensure that the hardware would meet the standards laid down.

A weighbridge micro was configured with its peripheral equipment (optical bar code reader, printer and weighing equipment) and an elementary program developed so that a printed receipt could be produced showing stub card number and weight.

This test unit was offered to the Department of Trade and tested to their satisfaction during May 1983.

The successful conclusions of these early tests were most encouraging as the only changes between the test unit and the final operating system would be in the application software.

King' Lynn commissioning

Final Department of Trade testing on the weighbridge system was successfully carried out on September 7. Although slippage had occurred during final software integration on site, it was hoped that at least the weighbridge system would be available at the campaign start. In the event, further weighbridge system faults were highlighted when attempting to process data at high rates. In the tarehouse, problems centred around interfacing station equipment to micro equipment. The commercial system development had proceeded to schedule and was available for campaign start-up.

Operations subsequently commenced using the original data collection systems which wisely had not been removed. A positive benefit was that the bar coded permit documentation issued to growers could be used and, by manually entering permit details into the connercial system, the update of grower allocation records was live from the campaign start.

Following significant levels of functional and volume testing the weighbridge system was put into operation on November 21 and the tarehouse system on December 13. All load data were cleared locally on the commercial system until the end of the campaign.

Cleared data were transferred from the King's Lynn mini-computer system to the Company's central mainframe computer each evening via public telephone lines.

The on-line link between the weighbridge micro system and the commercial system was tested and ran satisfactorily for the last week of the campaign.

System performance

As a beet reception tool

The record of success of the data system used at King's Lynn over the past thirteen years had been good. Operators had been accustomed to simple and reliable equipment and were thus expected to be critical of change if it were associated with problems.

Experience at Bury and Ipswich factories with mini-computer-based systems had been that operators, in general, accepted new technology providing that station layouts were good and the equipment — to use a modern idiom — was "user-friendly".

The delay in putting the system on-line meant that at the end of systems testing the weighbridge operators were so familiar with the equipment that the change from old systems to new went largely unnoticed and no hold-ups occurred.

In the tarehouse only a lower level of training of operators was possible and no problems were encountered on changing systems.

The following points are emphasized:

(a) The adoption of bar-coded permits, with a separate bar-coded adhesive "authority to deliver" label to be attached to the permit at point of delivery, was a fundamental change to the permit system. It was introduced to give total flexibility to growers and hauliers without loss of control to British Sugar over numbers of deliveries.

The new system maintained good control of deliveries and the reports from the Agricultural Department at King's Lynn and their growers and hauliers were very favourable.

It is worth noting that the bar-coded information proved reliable to read and permits were generally kept in good condition by the growers and hauliers.

(b) The use of external permit readers was also a departure from previous practice.

It was evident that the tests conducted at Ipswich with the new documentation and bar code reader had been well worthwhile. The optical reader proved highly successful with a low rate of failures to read.

The reader was quickly accepted by the vast majority of drivers who seemed to welcome the fact that they made a positive contribution to good weighbridge throughput.

Use of the optical reader was successful at all stations whether reading permits or stub cards. In the tarehouse the readers either

give a correct reading or very occasionally "failure to read", a big improvement on the traditional light-sensitive stub card readers which produce errors of which the operator is unaware.

(c) The level of failure of micro-computer hardware was low (2 CMOS memory boards and 1 Multiple or board suspected) of which only 1 CMOS board is proved to have failed, leaving the suspicion that faulty software may have been the true cause of the problems.

(d) The electronic tarehouse weighers gave some cause for concern although again some suspected hardware failures have not been substantiated and may have been software based. In any case the decision to change to the now competitively priced (and very reliable) instrument is welcomed.

This decision, besides giving an improved weigher, will obviously simplify spares holding

(e) The most radical change in the system as it affected the Beet Receptionist and Beet Clerk was the method of clearing on the commercial system all data before they were transmitted to the centre.

This is a distinct improvement on all previous systems where all data are despatched to the centre as produced and any load details with missing or faulty data returned to the factory for clearing. The "uncleared loads" system was time-consuming and often led to problems being caused outside the beet reception area, e.g. late returns to growers. Breakdowns of the older data systems could also cause errors in week-by-week factory accounting because large tonnages of beet had to be estimated.

The load clearing process was well accepted.

When the sytem was installed at all factories the receipt at the central mainframe computer of cleared data will produce a major saving in the clerical effort required to run the current beet system.

(f) The design of the system is such that all stations can work in "local" mode and the concept is such that only a minimum of written emergencies should occur. It is difficult to foresee a situation when large numbers of emergencies will be produced; complete stoppage of beet reception operations prior to this point is likely.

(g) The demise of a system producing paper tape which caused some handling problems at the factory and considerable handling and reading problems at the centre was welcomed.

(h) The production of a complete set of beet reception management reports on a daily and, more important, a *next-day* basis, was an asset enjoyed by all those concerned including local National Farmers' Union officials.

(i) The method of allocating permits on the commercial system and also reconciling their usage was an advantage to the Beet Office and to the Agricultural Department in general. As the system is replicated the manual accounting attached to the permit system will largely disappear.

There is general agreement that in spite of a late start the performance of the equipment was close to the high expectations of those involved in the design, installation, commissioning and running of the system.

In the light of experience at King's Lynn relatively few modifications are required for the system to become an excellent beet reception tool for data collection and site management.

Conclusions

It is fair to say that, using current technology and, in particular, the power of micro-computers, a system has been developed, which collects data accurately and offers maximum availability of the system under failure conditions.

The system development and installation, in a relatively short time, displays the value of applying the Task Force concept to a multi-discipline development project where team members work in a highly interactive environment avoiding the rigours of inter-departmental protocol.

The remaining challenge for British Sugar is to achieve the projected replication program at 12 more locations together with acceptance of the system technology by the personnel involved in running and maintaining it.

Acknowledgements

The authors wish to record their appreciation of the co-operation received from Task Force members based at Central Offices, King's Lynn and Ipswich. They also wish to thank King's Lynn factory management for their patience and Messrs. Stimpson, Irons and Braybrook for their endeavours during system installation and commissioning.

Summary

The paper traces the history of beet reception data collection in British Sugar and describes the design and installation of a new micro-computer based system for British Sugar.

Application du micro-ordinateur à la réception de la betterave

L'article retrace l'historique de la collection des données dans la station de réception des sucreries de la British Sugar. On décrit le développement et l'installation d'un nouveau système basé sur micro-ordinateur dans le groupe.

Der Mikrocomputer bei der Rübenannahme

Die Arbeit beschreibt die Geschichte der Datenfassung bei der Rübenannahme in der British Sugar sowie die Auslegung und Installation eines neuen auf Mikrocomputer basierenden Systems in der British Sugar.

Aplicación del micro-computador en la recepción de remolacha

Este artículo rastrea la historia de la colección de dados en las estaciones de recepción de remolacha de las azucareras de la British Sugar. Se describen el desarrollo y la instalación de un nuevo sistem basado en micro-computadores en la sociedad azucarera inglés.

Continuous centrifugal development for high-grade massecuites

By B. C. Goodacre, H. C. Bristow and R. Connor

Continued from page 49

Table IX shows that there was a steady increase in the amount of breakage occurring as the speed was increased. This effect is shown by both assessment criteria.

Table IX. Crystal breakage at different speeds of rotation (12 tonnes/hr white massecuite – Mk. II trials)

	Speed of rotation, rpm	Mean aperture, μm		Fines less than 300 μm, %	
		Actual	Decrease from massecuite	Actual	Increase over massecuite
Rota 900	1000	605	25	6.4	0.9
	1200	580	50	10.8	5.3
	1400	550	80	15.5	10.0
	1600	520	110	19.5	14.0
Batch	–	620	10	7.3	1.8
Massecuite		630	–	5.5	–

Discussion

The machine development has resulted in greatly improved performance both for white sugar and for affination, as illustrated in Tables I-III and X. The white sugar quality produced in the Mk III machine was equal to the batch sugar in respect of moisture, and only marginally higher in respect of ash and colour. However, particle breakage remains a problem that detracts from the appearance of the sugar. Tests on affination have indicated that particle breakage can be reduced by increasing the magma flow rate. This may also offer a solution to the white sugar breakage problem.

The Mk IV affination performance, in terms of sugar ash and syrup purity, was not significantly different from the batch equivalent, while the machine throughput was approximately twice that of the existing batch machines. Westburn refinery will thus use the machine on affination when the present development program has been completed.

Table X. Results for Mk. III and Mk. IV affination trials (12 tonnes magma/hr)

Trial		Wash water, %	No. of readings	Ash*, %		Purity of run-off syrup
				Mean	Std. Dev.	
Mk. III	Rota 900	3.6	18	0.09	0.02	
	Batch	3.5	4	0.04	0.03	
Mk. IV**	Rota 900	4.1	16	0.063	0.011	85.5 (mean of 6)
	Batch	3.5	15	0.056	0.017	85.5 (mean of 3)

* Corrected for occluded ash.

** Some data with acceleration cup and feed tube removed.

The main improvements in performance were achieved by (a) reducing the basket angle to 25°, thereby increasing the residence time on the screen and (b) applying the water through solid stream nozzles, thereby reducing the formation of spray. Wash water temperature and point of addition have proved not to be critical.

The modifications designed to change the air flow did not have a large effect on measured air velocities, probably because there is a large degree of air recirculation within the machine. Further design work will be necessary if there is to be any significant reduction in the air flow through the basket rim gap. Nevertheless, affination results were improved by these modifications.

Further effort to solve the problem of crystal breakage will be required before the machine can compete with a batch machine for white sugar at Westburn. However, for mill white grades of sugar the current performance may well be adequate. Long term tests will also be required

ISJ Abstracts

Cane sugar manufacture

Contracts for supply of heavy gearing

R. F. Beale and J. C. Fleming. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 181-185.

Gear rating under the AGMA (American Gear Manufacturers' Association) system, and the determination of load distribution factors C_m and K_m and service factors C_{SF} and K_{SF} are discussed. AGMA standards are to be applied in Australia until they become superseded by those of the International Standards Organization. Experience with AGMA-rated gearing and contractual aspects are discussed, and suggested values of the lead (helical pitch) variation of wide-face gears are tabulated. It is stressed that, since the AGMA standards are usually less conservative than previous Australian standards based on UK practice (particularly where long service life is required), a much more detailed and cautious technical and commercial approach is necessary for their successful application.

Number one mill low-speed gearbox failure at Pioneer mill

B. Dillon and A. R. Millett. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 187-190.

An account is given of the failure of the low-speed gearbox on the No. 1 mill at Pioneer and of the welding repairs carried out. The value of ultrasonics as a non-destructive testing technique for detecting cracks in mill shaft sections below the shell is indicated, although it is stressed that it is not infallible and may overlook shallow cracks some distance along the shaft. Testing should be carried out at intervals throughout the season so as to prevent growth of a crack to a critical size between tests, which are normally conducted only infrequently. One disadvantage of testing shafts *in situ* is the occurrence of spurious or ghost echoes as a result of contact between the shaft and the bearing surfaces; these may be interpreted as cracks. Magnetic particle crack detection is superior to dye penetrant testing for crack detection in the exposed area of a shaft. With the use of impulse steam turbines as mill drives because of their ability to sustain high torques at reduced speed, it is important that all mill components should be designed to withstand all loads over the entire torque-speed range of the turbine supplied.

Purchasing boiler plant for sugar mills

N. R. Sheridan, J. D. White and A. H. Thomas. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 199-204.

Usually, large boiler plant is custom-built to suit the particular fuel and load requirements of the user, who therefore should be involved in several aspects of the design and construction. Factors of importance are discussed, including: bagasse fuel properties and the question of alternative fuels; boiler capacity; steam temperature and pressure; efficiency; flue conditions; controls and instrumentation; and ancillary equipment and processes. Other aspects of ordering, purchasing and commissioning a boiler, and the role played by an independent consultant in vetting the specifications and equipment, are also discussed.

The lubrication of mill brasses

D. J. Hargreaves. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 191-197.

A survey of brass bearings on cane mill roller shafts showed wide variations in their wear, with examples cited of a life of only one or two seasons for a top roller bearing operating under normal conditions. Although considerable differences were found in parameters such as bearing pressure, type of lubricant and lubrication scheme, grooving and cooling water arrangements, none of these were found to be related to the variation in bearing life, which is therefore regarded as a function of fitting and operational practices. In view of this, it may be that bearing life can be substantially extended simply by paying more attention to detail during installation and operation. Investigations showed that mill brasses probably operate in a "chemisorbed" type of boundary lubrication, whereby considerable surface asperity contact takes place and there is no solids separation by a continuous lubricant film. The physical and chemical properties of thin surface films of molecular proportions govern the characteristics of contact. The possible savings resulting from increased bearing life are calculated, but it is stressed that a further study is necessary to indicate possible ways of improving practices or arrangements.

A laboratory data processing system

P. Finn and A. H. Westmoreland. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 205-209.

Details are given of the system of entry, security and reporting of data pertaining to cane reception and sampling and of laboratory data relating to factory control at Bundaberg Sugar Co. Advantages of the system are indicated.

Rotary dryer flight design

M. C. J. Hodgson and W. J. Keast. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 211-218.

Since the mass and heat transfer processes within a rotary sugar dryer/cooler are directly related to the surface area of sugar particles in contact with the flowing air stream, the overall dryer efficiency is intimately related to the characteristics of the sugar particle distribution which in turn are a function of the layout, shape, size and number of flights within the drum, as well as of the drum

speed, diameter and slope. A survey of dryers in CSR sugar factories revealed a diversity of flight designs and layouts, with some configurations being highly effective while others had scope for improvement. Where performance of the dryer was considered marginal, upgrading of the design of the flights was regarded as a means of raising efficiency. The approach used was that of a mathematical model in which the equations related the trajectory of falling particles to the flight design. The computer model was based on several major design criteria aimed at approaching ideal distribution (of uniform density and covering the entire drum cross-section); reasons why such an ideal distribution is never achieved are listed. The mathematics of the design criteria are explained for: (i) sugar distribution across the drum, (ii) distribution of the particles as they fall from the edge of the flight, (iii) the requisite number of flights, (iv) the carrying capacity requirements of a flight, and (v) the flight shape and layout that will ensure no hindrance to the flow of particles into or out of the flight as it fills and empties. An account is given of verification of the predicted values derived from the model; results showed that single-sided flights are unable to give a sugar distribution as good as two-sided flights, while a specially curved flight would produce optimum distribution in rotary dryers and lead to reduced temperature and/or moisture levels in treated raw sugar.

Corrosion and erosion of (centri)fugal screens

C. R. Greig, G. J. Kelly, E. T. White and L. K. Kirby. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 243-249.

In an investigation of the wear of screens in low-grade centrifugals, serious flaws were found (by scanning electron microscopy) even in the chromium coating of new, unused screens; such cracks can hold hot molasses and/or water and thus provide an ideal site for galvanic corrosion of the nickel base metal, eventually leading to shedding of the coating and rapid wear of the nickel. During normal usage, wear produces a rough, uneven working surface and up to 3-fold enlargement of the perforations. Possible solutions include adoption of manufacturing processes to provide a crack-free chromium coating, use of alternative materials having certain specified desirable properties, and application of homogeneous screens made from material (e.g. nickel) that is much less wear-resistant than chromium but having slots that do not have a diverging profile (although other disadvantages are mentioned).

Thickness of the crystal layer in continuous centrifugals

C. R. Greig, E. T. White and L. K. Kirby. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 251-256.

A laboratory-scale continuous centrifugal driven by variable-speed motor was used in preliminary experiments to develop techniques for the measurement of the massecuite layer thickness and residence time and to investigate the effects of operating conditions and massecuite properties on performance. Layer thickness was measured by means of a marker technique, using a stroboscope and microscope; surface velocities were determined above and below the colour line (demarcation between the darker massecuite layer and "dry" crystal region) by measuring the residence time of paper tracers introduced with the feed. The position of the colour line was found to be highly variable as a result of surging, partly caused by the inability of the feeding system to provide a uniform layer on the basket, and partly a result of variation in basket speed and massecuite feed rate and viscosity. The layer thickness above the colour line was much greater than below it and increased with a fall in feed rate. Surface layer velocity was most affected by the massecuite feed rate, increase in which caused an increase in the velocity, while basket speed had apparently little effect; viscosity may have a small effect, but insufficient data are available. There were differences between a new and a worn screen as regards colour line position.

The detection of sugar crystals in *C*-molasses

S. R. Reichard and A. L. Fitzmaurice. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 257-262.

The screens in continuous centrifugals can become damaged, allowing sugar to escape into the molasses; sometimes the operator may remain unaware of the damage, so that the sugar loss can be significant. Hitherto, methods of detecting crystals in molasses proved unsuccessful, but preliminary tests on an experimental instrument developed by the Sugar Research Institute have shown promise. The device consists of a plain electrically-driven metal roller that rotates slowly, partly immersed in the stream of molasses; a small quantity of molasses clings to its surface and is carried to a metal anvil bar which forces out most of the molasses over the ends of the roller. A small adjustable clearance (approx. 0.1 mm) exists between the roller and the anvil bar; the molasses that is still adhering to the roller passes through the gap and is removed by a plastic scraper, so that the roller is in a clean state and ready to pick up the next sample of molasses. If crystals present in the molasses are too big to pass through the gap, they are crushed between the anvil bar and the surface of the roller (very small crystals that can pass through the slots of undamaged screens and are often found in molasses will pass through the gap); shock-waves created in the anvil as a crystal breaks are converted to electrical signals by an accelerometer (vibration sensor) rigidly attached to

the anvil bar. Amplification and further processing of the signals provide audible or flashing indications of the presence of large crystals (the signals may also be fed to an analogue or digital integrator, and the output given in the form of a chart plot or digital display). Typical chart recordings of crystal detection are reproduced. The instrument proved capable of detecting even small damage to screens.

Mixing of high-viscosity materials with thinning fluids

E. T. White and C. K. Hertle. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 263-270.

Batch tests were conducted on three types of mixer used for dilution of molasses: a helical ribbon type, a propeller with draught tube, and a Burnett-type crystallizer. Both mixing efficiency and power consumption were determined. Results indicated the crystallizer as the best mixer and the helical ribbon as the poorest, while power consumption was highest for the crystallizer and lowest for the propeller. However, for a better comparison of the mixers it is suggested that continuous experiments should be carried out. The question of optimum rotor speed is also briefly discussed.

Viscometry in cane sugar processing

J. N. Ness. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 271-277.

A survey is presented of types of viscometer and viscosity measuring techniques used in the sugar industry, and possible applications are indicated.

Viscosity limitations on massecuite exhaustion

R. Broadfoot. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 279-286.

The major process variables affecting sucrose solubility in molasses and the viscosities of massecuite and molasses are briefly discussed in turn, with the appropriate mathematical correlations given. The changes that occur in massecuite viscosity during crystallization (mainly as a result of the reduction in temperature for maintenance of the supersaturation driving force) are examined, and the limiting value of the viscosity which can be adequately handled by the crystallizer station is discussed; while exhaustion can be increased by processing massecuite of higher viscosity, the monetary return has to be balanced against the increased capital investment in crystallizer equipment capable of handling the massecuite. In practice, sufficient crystallizer residence time is provided for exhaustion to a supersaturation at which the increase in sugar recovery is economically balanced with the capital cost of the additional volumetric capacity. In addition to the effect of the limiting massecuite viscosity on exhaustion, other process variables having influence are considered, including the molasses impurity composition, massecuite purity and massecuite impurity:water ratio. It is shown that improvement in exhaustion is obtainable by processing a low-purity massecuite (provided the sugar losses in the continuous centrifugals can be kept at a reasonable level) or by processing a massecuite of high impurity:water ratio and thus limiting the degree of cooling that is required. This presupposes a massecuite of high Brix and high viscosity discharged from the low-grade pan.

Vertical continuous crystallizer — Victoria mill

W. J. Keast and N. J. Sichter. *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 293-299.

Because of abnormal molasses losses for several years in the batch crystallizer station at the Victoria factory of CSR Ltd., a vertical continuous unit of BMA design was built and brought on stream in 1981 to lower the final *C*-massecuite temperature and improve exhaustion. Nominal throughput is 43 tonnes/hr at a residence time averaging 5.35 hr and a shaft speed of 0.55 rpm. The unit contains 13 horizontal cooling discs with segments removed for massecuite passage; water flows through a series of annular passages within the discs, which are arranged in staggered formation from top to bottom of the crystallizer. Full-diameter rotating stirrer arms are located above and below each disc; each arm has an adjustable blade for close sweeping across the cooling surface. The performance of the crystallizer was assessed in trials lasting a total of 200 hours and covering a range of operating conditions and massecuite viscosities. Typical cooling was from 72° to 62°C at 34 tonnes/hr flow rate and a heat transfer coefficient of 20 $W/m^2/°C$, compared with design rates of a fall from 68° to 58°C at 43 tonnes/hr flow rate and a heat transfer coefficient of 35 $W/m^2/°C$; thus, average massecuite temperature fall was 10.3°C and the cooling rate 1.7°C/hr compared with rated values of 10°C and 1.9°C/hr, respectively. The differences are attributed to differences in characteristics between cane massecuite (of higher viscosity) and beet massecuite (on which the design rates are based). Crystallizer performance was severely affected by changes in feed consistency and temperature, so that the unit is considered more suited to massecuite feed from a continuous pan. Increase in throughput was accompanied by deterioration in the flow pattern, with increasing quantities of short-circuiting hot massecuite. Once initial problems involving massecuite feed uniformity and the clearance between the scrapers and cooling elements had been overcome, operation of the crystallizer was relatively straightforward with minimal supervision required.

Beet sugar manufacture

Change in the ζ-potential of $CaCO_3$ with stepwise defeco-saturation and activation of 1st and 2nd carbonatation muds

S. P. Olyanskaya, L. M. Khomichak, N. A. Arkhipovich and O. L. Alekseev. *Sakhar. Prom.*, 1984, (6), 35-38 (*Russian*).

The effect of alternate liming and gassing on the zeta-potential of $CaCO_3$ was studied for up to 6 stages in laboratory investigations involving both raw juice and sugar solution, the pH of which was alternately raised from 11.40 to 12.45 and reduced to 11.40. In the case of the sugar solution, the zeta-potential was reduced markedly by liming, e.g. by 40% at the 2nd stage, but subsequently raised to slightly above the initial value by each gassing stage, the final value being very high at +35.7 mV, whereas the raw juice had negative values throughout the experiment which did not alter greatly. The difference was attributed to the presence of large quantities of non-sugars in the raw juice by comparison with the sugar solution. Subsequent similar experiments with sugar solution to which 1st carbonatation mud was added showed that liming reduced the zeta-potential from a positive to a negative value, while subsequent gassing raised it to a positive value, evidence of adsorption of newly formed $CaCO_3$ on the original carbonatation mud and masking of its negative zeta-potential. Further studies with factory and laboratory 1st carbonatation mud are described, which showed that the degree of activation of mud recycled to pre-liming was relatively small, in contrast to 2nd carbonatation mud, and depended on the quantity and composition of the non-sugars in the juice as well as on the amount of lime added. It is therefore recommended to recycle 2nd carbonatation mud; with addition of 0.2% CaO on beet to juice before 2nd carbonatation, only 0.07-0.10% CaO needs to be added when all the mud is recycled to preliming.

Operating effects of water-in-oil emulsifer

T. Ikeshita, K. Sasaki, S. Adachi and S. Watano. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1984, **33**, 55-63 (*Japanese*).

A water-in-oil emulsifier, Type 6300, manufactured by Cleanodan Co. of Denmark, was used at Honbetsu sugar factory for 5 months during the 1981/82 campaign. The combustion and atomization of the fuel oil used in the boiler were much improved by the emulsifier, while decreases in particulates and carbon emission as well as in flue gas SO_3 and nitrogen oxide concentrations contributed to substantial reductions in atmospheric pollution. Noticeable reductions in heat losses resulted from a low excess air combustion.

Sucrose degradation during raw juice purification

P. P. Zagorodnii and L. I. Zagorodnyaya. *Izv. Vuzov, Pishch. Tekh.*, 1984, (2), 65-69 (*Russian*).

The kinetics of sucrose decomposition during juice purification, where unfiltered 1st carbonatation juice or mud is recycled to preliming, are examined mathematically, particularly as a function of mean residence time τ_{av} and its distribution parameters σ. Calculation of the total amount of sucrose degraded in any given vessel together with graphed values demonstrate the increase in sucrose decomposition with increase in the amount of recycle and in the value of σ, i.e. with fall in the hydrodynamic quality of the vessel. Two possible means of reducing undetermined losses and improving sugar quality are given as: (1) minimization of the amount of recycle to preliming (obtainable by recycling 1st carbonatation mud rather than juice or, where liming is carried out before 2nd carbonatation, 2nd carbonatation mud), and (2) improvement in vessel design so as to approach as near as possible to ideal displacement, where $\sigma = 0$. Particular attention should be paid to the hot stage of fractional liming and to 1st carbonatation, where juice is exposed to high temperatures and pH values.

The control technology used for the new 100 tonnes/hr boiler and its auxiliaries at Elsdorf sugar factory, Pfeifer & Langen

H. Herold, L. Schuster and G. Sodeik. *Zuckerind.*, 1984, **109**, 538-542 (*German*).

Details are given of the Siemens automatic control and instrumentation systems installed for the new lignite-burning boiler at Elsdorf, which operates throughout the year, i.e. processing beet during the normal campaign and subsequently refining some 140,000 tonnes of raw sugar. A Teleperm M digital system is used for process control, complemented by a Simatic S5-110F automatic burner control system and a Simatic MS3 optical/acoustic annunciation system. Since its installation in September 1982 the system has operated completely satisfactorily.

New anti-corrosion coatings for food industry equipment

S. N. Kukota, T. M. Verbovskaya, G. F. Dregval' and N. P. Romenskii. *Pishch. Prom., Nauchno-Proizvod. Sb.*, 1983, (1), 41-42; through *Food Sci. Tech. Abs.*, 1984, **16**, (4), 4C109.

In a series of acceptance tests, two composite coatings provided protection against corrosion (based on the fluorine-epoxy varnishes PKS-710/S and PKS-710/K) for general use in food factories, but particularly in sugar factories, and showed migration rates within permissible tolerance levels. The PKS-710/S coating proved particularly corrosion-resistant after two seasons' use on equipment for sugar manufacture, and is recommended for general use.

A graphical method for calculation of a boiling house scheme. II. Raw sugar factory

V. Valter, F. Gerza and J. Gebler. *Listy Cukr.*, 1984, **100**, 132-137 (*Czech*).

Details are given of a vector diagram approach to calculating quantities involved in two-massecuite boiling in a raw sugar factory. Use of the system is described, and information is given on a relatively simple three-flow proportioning device that operates on the principle of a weir tank and can be used for flow control of syrup in the boiling house as at Hrusovany sugar factory or e.g. for milk-of-lime proportioning.

Experiences with processing during the thick juice campaign at Delitzsch sugar factory

H. J. Haloun. *Listy Cukr.*, 1984, **100**, 138-139 (*Czech*).

An account is given of thick juice storage and post-campaign processing at Delitzsch sugar factory in East Germany which has used the system since 1977. In the 1982/83 campaign, the thick juice from 1500 tonnes of beet per day, i.e. nearly 31,000 tonnes, was stored for 99 days in a 10,000 m^3 sealed tank as well as a 5000 m^3 molasses tank. Before storage, the juice was concentrated to 65-69° Bx in a falling-film evaporator located after the quintuple-effect evaporator, cooled to 25-30°C and adjusted to pH 8.8-9.0. There was little change in the quality of the juice as a result of storage, and subsequent processing posed no problems. The Brix of the juice remained uniform during storage except in the very top layer where it was higher. The reclaimed juice was heated to 85°C and filtered together with remelt liquor and raw washings. Heat consumption rose by 31% and electricity consumption by 5% compared with normal processing, but the costs of producing sugar from stored thick juice were lower than those of conventional beet sugar production.

Manufacture of icing sugar with an extended storage period

R. Stengl. *Listy Cukr.*, 1984, **100**, 140-141 (*Czech*).

As part of a broadening of the manufacturing base and to meet sudden increases in customer demand, it was decided to produce icing sugar that had extended storage properties. Two approaches have been adopted in the prevention of caking of the bagged product: addition of 2% potato starch to the sugar which meets quality requirements after 6 months' storage, and preconditioning of the sugar. A conditioning unit is described in which the sugar was heated to 50-55°C with water at 90°C as the heat carrier, and the moisture content reduced from a maximum of 0.10% to 0.02-0.03%.

Recirculation of 1st carbonatation juice by a tube carbonatation device

M. I. Daishev and Yu. I. Molotilin. *Sakhar. Prom.*, 1984, (7), 26-28 (*Russian*).

While over-saturation of 1st carbonatation juice is a means of improving its settling and filtration properties, it also causes increased colour and lime salts. However, juice recirculation via an external pipe system using an airlift pump, in which the compressed air is replaced by CO_2, provides over-saturation without the snags. Details are given of such a system which operated at a factory in 1983; the circulation juice was gassed to pH_{20} 9.5-10 and its alkalinity taken to 0.040-0.050% CaO, giving a 1st carbonatation juice pH_{20} of 10.8-11.0 and an alkalinity of 0.09-0.11% CaO. Settling rate was 4.0-4.5 cm/min and the filtration coefficient F_k 2.3-2.6; the juice was recycled no more than three times. When recirculation was stopped for a short period, the filtration coefficient rose to 3.5-5.0 and two extra filters had to be used to handle the juice; reversion to recirculation restored the better filtrability and made the extra filters unnecessary.

Intensification of the processes of sugar extraction from beet cossettes in an electric field

I. M. Katrokha, A. B. Matvienko, L. G. Vorona, M. P. Kupchik and V. A. Zaets. *Sakhar. Prom.*, 1984, (7), 28-31 (*Russian*).

Experiments were carried out in a laboratory unit consisting of five electric diffusers at a voltage in the range 0-15 V/cm and a temperature of 40-70°C. A 0.4% NaCl solution was used as electrolyte, flowing through the ion exchange membranes separating the working chamber from the electrode chambers in each diffuser, and in each test 350 g of cossettes was loaded into the unit together with 700 g of 10% sugar solution. Voltage was then applied and an attached vibratory mechanism switched on; extraction continued for 3-24 minutes. The amount of sugar extracted was greater when voltage was applied than in its absence, but the effect of the electric field was reduced by temperature rise, e.g. a 45% increase in extraction at 40°C contrasted with only 27% increase at 70°C, both at 15 V/cm. Less non-sugar material was extracted in the electric field than with normal extraction techniques. At 5 V/cm and 60°C, equilibrium in sugar concentration between the extraction liquid and cossettes was established within 24 minutes. Linearity was established between the diffusion coefficient and voltage.

An efficient system for the vacuum/condensing plant

S. A. Zozulya and A. I. Khomenko. *Sakhar. Prom.*, 1984, (7), 37-42 (*Russian*).

A survey was carried out of the types of condensers used in Soviet sugar factories, and an indication obtained of the extent to which each type met a list of 20 requirements. An A2-PKB combined system comprising a co-current condenser linked to a counter-current cooler proved the best, meeting all but one of the requirements — it could not store pan vapour condensate, a feature applicable only to surface condensers.

Scale removal from evaporators using complexones

A. M. Gavrilov, K. I. Popov and A. R. Sapronov. *Sakhar. Prom.*, 1984, (7), 45-46 (*Russian*).

Experiments were conducted on the use of a chelating agent, Trilon B (the disodium salt of ethylene diamine tetraacetic acid) instead of soda ash plus HCl for evaporator scale removal. Annular samples were cut from scaled tube sections and immersed in 0.15-0.25% EDTA solution (in the case of 1st effect samples) or 5% solution (in the case of 2nd, 3rd, 4th effect and concentrator samples). The tubes from the first 3 effects were of steel, and those from the 4th effect and concentrator were of brass. Treatment time was 60-120 min for the 1st effect samples, 240 min for the 2nd and 3rd effect samples, and 120 min for the 4th effect and concentrator samples. Results indicated a scale removal efficiency of 100% for the 1st effect, 98% for the 2nd and 4th effects, 96% for the concentrator and 95% for the 3rd effect, the scale in which had a dense structure and was firmly attached to the tube inner surface. Regeneration of used EDTA with 15% HCl was investigated; the result was a descaling activity comparable to that of the fresh product.

Aspects of the evolution of second-generation fermenters for anaerobic treatment of effluent

A. Bories and D. Verrier. *Ind. Alim. Agric.*, 1984, **101**, 493-497 (*French*).

Second-generation fermenters for anaerobic treatment of waste water from various sources, including sugar factories and molasses distilleries, are reviewed and some performance data given. The aim of the systems is to provide increased solids retention time at a higher concentration; this is done by the use of packing, of fixed beds, of expanded beds as in the UASB (Upflow Anaerobic Sludge Blanket) system, and of fluidized beds in which the biomass is fixed on fine, circulating particles of varying materials such as ceramics, active carbon or sand. Their ability to meet the two requirements stated above means that they are capable of handling greater loads at a higher fermentation rate; this in turn permits a reduction in the size of the plant and extension of the fermentation process to more dilute waste water, as well as use of lower temperatures. Design and operational parameters discussed include the nature and characteristics of the packing, particularly specific surface area and porosity, flow conditions and problems associated with the retained biomass.

Operational experiences with the application of a heat pump in the evaporation station of a sugar factory

P. Christodoulou. *Zuckerind.*, 1984, **109**, 628-637 (*German*).
See *I.S.J.*, 1983, **85**, 377.

20 years of district heating at Turenki sugar factory

L. Bergfors, H. Huttunen and J. Viljanen. *Zuckerind.*, 1984, **109**, 634-637 (*German*).

After a brief survey of the Finnish beet sugar industry, the advantages of district heating for the national economy are indicated and details given of the arrangements at Turenki, which supplies hot water from its 28 MW boiler plant in paired 200 mm diameter pipes encased in concrete at a soil depth of 700 mm. The water is pumped at the rate of 450 m^3/hr and a temperature of 75-120°C (depending on the ambient temperature) to almost all industrial plants and dwelling houses in the town (of 7000 population) as well as to all the sugar factory buildings; the mains circuit covers 12 km, and the furthest consumer is 2.5 km away. The sugar factory also supplies surplus power to the public grid outside the campaign (besides sugar, the factory also produces fodder and agricultural machinery) and has an arrangement for buying back a corresponding amount at a favourable price during the campaign. Some of the recycled district heat is derived from 1st evaporator effect condensate in a plate heat exchanger during the campaign; the cooled condensate is then highly suitable as boiler feed water. The price structure of the district heating system is explained.

The technological effects of beet storage in piles

E. Walerianczyk. *Ind. Sacc. Ital.*, 1984, **77**, 73-75 (*Italian*).

The effect of storage for up to 85 days on the processing quality of beet is discussed with reference to conditions in Poland. Comparison is made between the deterioration of beets stored in forced-ventilated piles and "uncontrolled" piles, showing a greater drop in purity and a higher rise in non-sugars concentration with storage time (25, 45, 65 and 85 days) when no forced ventilation was used. It is therefore recommended to restrict storage to about 1 month.

Brief note on a visit to Poland

F. Gulinelli. *Ind. Sacc. Ital.*, 1984, **77**, 76-78 (*Italian*).

A brief account is given of the Polish sugar industry on the basis of a visit made by the author, including three sugar factories.

Sugar refining

Continuous vacuum crystallization at Nantes refinery

J. Cuel and C. Longue Epée. *Sugar y Azúcar,* 1984, **79,** (5), 62, 65, 68.
See *I.S.J.,* 1984, **86,** 109-113.

Effect of sulphitation on the refining quality of raw sugar

C. C. Chou. *Sugar J.,* 1984, **46,** (11), 18-19.

Cargoes of raw sugar are being received by US refineries in increasing frequency where sulphitation has been used in the manufacturing process. While such raw sugar appears to meet the raw sugar contract requirements for colour, it is not as easy to decolorize as raw sugar manufactured without sulphitation, and causes increase in energy costs at the refinery in order to obtain products of required quality. Tests were conducted on treatment of press-filtered washed sugar liquor (PFWSL) with 200 and 500 ppm sodium hyposulphite; the liquor was taken from a refinery stream of unknown raw sugar origin. As expected, the colour content fell with increasing sulphite dosage as did the pH. The untreated control was then adjusted with white sugar to the same colour levels as the two treated liquors, and all four liquors then subjected to decolorization with bone char. Results showed that the decolorization efficiency for the unsulphited liquors was greater than for the sulphited samples. Similar results were obtained when a known raw sugar was affined in the laboratory and treated with 250 and 500 ppm hyposulphite, followed by the same procedure as above. Other disadvantages of sulphitation include the increased inversion losses caused by the low pH, the increase in ash (particularly sulphate) content and the combined effects of these on refined sugar yield.

Studies on desalting of sugar liquor with ion exchange resin in a refinery. III. Development of the mixed bed-two bed (MAK) system and its practical use

F. Maekawa, K. Kawasaki, S. Fujii and M. Komoto. *Proc. Research Soc. Japan Sugar Refineries' Tech.,* 1984, **33,** 1-13 (*Japanese*).

This work was undertaken to provide an improved reverse ion exchange process for refinery liquor treatment as well as a new regeneration system. The liquor, containing a large amount of impurities, is passed through a mixed bed of I-type strongly basic anion exchange resin in OH^- form and a strongly acidic cation exchange resin in Na^+ form in the first column of a 3-column system, and is then treated in the second column with an I-type strongly basic anion exchange resin in OH^- form, followed by treatment with a weakly acidic cation exchange resin in H^+ form in the third column. The resins in columns 2 and 3 are regenerated with NaOH and HCl, respectively, and the regenerant wastes from the columns used to regenerate the resin in column 1, where NaOH is recovered from the regenerant waste and returned to the top of the column for re-use. Advantages of the new system include: (1) the possibility of treating a highly coloured liquor, e.g. of 136 colour units, to give the same good results as with the conventional 2-column system fed with a liquor of 39.6 units and decolorizing to 8.6-8.7 units; (2) reduction in regenerant consumption; (3) reduction in contamination of the strongly basic anion exchange resin; and (4) increase in yield of the finished product. The process has been used successfully since 1980 by C. Itoh Sugar Co. Ltd. without the use of bone char. The paper also discusses theoretically the behaviour of colouring matter on the strongly basic anion exchange resin.

Conditioning of refined sugar

Anon. *Ann. Rpt. Sugar Milling Research Inst.* (Natal), 1983-1984, 9.

With the increased demand for bulk refined sugar, the possibility of installing a conditioning silo at Noodsberg was considered. In order to check on the minimum time required for conditioning, refined sugar was conditioned in test tubes and experimental mini-silos, after which it was subjected to caking tests to ascertain whether the conditioning time had been adequate. Results showed that the sugar did not cake at all after 72 hours' conditioning; after 48 hours' conditioning, the sugar in the test tubes caked in only 10% of the cases, whereas in the larger-scale tests the sugar always caked. Although variation was found in grain size and moisture content of the sugar samples, all the samples tested behaved similarly with respect to conditioning and caking. The moisture content, determined by the Karl Fischer method using formamide as solvent, ranged from 0.050% to 0.144% before conditioning and from 0.040% to 0.060% after.

Neutralizing waste water by evaporation

G. M. Solovets *et al. Sakhar. Prom.,* 1984, (7), 20-22 (*Russian*).

Trials are reported on concentration of regenerant waste from the ion exchange plant at Tula refinery; the waste was concentrated to 34-37% dry solids in a combined vertical and horizontal rotary film evaporator station, and the NaCl residue was filtered off, washed, dissolved in condensate and sent to a brine tank for future use as resin regenerant. The filtered liquid was transferred to storage for use in other industries. Under typical refinery conditions, the evaporation process was stable and yielded a finely dispersed free-flowing powder having a bulk density of 0.928 kg/litre and a moisture content of 6-18%. Analysis of the distillate revealed a low optical density, a slight odour associated with products from beet sugar manufacture, a Cl^- content of 32-45 mg/litre and an ammonium content of 27.7 mg/litre.

Starch based sweeteners

High-temperature evaporation of starch with use of sulphitation

I. R. Khanukhov, V. D. Lazarev, N. N. Tregubov, V. I. Syroedov and V. A. Kovalenok. *Sakhar. Prom.*, 1984, (6), 55-58 (*Russian*).

While high-temperature evaporation of starch hydrolysates is of advantage in reducing the process time and energy consumption, it also leads to increased colour formation unless an appropriate additive such as Na_2SO_3 is used. Factors governing colour formation are indicated, and views on the use of sodium sulphite are discussed. An experimental unit is described which allows rapid heating of starch syrups to a required temperature and measurement of the changes in properties of a sample. From experimental data a formula was derived for calculation of optical density at 474 nm in terms of temperature, solids content, time and sulphite dose.

High-fructose glucose syrup—a new high-calory alternative to sugar

Z. A. Prishchepova. *Sakhar. Prom.*, 1984, (6), 58-60 (*Russian*).

A survey is presented of developments in the manufacture of HFS in Canada, Japan and the USA, with details of consumption relative to sugar and other glucose syrups as well as total corn syrups in 1975, 1979 and 1985 (estimated).

A light at the end for Tunnel?

A Kimber. *Food Mf.*, 1984, **59**, (3), 49, 51, 53; through *S.I.A.*, 1984, **46**, Abs. 84-664.

Tunnel Refineries, Greenwich, produces a wide range of glucose syrups and is the only UK company allowed to produce HFS. The properties of these products make them complementary to sucrose in many food applications. A general description is given of the processes involved in their manufacture from maize; acid and enzyme conversion processes are used. Some UK soft wheat is now also being processed.

Results of experiments aimed at increasing the filtrability of maize starch syrup

A. Hersiczky. *Acta Alimentaria*, 1983, **12**, (4), 291-300; through *S.I.A.*, 1984, **46**, Abs. 84-668.

The filtration rates of glucose syrups, obtained by hydrolysis of maize starch with H_2SO_4, were measured; they increased rapidly with DE in the range 15-52, and more slowly in the range 52-78. In a laboratory bag filter, the filtration rate was low; this is attributed to the presence of unhydrolysed starch and of $CaSO_4$ formed during neutralization. A clarification apparatus was designed which enabled sediment and floating impurities to be drawn off before the syrup was filtered; this increased the filtration capacity at a glucose syrup factory from 20 to 30 tonnes/day.

Enzymatic isomerization of glucose to fructose in (potato) starch hydrolysates. I. Batch isomerization by means of soluble and insoluble glucose isomerase preparations

M. Boruch and E. Nebesny. *Zeszyty Naukowe Politechniki Lodzkiej*, 1981, (384), 31-41, 42, 43; through *S.I.A.*, 1984, **46**, Abs. 84-674.

Isomerization for about 24 hours at 40°Bx, with $MgSO_4 + CoCl_2$ as enzyme activators, were performed (A) with Optisweet-P (soluble, by Miles Cali-Chemie) at 20 TGIU/g glucose, 74°C, pH 6.5 on solutions of crystalline glucose (monohydrate) and the following hydrols containing high wash (white run-off syrup from 2nd glucose massecuite): crude, 75 DE; resin-purified, 76 DE; purified then saccharified with Novo 150 glucoamylase, 83 DE; (B) with Sweetzyme-A (insoluble, Novo Industri) added once at 10 GINU/g glucose and used 14 times in succession at pH 7, 65°C, on the following solutions: crystalline glucose; 68 DE hydrol (no high wash added, but purified with carbon and resins); 84 DE feed syrup to 2nd glucose massecuite (resin-purified, diluted from 71°Bx); 40 DE confectionery syrup (resin-purified, diluted from 81.5°Bx). In A, the % conversion of glucose to fructose was 51.5, 32.5, 43.5 and 50, respectively. In B, it gradually decreased from 41.5-45.1 in the 1st run to 18.7-24.9 in the 14th, remaining above 38% for 6-8 runs. Considerable colour was generated in all the 1st runs but this amount progressively decreased in later runs.

A kinetic study of the isomerization of glucose in the presence of immobilized glucose isomerase

T. C. Huang and C. S. Lee. *J. Chinese Inst. Chem. Engrs.*, 1983, **14**, (1), 127-133, 141; through *S.I.A.*, 1984, **46**, Abs. 84-675.

In tests on the above isomerization of glucose to fructose, optimal operating conditions were: pH 8.6, Mg^{++} concentration 5×10^{-3}M, or Co^{++} concentration 10^{-4}M. Co^{++} strongly enhanced enzyme activity in the presence of Mg^{++}. Small amounts (about 40 ppm) of Fe^{++} enhanced enzyme activity about 25% in 5×10^{-3}M Na_2SO_3. Film diffusion and particle diffusion resistances could be neglected when the conditions were: pH 8.6, Co^{++} concentration 10^{-4}M, 60°C, agitator speed 500 rpm. At pH above 7.0, chemical isomerization occurred in the absence of glucose isomerase. The first order forward and reverse rate contants were calculated, and the rate equation of reversible isomerization in the presence of the enzyme was derived. The kinetics of non-enzymatic + enzymatic isomerization can be represented by a modified Michaelis-Menten rate equation; theoretical results agreed well with experimental data. At 40-70°C, the forward apparent activation energy was 17.6-14.2 kcal/mole and the heat of reaction was 3.4 kcal/mole.

Laboratory studies

Polarographic evaluation of white sugar colour content

I. A. Tikhonova, Ya. I. Tur'yan and N. K. Strizhov. *Izv. Vuzov, Pishch. Tekh.*, 1984, (2), 23-25 (*Russian*).

Polarographic determination of white sugar colour content has not received wide recognition because of poor reproducibility of the oxygen maximum, depression of which by colouring matter is the basis of the method. The authors have proposed a method which is based not on the oxygen maximum but on the shift of the catalytic wave produced as a result of reduction of indium (III) ions by thiocyanate in the presence of sugar colorants. The sugar has a two-fold effect on the wave: it has a depressing effect when in excess of the SCN^- ions which are desorbed while the adsorption of the sugar dominates, and it has a reverse effect through the introduction of colorants acting as supplementary catalysts. A mercury dropping electrode is used as cathode (details are given of the capillary parameters), and the currents are measured at the constant potential of a calomel standard electrode. The electrolyte comprises a mixture of sodium perchlorate, perchloric acid, sodium thiocyanate and indium nitrate. Correlation was found between colour as determined photometrically and the difference between the catalytic waves in the presence and absence of 3.5% sugar. Reproducibility of the polarographic method for colour content in the range 0.5-1.5 reference units was, at ±3%, higher than for the photometric method. The polarographic method takes 20 minutes and is accurate to within ±3% down to 0.1 reference colour unit. Details are given of the measuring procedure.

Electromembrane separation of fructose and ammonium gluconate

N. P. Gnusin, N. P. Berezina, V. N. Fedoseev, N. A. Kononenko and I. V. Grebennikova. *Izv. Vuzov, Pishch. Tekh.*, 1984, (2), 83-85 (*Russian*).

In investigations of the possibility of using electrodialysis to separate fructose from ammonium gluconate in an equimolar solution obtained by fermentative oxidation of an invert syrup, the contribution of fructose to the electrical conductivity of the solution was much smaller than that of salts of gluconic acid present. Although the gluconate had less effect on the performance of an MK-40 cation membrane in H^+ form than on an MA-41 anion membrane in OH^+ form, both membranes exhibited Donnan adsorption of the fructose. In view of the relatively high permeability coefficient of the MA-41 membrane for the gluconate, diffusion restrictions caused no real delay in the process. The solution was passed at 60 ml/min through a 6-cell dialyser in which the membranes were arranged in parallel with platinum polarizing electrodes. Optimum current density was 20 A/m², at which fructose loss did not exceed 8%. Use of an MA-41 in combination with KU-2 cation exchange resin to form a mixed membrane proved better in terms of deterioration after 100 hours' processing than an MA-41 and an MA-411 membrane.

Determination of sugars (and betaine) in molasses by HPLC. Comparison of the results with those obtained by the classical Lane-Eynon method

E. Rajakyla and M. Paloposki. *J. Chromatography*, 1983, **282**, 595-602; through *S.I.A.*, 1984, **46**, Abs. 84-707.

The adaptability of four different HPLC columns (ion exchangers in the Na^+ form, Ca^{++} form, ODS and NH_2) for the determination of sugars in molasses was studied. Some methods of sample pretreatment were also examined. A strong cation-exchange column in the Na^+ form was the most suitable for both determination of sugars in cane molasses and of sugars and betaine in beet molasses. The only pretreatment needed was filtration of the diluted sample through a 220 nm membrane before injection. Total sugar contents (sucrose + glucose + fructose) found by the HPLC method were lower than those found by the classical Lane-Eynon method. The HPLC values are more reliable because the method eliminates interfering compounds.

Post-column fluorometric detection of reducing sugars in high-performance liquid chromatography using arginine

H. Mikami and Y. Ishida. *Bunseki Kagaku*, 1983, **32**, (6), E207-E210; through *S.I.A.*, 1984, **46**, Abs. 84-711.

Arginine was found to react with reducing sugars when heated in boric acid solution at neutral pH; highly fluorescent derivatives were produced. This reaction was applied to a post-column detection system for use in HPLC; it enabled highly sensitive determination of reducing sugars. Relative fluorescence intensities (glucose = 100) are tabulated; values were 31-187 for 12 reducing sugars, 4 for sucrose and raffinose, and 0 for mannitol and sorbitol.

The solubility of $CaCO_3$ and $CaSO_4$ in glucose and fructose solutions

N. A. Arkhipovich, L. I. Tanashchuk and T. Ya. Chernyakova. *Sakhar. Prom.*, 1984, (7), 24-26 (*Russian*).

Solutions of fructose and glucose obtained by acid hydrolysis of sucrose (using H_2SO_4 followed by liming and gassing with CO_2) are treated by ion exchange to remove colour, $CaCO_3$ and $CaSO_4$ in a process developed by the authors. However, this requires knowledge of the solubilities of the two salts mentioned, and details are given of an experimental unit used for this purpose. Tabulated data are given of solubilities in water and in 5, 10, 15 and 20% solutions of the individual monosaccharides at temperatures in the range 5-30°C at 5° intervals.

By-products

Palatinose production by immobilized α-glucosyltransferase

Y. Nakajima. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1984, **33**, 55-63 (*Japanese*).

Details are given of immobilization in a granular calcium alginate gel of α-glucosyltransferase obtained from cells of *Protaminobacter rubrum* and *Serratia plymuthica*, and subsequent use of the enzyme to convert sucrose to palatinose, described as a low-cariogenic and digestible disaccharide. The above-mentioned bacteria were cultured under aerobic conditions in a sucrose-containing medium to accumulate the enzyme; the activity of the enzyme in *P. rubrum* was more stable than in *S. plymuthica*, and the half-lives of the immobilized enzymes from the two cultures were 73 and 23 days, respectively, so that *P. rubrum* was used in subsequent experiments. A 40°Bx sucrose solution, adjusted to pH 5.5, was passed at 25°C through a column containing the immobilized enzyme at a flow rate at which the sucrose concentration in the effluent could be maintained below 0.8% w/w. Under these conditions, more than 85% of the sucrose was converted to palatinose, together with small amounts of other sugars. The effluent was treated by ion exchange resin and evaporated under reduced pressure, after which the palatinose was crystallized and separated from the molasses by centrifuging. The final molasses contained sweet-tasting 1-O-α-D-glucosyl-D-fructose as the largest component (39.4% on total sugars). Alternatively, the refined solution could be concentrated to a solid product and pulverized to yield a crude product.

Improvement of lime cake treatment process

N. Sekine. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1984, **33**, 72-74 (*Japanese*).

Since 1974, lime cake at the author's refinery has been treated and discharged for use as a fertilizer. Investigations were carried out with the aim of reducing dust emission from the treatment process as well as decreasing operating costs. The resultant modifications to the process include mixing waste sludge with the lime cake slurry (previously the two waste products had been initially treated separately) and dewatering of the mixture before drying by band dryer (instead of a fluidized-bed dryer used previously). As a consequence of the changes, product quality was improved, fuel consumption was reduced by 80% and electricity consumption by 50%, and dust emission from the gas scrubber fell from 0.2 to 0.005 g/m^3.

Bagasse hydrolysis

Anon. *Ann. Rpt. Sugar Milling Research Inst.* (Natal), 1983-1984, 12.

Investigations as part of a major national project to convert bagasse cellulose to ethanol have been aimed at optimizing acid prehydrolysis of bagasse to convert hemicellulose to xylose, and attritor milling and enzymatic hydrolysis of the residual solids to yield glucose. After testing a range of conditions, the optimum for prehydrolysis was found to be 90-100°C and use of 1% sulphuric acid; at lower temperatures the reaction is too slow, while at higher temperatures the materials of construction required for the equipment are too expensive and the resultant hydrolysate contains substances that interfere with fermentation. Data from determination of the dewatering and washing characteristics of prehydrolysed bagasse were used to draw up a proposal for recycling various streams in an overall bagasse-to-ethanol process; the recycling should permit 6.5% xylose in the final output stream. Tests involving an integrated system of attritor milling and enzymatic hydrolysis showed that it was possible to produce a 10% glucose syrup from prehydrolysed bagasse, although they also highlighted problems of microbial contamination and high enzyme consumption. Saccharification tests on bagasse residue from a furfural factory showed that it is a promising material, particularly when polyvinylpyrrolidone (PVP) is added before saccharification to suppress the effect of the phenols. In a search for cheapter alternatives to PVP it was found that washing with dilute NaOH often had a beneficial effect when PVP was omitted.

Yeasts fermenting concentrated molasses solutions

A. F. Zelinskaya-Tkachenko *et al. Mikrobiologicheskii Zh.*, 1982, **44**, (5), 19-23; through *S.I.A.*, 1984, **46**, Abs. 84-764.

Osmophilic yeast strains, isolated from concentrated fermented media based on molasses or raw cane sugar, were progressively adapted to 30°Bx media by subculturing about 100 times in 5 months. Eventually a strain with significantly better tolerance towards high Brix and ethanol was obtained which produced 13.11% enthanol by volume (instead of 12.5%) from 30°Bx media, with an unfermented sugar concentration of only 6.7 g/litre. It has been patented as SU 498 337 and registered as *Saccharomyces cerevisiae* Meyen, 1838, Sh-1.

Use of yeast cell recycling for rapid ethanol production from molasses

G. Verma, R. K. Sedha and R. P. Gupta. *J. Ferment. Technol.* (Osaka), 1983, **61**, (5), 527-531; through *S.I.A.*, 1984, **46**, Abs. 84-766.

Seventeen strains of *Saccharomyces cerevisiae* were screened, by means of a cell recycling technique, for the maximum number of fermentation cycles, rate and efficiency on a cane molasses medium. Strains HSR, RI, G, Sc6 and JIL were capable of undergoing 6, 8, 8, 8 and 10 cycles, respectively. The greatest net saving in fermentation time, 30.5% compared with batch fermentation, was observed

with Sc6, corresponding to an increase of 49% in hourly alcohol production, without affecting the fermentation efficiency.

Effect of oils and fatty acids on molasses fermentation by distillers' yeast

D. Saigal and L. Viswanathan. *Enzyme and Microbial Technol.*, 1984, **6**, (2), 78-80; through *S.I.A.*, 1984, **46**, Abs. 84-765.

In the fermentation of a cane molasses medium by yeast, some vegetable oils (linseed, cottonseed and soyabean oils) stimulated utilization of sugars and increased the alcohol production rate and yield. The effects were in general greater with mixed fatty acids derived from the oils, and greater at 40° than at 30°C.

Research and development on fuel ethanol production from bagasse or pith at Taiwan Sugar Research Institute

S. L. Sang, L. H. Wang, M. C. Hsie and W. F. Yee. *Taiwan Sugar*, 1984, **31**, 41-46.

An account is given of research on alcohol manufacture from whole bagasse or pith. Investigations of xylose production by acid hydrolysis showed that concentration and yield, generally very low in conventional processing, could be raised to 20% and 86%, respectively, but only with considerable sulphuric acid consumption, and further work will be concerned with reducing the amount used. Attempts to carry out xylose isomerization to xylulose and ferment the latter with conventional yeast to ethanol in the same reaction vessel proved unsuccessful because of the vast difference between optimum conditions for the two reactions; use of isomerase for the conversion to xylulose and fermentation of the xylulose were carried out in two separate columns to yield 6% ethanol (v/v) at a fermentation efficiency of about 61%, while trials on direct fermentation of the xylose to ethanol using a special strain of *Pachysolen tannophilus* yielded a maximum of only 3.8% alcohol, although the process was much simpler. A low-temperature cellulose saccharification process using HCl of high concentration, whereby the acid is mixed with the cellulosic residue (rather than pumped through it) and lignin separation postponed until the end of the saccharification process, gave glucose and HCl recoveries up to 91% at an optimum liquid:solids ratio of 4:1 and a hydrolysis time of 4 hours. Culturing a thermophilic micro-organism, *Thermomonospora* sp., on bagasse yielded an enzyme which was fairly thermostable, but cellulose hydrolysis was poor, possibly because of the crystalline nature of the cellulose structure; a rapid explosive decompression process to destroy this structure proved ineffective. A combination of *Clostridium thermocellum* and *C. thermosaccharolyticum* increased ethanol yield by bagasse pith hydrolysis to an average of 2.26 g/litre by comparison with 0.48 g/litre using *C. thermocellum* alone. Encouraging results were obtained in preliminary tests on manufacture of α-cellulose or qualified pulp from xylose-extracted bagasse; however, while the cellulose was of superior quality in terms of brightness, its ash content was more than double the standard specification at about the same purity, while the pulp from xylose-extracted bagasse was poorer in quality than an unbleached control. The economics of ethanol production from bagasse under Taiwan conditions are briefly examined.

Enzymic saccharification of sugar cane bagasse pretreated by autohydrolysis—steam explosion

R. F. H. Dekker and A. F. A. Wallis. *Biotechnol. Bioeng.*, 1983, **25**, (12), 3027-3048; through *S.I.A.*, 1984, **46**, Abs. 84-796.

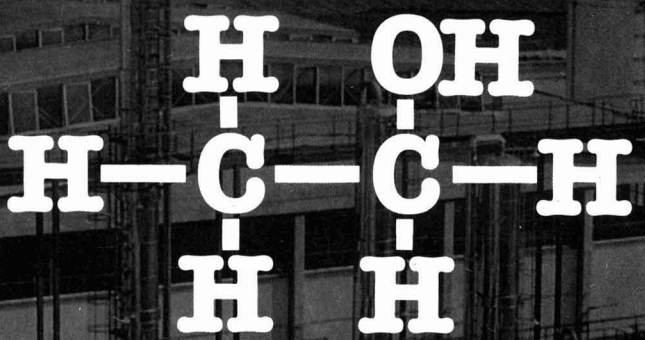
Pretreatment of bagasse by autohydrolysis at 200°C for 4 minutes and explosive defibration resulted in solubilization of 90% of the hemicellulose and in production of a pulp which was highly susceptible to hydrolysis by cellulases from *Trichoderma reesei* C-30 and QM 9414, and by a commercial preparation, Meicelase. By addition of exogenous beta-glucosidase from *Aspergillus niger*, saccharification yields of over 80% could be achieved in 24 hours. Extraction of the autohydrolysis-exploded pulps with alkali or ethanol to remove lignin resulted in lower conversions of cellulose (28-36% after 25 hours) than with unextracted pulps. Autohydrolysis-explosion was as effective a pretreatment method as 0.25M NaOH at 70°C for 2 hours.

Production of single-cell protein from sugar and alcohol industry waste waters

A. García, E. Valdés J., M. C. Obaya A. and M. Chivás R. *ATAC*, 1983, **42**, (4, 5 & 6), 43-51 (*Spanish*).

Waste water from a sugar factory and distillery vinasse were used as substrates for growth of different yeast strains and it was found that they could be used to produce protein while at the same time having the COD content reduced by 73-88%.

ETHANOL



Sugared or amylaceous raw material
(fruits, beet, cane, molasses, grains, etc...)

Batch or continuous fermentation

Recuperation of CO_2, yeast

Distillation, rectification, deshydratation
High yields - low energy consumption

By-products valorization
Waste concentration
Waste incineration

Speichim

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sjb

for both affination magma and white sugar massecuites in order to demonstrate consistent performance under expected factory conditions.

Summary

Although continuous centrifugals offer many advantages compared with batch machines their adoption has been limited to lower grade massecuites. This is due to the relatively poor separation efficiency and to crystal breakage with high-grade massecuites. A recent development project has identified some of the factors which inhibit efficient separation of white sugar massecuites. Design modifications have been implemented, resulting in successive improvements in performance, measured in terms of throughput, sugar analysis, appearance and yield. In addition, these modifications have also resulted in improved separation of affination magma.

Développement des centrifuges continues pour les massecuites de 1er jet

Bien que les centrifuges continues offrent de nombreux avantages par rapport aux machines discontinues, leur adoption a été limitée aux massecuites de jet inférieur. Ceci est dû à l'inefficience plutôt faible de la séparation et au bris de cristaux observé dans le cas des massecuites de 1er jet. Un projet récent de développement a identifié quelques-uns des facteurs qui inhibent une séparation efficiente dans le cas de massecuites de sucre blanc. On a prévu des modifications dans la conception ce qui a conduit à des améliorations successives en performance. Celle-ci fut mesurée en termes de produit travaillé, d'analyse du sucre, d'apparence et de rendement. Ces modifications ont également contribué à une meilleure séparation du magma d'affinage.

Entwicklung kontinuierlicher Zentrifugen für Weißzucker-Füllmassen

Obwohl kontinuierliche Zentrifugen viele Vorteile im Vergleich zu diskontinuierlichen bieten, ist ihr Einsatz bisher auf Füllmassen niederer Qualität beschränkt. Dies liegt an der relativ geringen Effektivität der Trennung und dem Kristallbruch bei Hochqualitäts-Füllmassen. Ein neueres Entwicklungs-Projekt hat einige der Faktoren identifiziert, die eine effektive Trennung der Weißzucker-Füllmassen inhibieren. Veränderungen in der Konstruktion haben zu Verbesserungen der Leistung, gemessen nach Durchsatz, Zuckeranalyse, Aussehen und Ausbeute, geführt. Weiterhin haben diese Modifizierungen zu einer verbesserten Trennung des Affinationsmagmas geführt.

Desarrollo de centrífugas contínuas para masas cocidas de alto grado

Mientras que centrífugas contínuas ofrecen muchas ventajas por comparacion con centrífugas no-contínuas, su adopción se ha limitado al uso con masas cocidas de bajo grado. Esta situación resulta de la relativemente pobre eficiencia de separación y del rompimiento de cristales en el caso de masas cocidas de alto grado. Un proyecto reciente de desarrollo ha identificado algunos de los factores que inhiben la separación eficiente de masas cocidas de azúcar blanco. Modificaciones del diseño se han implementado y se han resultado mejoramientos sucesivos de funcionamiento, medido en términos de capacidad y del análisis, apariencia y rendimiento del azúcar. Las modificaciones han permitido también una separación mejor de la magma de afinación.

Brevities

Restrictions on HFS production in Spain[1]

With a price advantage over sugar, HFS consumption in Spain rose from 37,000 tonnes, tel quel, in 1980 to 77,000 tonnes in 1983. Legislation was passed in December to control HFS production and consumption; producers will not be allowed to build new plants or expand capacities and restrictions may be placed on output. Manufacturers had been given assurances that production would not be controlled but since syrups containing 55% fructose were introduced in 1983 the soft drinks market for sugar has fallen from 120,000 to 80,000 tonnes/year of sugar and the decline is continuing. Sugar is currently in surplus and the government has had second thoughts on the matter. A problem is that capacity is currently set at 215,000-250,000 tonnes by the HFS industry and at 120,000 tonnes by the administration; this still leaves much scope for increasing production within the legislation.

Mali sugar complex[2]

Under the terms of a protocol signed by the governments of Mali and the People's Republic of China, a sugar-producing complex was inaugurated in southern Mali during November 1984. The complex, which includes two sugar factories and two cane plantations covering an area totalling 5000 hectares, has been developed by Chinese experts.

Mexico steps to self-sufficiency[3]

Industry sources in Mexico say that the 1984/85 crop, which began in November, looks promising and that Mexico will be self-sufficient in sugar. (Mexico has imported 550,000-950,000 tonnes annually in the past four years). The state-owned Azúcar S.A. has raised domestic prices to check the growth in sugar consumption and the new prices are regarded as realistic and ultimately designed to reduce substantial federal subsidies. The outturn of the 1984/85 season is still uncertain because of unpredictable weather, labour unrest, etc., but a need for imports would be surprising, especially as stocks at the beginning of the season were at a relatively high level.

Yugoslavian sugar expansion[4]

It is officially planned for the sugar beet crop in Yugoslavia to rise to 7.8 million tonnes in 1985 and to process it to yield 1.0 million tonnes of sugar. It is thought that 6,285,000 tonnes of beet were harvested in the 1984/85 campaign, from 145,000 hectares, and that sugar production closed at around 860,000 tonnes, white value.

Japan sugar imports, 1984[5]

Total imports of sugar into Japan in 1984 amounted to 1.84 million tonnes, up 1.9% from those in 1983.

1 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 21, 66.
2 C. Czarnikow Ltd., *Sugar Review*, 1985, (1734), 9.
3 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 36.
4 C. Czarnikow Ltd., *Sugar Review*, 1985, (1734), 10.
5 F. O. Licht, *International Sugar Rpt.*, 1984, **117**, 64.

Candle filtration of cane juice

By W. A. Mellowes, Ph.D.

(Department of Chemical Engineering, University of the West Indies, St. Augustine, Trinidad, W.I.)

Introduction

Raw cane juice is essentially a mixed colloidal suspension of very fine particles of fibre, soil, cane wax and yeasts. In addition there are present organic non-sugars such as gums, proteinic acids, etc. A separation process is necessary to effect removal of these impurities.

In the sugar industry the method normally used is lime-phosphate addition followed by sedimentation in clarifiers. A problem associated with this method is the high residence time associated with multi-tray clarifiers. To overcome this difficulty a trayless, high-capacity clarifier was designed to reduce the retention time; however, large doses of flocculant are required to keep this clarifier working.

The present work started prior to the introduction of the trayless clarifer and was intended to investigate the design and operation of a filter which could possibly eliminate, to a large extent, the bulky and wasteful operation of settling. A pressure filter using synthetic filter media and vibratory cake removal was developed to study the parameters involved in filtering cane juice.

Most filters presently in use require large quantities of back-wash water which dilutes the process juice, with consequent need for large evaporative capacity. The vibratory filter system is intended to permit the quantity of back-wash water required to be lessened.

Descriptions and illustrations have been given for eight different types of candle filters used in the sugar industry[1]. Olier[2] investigated the use of a candle type filter on carbonatation juices. Zagrodzki[3] has reported the successful use of a vibratory candle filter for thick juices. Filter cake was removed by axial vibrations of the filter candle. Experiments were performed under constant volume conditions.

In the vibratory type candle filter, the filter elements may be suspended on springs. The cake can then be removed by mechanical oscillation transmitted through a rigid connexion to a set of vertical filtering elements. Axial or transverse vibrations are used in cake removal. The transverse system is simpler since the filtering elements are supported or stiffly held and vibrated at the top of the element. This, however, does not ensure equal oscillation amplitudes along the element. The axial system requires a suspension of springs which can, however, complicate the filter. The amplitude variation is nevertheless uniform over the entire length, and consequently the axial system was chosen for this work.

Whilst it is generally agreed that the principal role of the filter medium is to cause a clear separation of particulate solids from a fluid with minimum consumption of energy, there are few quantitative data in the literature which would facilitate the selection of the most suitable cloth for the separation of a particular solid-fluid mixture. There are also a large number and variety of media available. At present the stability of a medium must be decided by experiment.

The object of this study[4] was to provide an understanding of and information on the parameters contributing to cloth resistance and to find some practical means of reducing resistance and assisting with cake

1 Oglaza: *Gaz. Cukr.*, 1964, **77**, 229-239.
2 *I.S.J.*, 1961, **63**, 50, 87.
3 *Zucker*, 1974, **4**, 185-190.
4 Mellowes: *Proc. W. Indies Sugar Tech.*, 1976, 237-247.

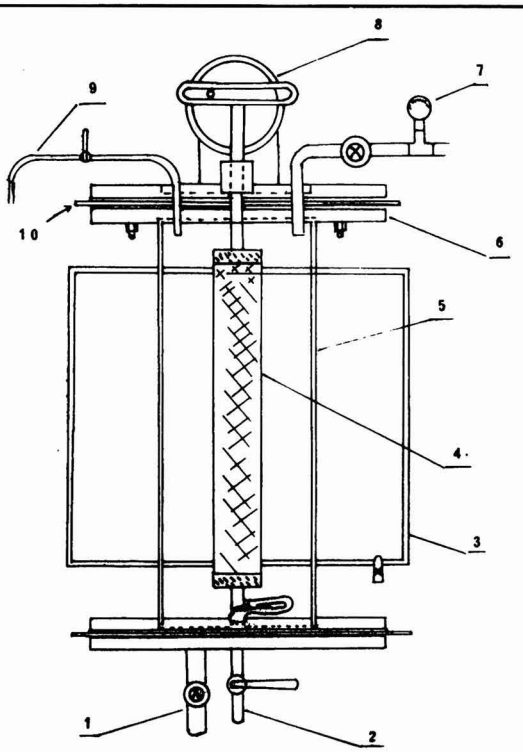


Fig. 1. Details of small filter. Key: 1 Drain, 2 Filtrate exit, 3 Water jacket, 4 Filter element, 5 Filter vessel, 6 Flange with rubber diaphragm in centre, 7 Pressure gauge in feed inlet, 8 Eccentric drive, 9 Vent, 10 Seal.

removal.

Experimental

Apparatus

Figure 1 shows a filter enclosed in a glass body through which observations could be made of flow patterns and of the cake removal characteristics of the various media. The filter element was of 4.4 cm diameter and height 22.0 cm and had a filter surface area of 103 cm^2. Vibration of the filter element was achieved by direct transmission from a rotating eccentric disc driven by a variable frequency DC electric motor.

The filter fabric was stitched in the form of a hose to cover the filter element. This was so designed as to ensure no interference with the cake removal.

The supporting apparatus consisted of a slurry tank for precoating mix, a filter feed tank filter and centrifugal pump.

Figure 2 is a diagram of the large-scale model used. This candle filter consisted of a vertical cylinder capable of holding up to 4 filter elements each of 0.227 m^2 filter surface area. The fabric was stitched in the form of long tubes to cover the aluminium filter element. The candle was made of aluminium strips set on stainless steel pipes in which holes were drilled to allow the filtrate to pass.

The feed tank was heated internally with steam coils, and the feed was agitated by means of a vibratory mixer in order to maintain the filter aid in suspension.

Juice flow from each element passed through rotameters and into precalibrated vessels to measure flow rates.

Experimental procedure

The standard procedure used throughout the work with the larger filter was as follows:

(a) The phosphate content of thin juice was brought to 300 ppm using 12 Bé solution of triple phosphate.
(b) The juice was cold-limed to a pH in the range 6.8-7.0.

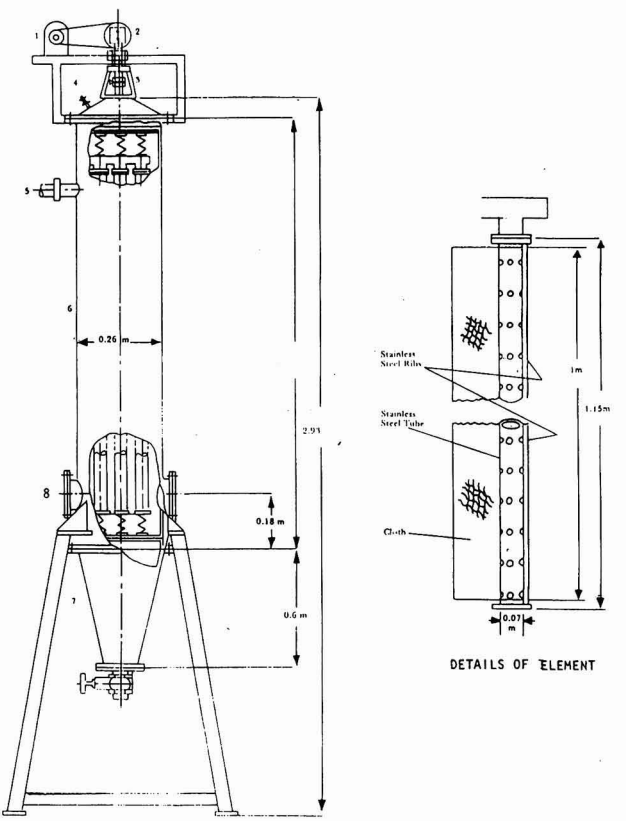


Fig. 2. Details of Vibro-filter. Key: 1 Motor, 2 Eccentric drive, 3 Pressure seal (frictionless), 4 Vent, 5 Juice inlet, 6 Outer cylinder, 7 Mud cone, 8 Juice outlet.

(c) The juice was boiled and then kept at 95°C by means of the steam-heated coils.
(d) Filter aid (Dicalite, bagacillo or a mixture of these) was added to the extent of 3.75 grams per litre.
(e) The pump was started while the air vent at the top of the filter was kept open. When juice started to spout from the air vent it was closed.
(f) The valve on the recycle line was adjusted to a preset position such that a feed pressure of 20 psi could be maintained.
(g) The pump, stop-cock and discharge valves were opened simultaneously. For filtration tests under vibrating conditions the vibrator was also started, and ran at a preset frequency and amplitude.
(h) The filtrate was collected and 25 ml samples taken for determining turbidity and colour.
(i) At the end of the cycle the pump was stopped. The pressure was released and the vibrator was switched on for 3 minutes.
(j) The next cycle of filtration was started.
(k) Before each set of experiments the filter medium was backwashed for 15 minutes at the start of a run. The flow rate of water through the

cloth was then checked. If the flow rate was lower than a set value the cloth was changed. Further details have been published elsewhere[4].

In the case of the small filter the procedure used was similar to that above, except that the juice was limed to pH 8-8.2. Filtration was done at a pressure of 1.034×10^5 Nm^{-2} and precoating when used was at a pressure drop of 3.45×10^4 Nm^{-2}. Precoat thickness on the filter cloth should be not less than 1.5 mm and not more than 6 mm.

Cake removal characteristics

At the end of a cycle a candle filter body was emptied. The filter element was carefully removed from the body. The element was vibrated and the mud shaken off was collected on preweighed filter papers at 10-second intervals. The papers were kept in a dessicator. In all cases mud removal was carried out for three minutes. The mud samples were weighed and oven-dried at 104°C to constant weight. The weight of dry cake was then recorded.

Details of the filter media used are shown in Appendix I.

The frequency of vibration was measured with a stroboscope, and the amplitude measured using a travelling microscope and stroboscope.

Colour determination and turbidity

The colour value was determined from transmittancy measurements made using a Bausch & Lomb spectrophotometer, by means of the expression

$$\text{Colour value} = \frac{1000\ (-\log T_{420} \times 100)}{B \times spg \times L}$$

where L = Cell length,
T_{420} = absorbance reading at 420 nm,
B = Brix of solution, and
spg = Specific gravity.

Turbidity was calculated from transmittancy measurements made at 625 nm. Bentonite was used as clarification aid. The formula employed was

$$\text{Turbidity} = \frac{(-\log T_{625}) \times 100}{B \times spg \times L}$$

Results and discussion

Tests were carried out using different bagacillo/Dicalite ratios to find out the best filter aid mixture. The major parameters investigated were flow rate, number of filter cycles before backwashing became necessary, ease of mud removal and colour characteristics.

Flow characteristics

Previous investigations on the larger model filter showed that the best flow rates were recorded using Dacron and polypropylene cloths[4].

Table I. Comparison of flow rates

Filter fabric	*Flow rate characteristics, $cm^3.m^{-2}.sec^{-1}$*		
	Cycle 1	*Cycle 2*	*Cycle 3*
Polypropylene	0.172	0.172	0.171
Dacron	0.250	0.183	0.181
Nylon	0.092	0.083	0.061
Cotton twill	0.061	0.010	0.003
Rayon	0.031	0.025	0.015
Propex	0.020	0.015	0.006

Table I indicates that the flow rate through polypropylene cloth does not drop appreciably over three cycles.

Polypropylene cloth showed higher permeability owing to its structure in which the pores are larger. The effect of cloth structure is also shown in that amounts of suspended matter and colour removed in the filtration process can give an indication of permeability. Table II shows that Dacron cloth gave good colour removal and flow rate characteristics. For Dacron the average colour removal was typically 84% while that for polypropylene was typically 72%. The turbidity of the Dacron filtrate was also lower than that of the polypropylene cloth (Table III).

For cotton twill and propex cloths the filtrate clarity was excellent, with 84% colour removal, owing to their close-knit structure.

However, reference to Table I shows that the flow rates were about one-third of those of polypropylene and Dacron and, in addition, flow rates dropped appreciably over the three cycles. Dacron media gave the best overall performance.

Mud removal characteristics

Reference to Figure 3 shows that typically mud removal is more pronounced from the Dacron than from cotton twill. This is also due to the influence of the cloth structure. The

Table II. Colour values of filtrate for different filter media

Fabric	*Original Juice Value*	*Cycle 1*		*Cycle 2*		*Cycle 3*	
		Colour Value	*% Colour Removed*	*Colour Value*	*% Colour Removed*	*Colour Value*	*% Colour Removed*
Polypropylene	3231	853	73.60	927	71.31	1129	65.06
Dacron	3567	549	84.61	616	82.73	712	80.03
Nylon	3341	704	78.93	768	77.01	842	74.80
Cotton twill	2815	446	84.16	449	84.04	448	84.08
Propex	3108	485	84.39	495	84.07	504	83.78

Table III. Turbidity values of filtrate for different filter media

Fabric	*Original*	*Cycle 1*		*Cycle 2*		*Cycle 3*	
		Value	*% Original*	*Value*	*% Original*	*Value*	*% Original*
Polypropylene	2.332	0.489	20.97	0.489	20.97	0.538	23.07
Dacron	2.740	0.172	6.23	0.223	8.14	0.259	9.45
Nylon	3.220	0.276	8.57	0.311	9.66	0.385	11.96
Cotton twill	2.060	0.106	5.14	0.110	5.33	0.109	5.29
Propex	2.226	0.112	5.30	0.115	5.43	0.124	5.86

yarn of the Dacron fabric was so aligned to give minimum interference with the mud as it moves over the surface of the cloth. The major ridges of the Dacron cloth ran axially. Where the cloth is precoated, mud removal is even greater, as shown in Fig. 3.

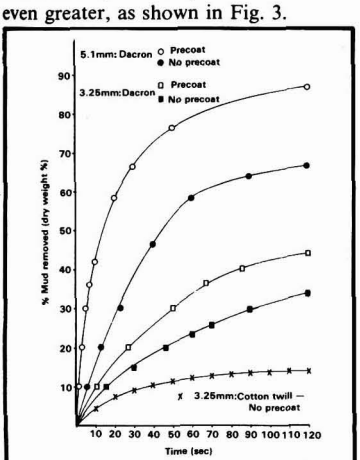


Fig. 3. Effect of amplitude at 60 Hz, cloth type and precoating on mud removal.

Figure 4 shows that, by increasing the frequency at a fixed amplitude, the weight of cake removed is increased. This indicates that the forces of adhesion of cake to cloth can be overcome by this means. Greater cake removal also occurs on increasing the amplitude at fixed frequency, as shown in Figures 5 and 6. The adhesive forces are also affected by the type of cake. A Dicalite precoat is more easily removed than bagacillo or bagacillo-Dicalite mixtures. Figures 7, 8 and 9 illustrate cycle differences on the small filter for Dacron cloth. Some pressure must be applied to the precoat at all times to prevent its falling off before actual filtration starts. Where vibration is used for cake removal the number of cycles possible therefore depends on the mud removal characteristics. For the small filter a typical 3rd cycle length for cotton twill was just over 200 seconds while that for Dacron was over 600 seconds. Filter aid usage was in the region of 500 $g.m^{-2}$ of surface.

Reference to Figure 10 shows that the use of compressed air to aid in vibratory mud removal results in improved flow rates over the three cycles. The air removes the clogging particles as well as lifting the cake from the surface of the filter medium.

The combination of synthetic cloth, use of filter aid, air and axial vibration in this type of filter allowed the cake to be easily sweetened-off and removed.

With conventional filtration processes, cloth life varies from two to six weeks in the severe conditions for defecated sugar liquor. Most cloth damage occurs during washing, removal and handling. In the case of a candle filter with mud removal by vibration, the cloth life is expected to be greater, since the above procedures would be reduced.

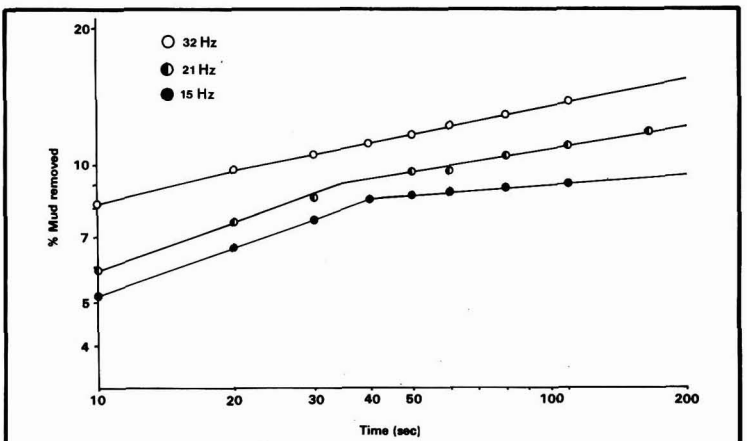


Fig. 4. Effect of frequency on mud removal.

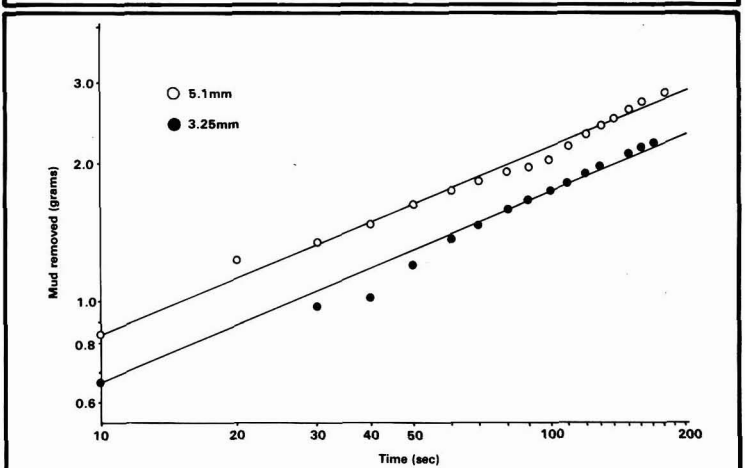


Fig. 5. Effect of amplitude on mud removal (no precoat, frequency 60 Hz).

Conclusion

Dacron filter cloth of the type mentioned in Appendix I is recommended for this type of vibratory filter. Cake removal can be accomplished in under 3 minutes with the use of vibrations and in less than

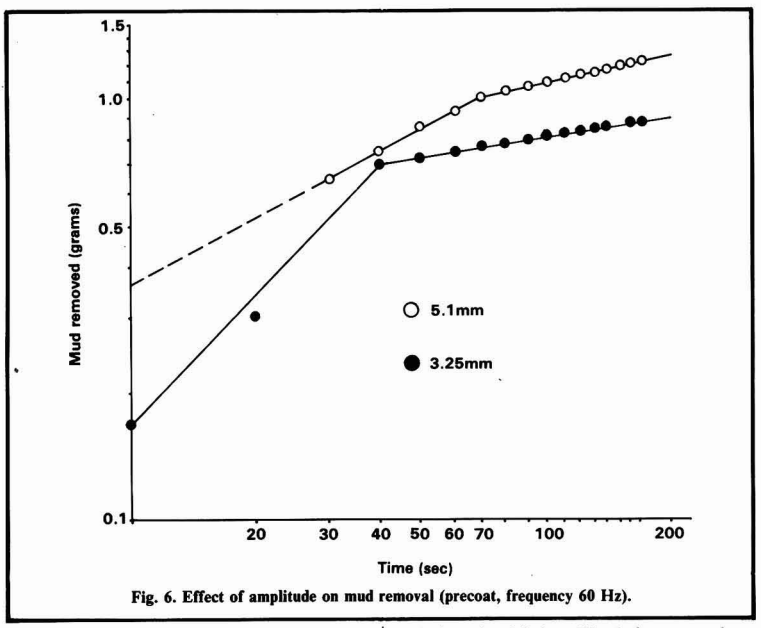


Fig. 6. Effect of amplitude on mud removal (precoat, frequency 60 Hz).

one minute where the cloth is precoated and compressed air is used to aid vibratory cake removal. Up to three cycles are normally possible before backwashing is required. Precoating of the filter with up to 3.5 g per dm^3 is allowable but greater amounts of precoating can reduce flow rates considerably. The filter worked well in mixed juice. Work is currently going on in filtering mud slurry from clarifiers. It is estimated that a filter of this type would require 12 m^2 surface area per ton of cane per hour.

Summary

A candle filter was used to investigate flow rate and vibratory cake removal characteristics of synthetic media. Parameters varied were frequency and amplitude of vibrations, filter aid type and filter fabric. In terms of filtrate flow rate, turbidity and colour removal, Dacron media gave the best overall results. Mud removal was greatest with precoating. More than three cycles before back-washing was possible where air was used to aid in cake removal. The combination of Dacron cloth, precoating and axial vibration allowed the cake to be easily removed.

Filtres à bougies sur jus de canne

On a utilisé un filtre à bougies et on a examiné le débit de jus et l'enlèvement de tourteau par vibration en fonction des caractéristiques du matériau synthétique. Les paramètres modifiés étaient la fréquence et l'amplitude des vibrations, le type d'adjuvant de filtration et le tissu des toiles. Au point de vue débit de filtration, d'enlèvement de trouble et de couleur, les produits Dacron donnaient les meilleurs résultats généraux. L'enlèvement de précipité fut le plus élevé lorsqu'on travaillait avec précouche. On pouvait faire plus de trois cycles avant un lavage à contrecourant si on utilisait de l'air pour aider à l'enlèvement de tourteau.

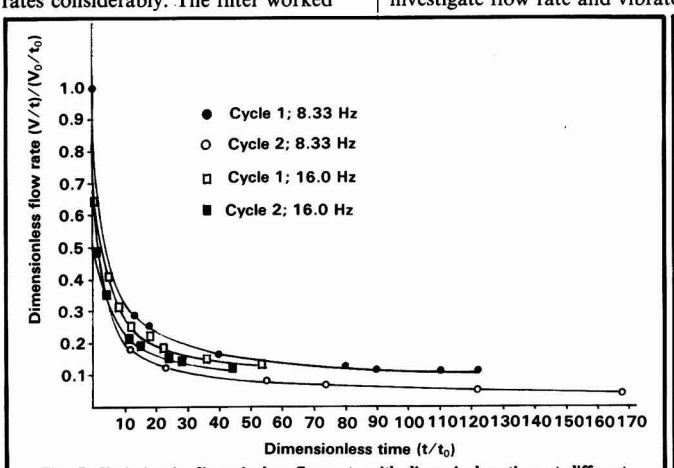


Fig. 7. Variation in dimensionless flow rate with dimensionless time at different frequencies and constant amplitude (3.2 mm).

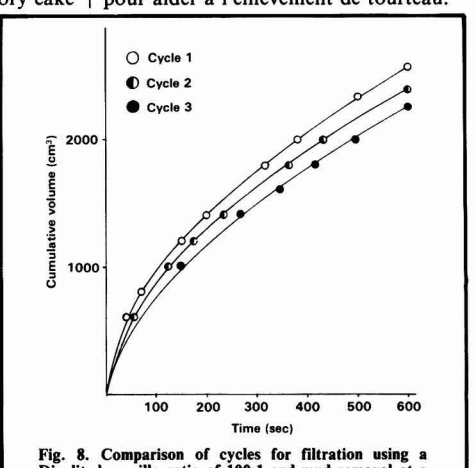


Fig. 8. Comparison of cycles for filtration using a Dicalite:bagacillo ratio of 100:1 and mud removal at a frequency of 15 Hz during 300 sec.

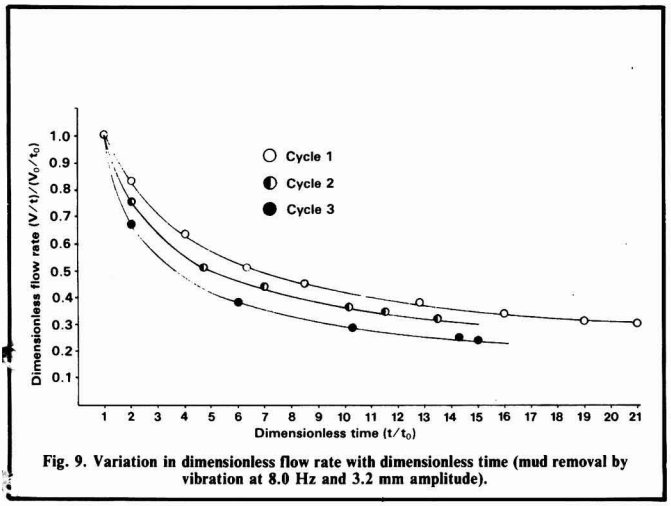


Fig. 9. Variation in dimensionless flow rate with dimensionless time (mud removal by vibration at 8.0 Hz and 3.2 mm amplitude).

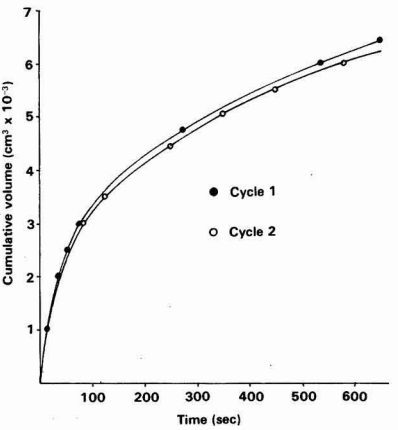


Fig. 10. Comparison of cycles using compressed air at 2 psi to aid in mud removal at the end of the cycle.

En combinant du tissus Dacron, une précouche et la vibration axiale, l'enlèvement du tourteau était fort facile.

Filtration von Rohrsaft mit Kerzenfiltern

Ein Kerzenfilter wurde verwendet, um Durchflußgeschwindigkeits- und Abreinigungscharakteristika mittels Vibration für synthetische Gewebe zu untersuchen. Die variierten Parameter waren Frequenz und Amplitude der Vibrationen, Filterhilfsmittel sowie Filtergewebe. In Bezug auf Durchfluß-geschwindigkeit, Trübung und Farbentfernung ergab Dacron die besten Ergebnisse. Die Schlammentfernung war nach Anschwemmen am besten. Falls Luft zum Abreinigen verwendet wird, sind mehr als drei Zyklen vor dem Rückwaschen möglich. Die Kombination von Dacron-Gewebe, Anschwemmen und axialer Vibration ermöglichte ein schnelles Abreinigen des Filterkuchens.

Empleo de filtros á candelas para jugo de caña

Se ha utilizado un filtro á candela para investigar el flujo de jugo y separación de torta como propriedades características de medios sintéticos. Los parámetros de variación incluyeron la frecuencia y amplitud de las vibraciones, el tipo de filtro-ayuda, y la tela. En términos de la velocidad de flujo y el turbidez y el color del filtrado, los mejores resultados en general se obtuvieron con tela de tejidos Dacron. La separación de la torta fué más completa en el caso del uso de filtro-ayuda. Si se usó aire para asistir en la separación de la torta, fué posible hacer más de tres ciclos antés de lavar en contra-corriente. Una combinación del uso de tela Dacron, de filtro-ayuda y de vibración axial permitió separación fácil de la torta.

APPENDIX I

Details of filter fabrics

Material multifilament fibre	*Weight, gram/m²*	*Ply*	*Yarn count*		*Construction per in²*	
			Warp	*Weft*	*Warp*	*Weft*
Nylon: 2 Harness Plainweave 1/1, 1 FD 538	105.6	Single	12.75	25.50	66	52
Dacron: 1 FD 438, 4 Harness Drill Twill 3/1	177.6	Single	25.5	25.5	76	64
Propypropylene: 1FD 1023, 4 Harness Twill 2/2 (Filter twill)	290.4	Single	82.67	63.59	52	36
Fabrics supplied by Nordiskafilt, Halmstad, Sweden: Style 7460-7000 6003/11						

Correspondence

The Editor,
International Sugar Journal.

Dear Sir,

In his article, "Economics and energy balances of ethanol from sugar cane and sugar beet"[1], Mr. Bert Mouris makes the point that "it is not possible to discuss all relevant aspects so a selection has to be made." This is particularly true in this case and the complex factors can affect the answers. For this reason, if some figure is chosen for an ethanol cost per litre, then care must be taken to ensure that this is not taken out of context by readers.

Attention is therefore drawn to the fact that average cane sugar factories work a longer — 150 day — crop than beet. This affects the economics and, while it does not contradict the theme of the report, can be important.

Yours sincerely,
JAMES E. SOMNER

Little Saltwood Farm,
Cranbrook, Kent,
England TN17 3PL.

1 *I.S.J.*, 1984, **86**, 282-286.

New books

The standard laboratory manual for Australian sugar mills. Volume 1. Principles and practices

Anon. 96 pp. 21×29.7 cm. (Bureau of Sugar Experiment Stations, P.O. Box 86, Indooroopilly, Queensland 4068, Australia.) 1984. Price: A$35.00.

Since the publication of the 5th Edition of "Laboratory manual for Queensland sugar mills", cane sugar technology has undergone considerable changes, with the introduction of many items of apparatus into factory laboratories, and modification of analytical methods and techniques to take advantage of the improvements in the equipment. A revision of the manual was therefore thought justified. Two major changes have been made: the manual is now produced as two volumes, and A4 format is used.

The first volume is divided into 11 chapters concerning: definitions; optical instruments; modern balances and weighing; densimetric methods of analysis; volumetric equipment; the BSES standardization laboratory; advanced analytical techniques; sampling of sugar mill products; the determination of pH; calculations involved with chemical control in the factory; and the boiler station. Volume 2 of the manual will be entitled "Analytical methods" and will contain descriptions of the methods plus reference tables.

The new manual has been expanded to cover techniques and instruments such as chromatography and the electronic balance. The text has been extensively reviewed and updated, and should remain current for a number of years, although the fact that the manual has been prepared using computer methods will make updating a simpler task than hitherto, a factor borne in mind in regard to the more frequent revisions that may be necessary with the analytical methods. The printing is very clear on matt paper, but unfortunately the pages do not fall flat, which could make reference to the manual something of a chore. The book concludes with a subject index. In view of the high standing of the Australian sugar industry, this book will undoubtedly find a ready market among cane sugar factory chemists in many countries.

Tätigkeitsbericht (Progress report) 1983/84

Anon. 35 pp; 17×24 cm. (Zuckerforschungs-Institut, Zaunergasse 1-3, A-1030 Wien, Austria.) 1984.

The 1983/84 report of the Austrian Sugar Research Institute covers, in three distinct sections, work carried out by the Agricultural, the Technological and the Medical Divisions. Emphasis of the experimental program of the Technological Division was on beet pulp ensilage; this section of the report also carries data for the 1983 beet campaign tabulated alongside results for the three campaigns of 1979/82. Scientific papers and publications by members of Institute staff are listed and details of the Institute organization and staff are given at the end of the report.

F. O. Licht's International sugar economic yearbook and directory 1984

Anon. 561+72 pp; 20.5×29.2 cm. (F. O. Licht GmbH, P.O. Box 1220, D-2418 Ratzeburg, Germany.) 1984. Price: DM. 132.00.

Two major changes have been made in the latest edition of this well-known publication: the sugar factory/refinery section has not been split into two distinct parts covering, respectively, the beet and cane sectors (merging the two sides into one directory with the countries arranged alphabetically would seem to be the more logical approach in view of those countries where both beet and cane are grown, especially since there is clear indication of which are beet and which are cane sugar factories); and the clear printing associated with the book has been replaced with computer print-out, which in many cases is not easy to read. Moreover, while it is understandable that a computerized system should be used for collating the details (this should make revision of the information relatively easy), it is important to check that there are no errors or omissions when using such a system; it seems that insufficient importance has been attached to this, since there are a number of major errors, such as the omission of two West German sugar factories that are still in operation, inclusion of a Guadeloupe sugar company and factory under Mauritius and misspellings that have occurred between the last edition and this. It is to be hoped that full advantage will be taken of the computer to rectify the mistakes by the next edition.

The remainder of the directory is devoted to a collection of articles on various topics, reports from machinery manufacturers, a list of international sugar organizations, a Buyers' Guide and a 72-page collection of sugar statistics inserted in a pocket.

La sucrerie belge

Ed. R. Hulpiau. 94 pp; 21.1×29.1 cm. (Avenue de Tervuren 182, B-1150 Bruxelles, Belgium.) 1984.

La Sucrerie Belge, established in 1872, ceased publication as a monthly journal in December 1982. However, the original title has been retained in this annual publication devoted to the Belgian sugar industry. Besides two technical articles ("The treatment of boiler house water in sugar factories" by F. Coget and M. Winkel, and "Anaerobic treatment of waste water at Hollogne-sur-Geer sugar factory" by P. A. Mullier *et al.*) there is a directory of the Belgian sugar industry, with details of the equipment and processes used at each factory and refinery. This is followed by information on the various organizations involved in sugar and beet research as well as marketing.

Brevities and statistics

Mauritius sugar exports, 1984[1]

	1984	1983
	— *tonnes, tel quel* —	
Belgium	359	0
Canada	13,000	14,997
Comoro Islands	0	100
France	66,127	132,461
Germany, West	501	0
Ghana	0	3
Holland	709	0
Ireland	341	0
Italy	3,771	0
New Zealand	0	13,300
Seychelles	0	498
UK	429,646	419,557
US	16,270	27,119
	530,724	608,035

New Yugoslavian sugar factory[2]

Final trials have been completed of a new sugar factory at Pabinska Skela, near Belgrade. It was built by Polimex-Cekop of Poland and is highly automated, with a processing capacity of 6000 tonnes of beet per day.

US blended sugar import limitations[3]

The US is to limit imports of certain blended sugars to 94,000 short tons per fiscal year, according to the USDA. Products affected include sweetened cocoa, limited to 3000 tons/year, pancake flours and mixes, limited to 7000 tons/year, and a category "edible preparations, under 5% butterfat" which includes mixtures of sugar and glucose, which will be limited to 84 tons/year. The action was taken because of material interference by such imports with the price support system for domestic sugar.

Personal notes

Dr. A. Carruthers, former Director of Research of the British Sugar Corporation, has for nearly 30 years served as a member of our Panel of Referees and has provided his expert advice on submitted articles during this long time. Living near the Research Laboratory, he has been able to maintain his awareness of progress in sugar technology but now, after moving away from Norwich, he has decided that the time has come to call a halt. We are most grateful to Dr. Carruthers for his splendid efforts and are sure that our readers will join us in wishing him a long continuation in good health of his retirement.

We have been fortunate in securing the agreement of **Dr. Robert Pieck,** until his recent retirement Director of Sugar Technology with Raffinerie Tirlemontoise S.A. in Belgium to replace Dr. Carruthers on the Panel. Dr. Pieck will be well known to our readers as one of the foremost beet sugar technologists in Europe and we are grateful to him for his willingness to advise us on manuscripts submitted to us for publication. He is continuing to serve as General Secretary-Treasurer of the Commission Internationale Technique de Sucrerie.

Barbados sugar exports, 1984[4]

Total raw sugar exports by Barbados in 1984 amounted to 79,725 tonnes, against 62,146 tonnes in 1983. They included deliveries of 73,925 tonnes to the UK and 5800 tonnes to the US, all at preferential prices which raised income from US$27.2 million to $31.8 million. The increased sales were directly due to a rise in production; the 1984 crop produced 97,682 tonnes of sugar, against 82,769 tonnes in 1983.

Mauritius sugar crop, 1984[5]

The 1984 sugar cane harvest began on June 8 and ended on November 29. The 21 sugar factories crushed a total of 5,008,774 tonnes of cane to yield 575,617 tonnes of sugar, tel quel, equivalent to 609,636 tonnes, raw value. Average cane yield per hectare was 64.2 tonnes, and average sugar extraction 11.49%. The 1984 cane crop was 1,573,088 tonnes less than the record figure achieved in 1982; the reduction was due to the very severe drought which prevailed throughout 1984 and which followed a drought which affected the 1983 crop. In spite of this drought, sugar outturn in 1983 was higher than 1984 at 604,730 tonnes, tel quel, or 639,804 tonnes, raw value. The dry conditions of 1984 favoured the maturation of canes, however, and this helped, to some extent, in offsetting the disastrous effect of the drought on cane output.

Argentina sugar crop reduction[6]

Authorizations for the 1985/86 (June/May) crop in Argentina total 1.1 million tonnes against 1.5 million tonnes in 1984/85 and 1.3 million tonnes in 1983/84, as a consequence of low world sugar market prices. Export availability will be reduced to 100,000 tonnes, all of which will go towards the US supply quota.

US beet sugar campaign extension[7]

The major processing cooperative in the Red River Valley (Minnesota-North Dakota) has been experimenting for several years on how to extend its campaign. Its major challenge has been how to keep the beets frozen until processed; an early spring would thaw the frozen beets and valuable sugar would be lost. In the 1983/84 season the cooperative erected a temporary air-inflated structure (a "bubble") and filled it to capacity with naturally frozen sugar beets. They maintained a high sugar content and were the last beets to be processed by the facility in Spring 1984. Two large permanent structures have since been built; each will hold 50,000 tons of frozen beets, effectively extending the processing season by 10 days each. There are plans to build six more units for 1985/86, at three other factories.

Poland beet sugar campaign, 1984[8]

According to official sources, Poland harvested 16.0 million tonnes of beet to produce 1,740,000 tonnes of sugar, white value, in 1984, 11.7% less than the 1,970,000 tonnes of sugar produced in 1983 from a beet crop 1.9% higher.

South African Sugar Technologists Association 1985 meeting

The 1985 Congress of the S.A.S.T.A. will be held during June 17-20, the opening address being given by Dr. J. R. Allen of Australia to members gathered at the Royal Hotel in Durban. Factory technical sessions will follow at the S.A.S.A. Experiment Station in Mount Edgecombe, while Agricultural technical sessions will be held at Huletts Country Club, also in Mount Edgecombe. A total of 50 papers have been submitted for presentation at the Congress. Further details may be obtained from the S.A.S.T.A. Secretaries, S.A.S.A. Experiment Station, Mount Edgecombe, Natal, South Africa 4300.

Record Zambia sugar crop in 1984[9]

Zambian raw sugar output hit a record 141,231 tonnes in 1984, 21,000 tonnes of which is available for export. The figure, the third record in a row, was nearly 7% up on the 132,005 tonnes produced in 1983 and came from a record cane crop of 1,180,000 tonnes. Domestic consumption is 120,000 tonnes a year and 70% of the surplus will be exported as white sugar.

Bangladesh mini-sugar factory[10]

DDS-Engineering, of Copenhagen, will be supplying a 300 tonnes per day small-scale sugar plant to replace the old Deshbandu sugar factory located in Narshingi district, Charsindur. The contract was signed in Dhaka with the Bangladesh Sugar and Food Industry Corporation and the project is funded by the Danish aid agency, DANIDA.

Tate & Lyle purchase of US refinery[11]

Preliminary agreement has been reached for the purchase by Tate & Lyle of the entire share capital of Colonial Sugars Inc., owners of the Gramercy sugar refinery, close to New Orleans, which has a capacity of 500,000 tonnes/year.

Taiwan sugar exports reduction[12]

Sugar exports from Taiwan in calendar 1984 were down substantially from 1983 at 131,500 tonnes against 170,000 tonnes. Major destinations were Japan, South Korea and the US.

1 *Mauritius Sugar News Bull.*, 1984, (12).
2 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 33.
3 *Reuter Sugar Newsletter,* January 30, 1985.
4 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 35.
5 *Mauritius Sugar News Bull.*, 1984, (11).
6 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 36.
7 *USDA Sugar & Sweetener Outlook & Situation Rpt.*, December 1984, 10.
8 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 117.
9 *Reuter Sugar Newsletter,* December 4, 1984.
10 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 42.
11 *Tate & Lyle News,* February 1985, 2.
12 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 84.

Trade notices

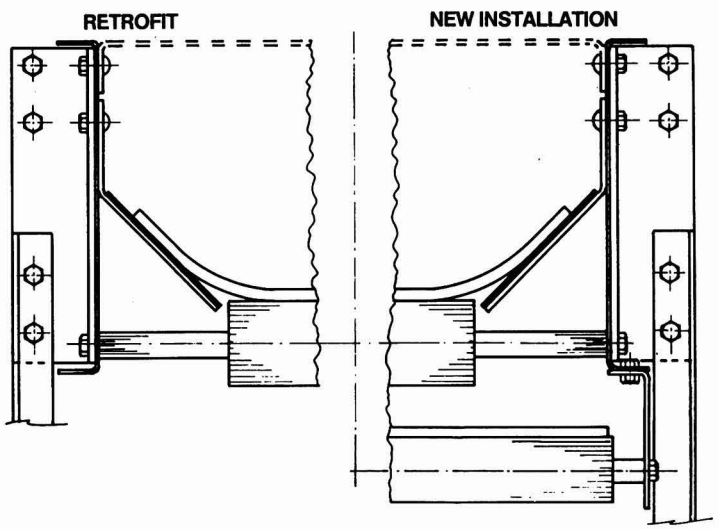
Antispill belt conveyor

Macawber Mechanical Systems Ltd., Shaw Lane Estate, Doncaster, South Yorkshire DN2 4SE, England.

Belt conveyors have usually been subject to spillage and accumulation of dust, so that they are frequently run until they become clogged and seize, at which point they are stopped, cleaned and the process repeated. The Macawber Cleanveyor system has been developed to avoid this and is designed so that existing conveyors can be converted. (This is indicated as "retrofit" in the illustration.) To the sides of the housing are fitted vertical plates with an angled bottom section (the angle chosen depending on the material to be conveyed). These may be provided with a support layer of low-molecular weight polyethylene glued or bolted to the plate, or construction may be in stainless steel when no support layer is required.

The belt is supported by rollers which are more close-pitched than with conventional conveyors, and its outer edges lie flush on the plate or support layer, forming a seal which prevents spillage of material on the belt. Because of the close pitch of the rollers, vibration is almost eliminated and the belt's carrying capacity is increased greatly, almost to its edges, because there is no sagging between rollers. Friction between the belt and the support layer or stainless steel plate is low, so that power requirements are less than with conventional conveyors; alternatively, the same power will provide greater capacity. Lack of spillage increases the life of the support and return roller bearings, but these are easily changed when necessary. When the material carried is dusty, a simple plate across the top of the housing (shown by the broken line in the drawing) seals it at low cost, while another plate across the bottom of the unit beneath the return roller provides a completely sealed unit for e.g. toxic materials. The current production units are suitable for more than 150 tonnes/hr loads, and tests on the polyethylene support layers have shown a durability of at least 5 years.

The design permits conveying at steeper angles than hitherto thought possible, and full-load starting with no roll-back. Trials are to be held during the off-season by one major sugar company during 1985 with conveyors adapted to the Cleanveyor system.



Magma pump

Braunschweigische Maschinenbauanstalt AG, Postfach 3225, D-3300 Braunschweig, Germany.

The F800 magma pump is a new BMA low-speed unit delivering at 65 m^3/hr. It has an overhung impeller rotating at 36 rpm with only one sealing point, and easy access to the housing. A slide ring seal prevents leakage, and there is no sealing water to dilute the magma. Large clearance between the sealing and anti-friction bearing housing protects the bearings, while amply dimensioned connexions reduce pressure losses. The pump has a favourable price:performance ratio and was used with success in the 1984 campaign.

Zanini distillery sales

Usina Campestre, at Penápolis, São Paulo, has signed a contract for supply of a distillery with a capacity of 120,000 litres/day, while the autonomous Destilaria Santa Maria Canarana at Conceição do Aragua, Goias, is to be equipped with a tandem including two sets of 36-in knives, a 36-in shredder and four 3-roller 23×36 in mills, the last to be fitted with a "press roller". Destilaria Porto Velho S.A., in Icém, São Paulo, has contracted to buy a 26×48 in tandem including four 3-roller mills driven by turbines through gear reducers. The distillery has a nominal capacity of 90,000 litres/day. Of the 61 projects currently approved by Proálcool, financed by the World Bank, 26 are to be supplied by Zanini. This figure represents 42% of the total number of projects and 50.35% of the alcohol production capacity.

Cuban order for automatic lubrication systems

The Lubrication Division of Denco Ltd., Hereford, has obtained an order worth £365,000 for the supply and installation of 19 dual-line grease lubrication systems in new and expanded sugar factories. The systems will lubricate on pre-set automatic cycles.

Pump order from Cuba

Stothert & Pitt Ltd. have secured a repeat order from Cuba for pumps to be used in the sugar industry, primarily for molasses although also including fuel oil pumps. This is the fourth such order to be received by the company, with a total value now approaching £1.5 million.

Turbo-generator order

Peter Brotherhood Ltd. have received an order for the supply of a 4000 kW multi-stage back-pressure turbo-generator to Nakambala sugar factory in Zambia.

SKF locks out aggressive cane juice.

Cane juice, bagasse and dirt have always caused problems with roller bearings in sugar cane mills. Service life has not been what it should be.

SKF has solved this problem. And roller bearings are staging a major comeback in cane mills owing to SKF research and development.

SKF is now able to offer the sugar industry a package solution for bearing arrangements in cane mills. The spherical roller bearings work in a completely sealed environment, with the best possible lubrication—using a high viscosity oil instead of a grease.

The result is a high degree of operating reliability and a long service life, which contributes to increased productivity and profitability.

The new seal designs and lubrication methods have been operationally tested under true, real world conditions. And performance has been fully in line with expectations—the new SKF bearing arrangement functioned perfectly.

Compared with plain bearings, the new SKF bearing arrangement offers numerous advantages.

Energy savings of around 25 per cent.

Considerably greater operating reliability.

Considerably simplified maintenance.

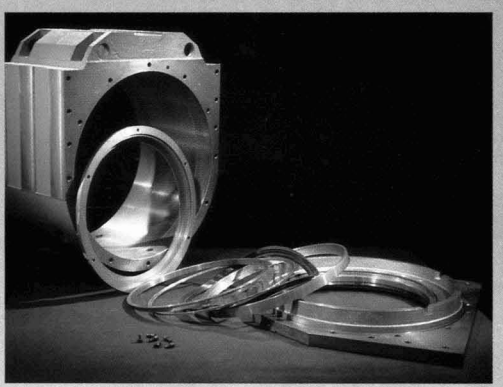
Longer bearing life—more than 20 crops.

New design possibilities.

The saving in power consumption alone means that the extra capital invested in rolling bearings will have a short payoff time.

The seal and lubrication of bearings in sugar cane mills has always been a weak link. Now, SKF has come up with a juice-tight breakthrough.

For more information, please send us the coupon or get in touch with your SKF representative. We would like to send you a brochure explaining the SKF breakthrough in detail.



The new sealing design for rolling bearings in cane mills is based on a combination of supported lip seals and labyrinth sealing with an external, removable V-ring seal. Here you see the bearing housing together with components of the sealing arrangements.

We help sweeten your profits.

Yes, I'd like to sweeten our profits.
Send me more information on the new SKF bearing application for sugar cane mills.

☐ Send me your brochure "The Juice-Tight Breakthrough".
☐ Contact me for a detailed discussion.

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Please fill out and send to: SKF Overseas Bearing Division, S-415 50 Gothenburg, Sweden.

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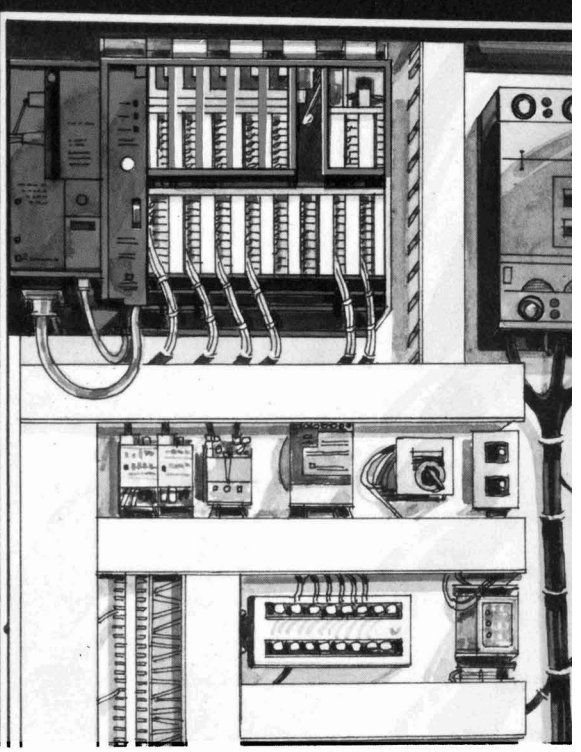
For new and existing Western States Centrifugals

A Programmable Control that you do not have to program



We program it for you

The results are in: programmable solid state control brings more flexibility and more reliability to massecuite processing.

That's why we've made it standard on every new Western States automatic centrifugal. And because application software is just as important as the controller itself, we also provide expert cycle control programming as a standard part of the package.

Available as a retrofit

The new programmable control is fully compatible with existing Western States centrifugals. A retrofit is simple and economical—and it lets you take full advantage of the latest technology.

The technology leader, again

Western States introduced solid state control for automatic centrifugals in 1973 . . . and set the worldwide industry standard. Now, we've advanced the standard again. For more information on how you can benefit from programmable centrifugal control, contact us or your Western States representative.

P.O. Box 327, Hamilton, Ohio 45012 U.S.A. • Phone: 513/863-4758 • Telex: (WUD) 21-4577 and (RCA) 21-2057

THE WESTERN STATES MACHINE COMPANY

Starch, glucose, isosyrup, yeast, alcohol ...

can be produced economically by our advanced technological processes. We build plants for the food and chemical industry throughout the world, in particular:

* Starch from corn (maize), wheat flour, cereals and starch containing tubers.
* Processing of starch to dextrose, total sugar, corn syrup, dextrin, isosyrup (HFCS), sorbitol (solution or powder) from dextrose or starch hydrolysate.
* Baking and active dried baking yeast from molasses.
* Ethanol and power alcohol from molasses and other raw materials containing sugar or starch, acetaldehyde from ethanol, acetic acid from acetaldehyde, acetic anhydride from acetic acid, etc.
* Plants for agglomerating pulverized material, wet separation and wet screening.

Please contact us for further information.

STARCOSA

a member of the BMA Group

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Your partner for food and chemical industries