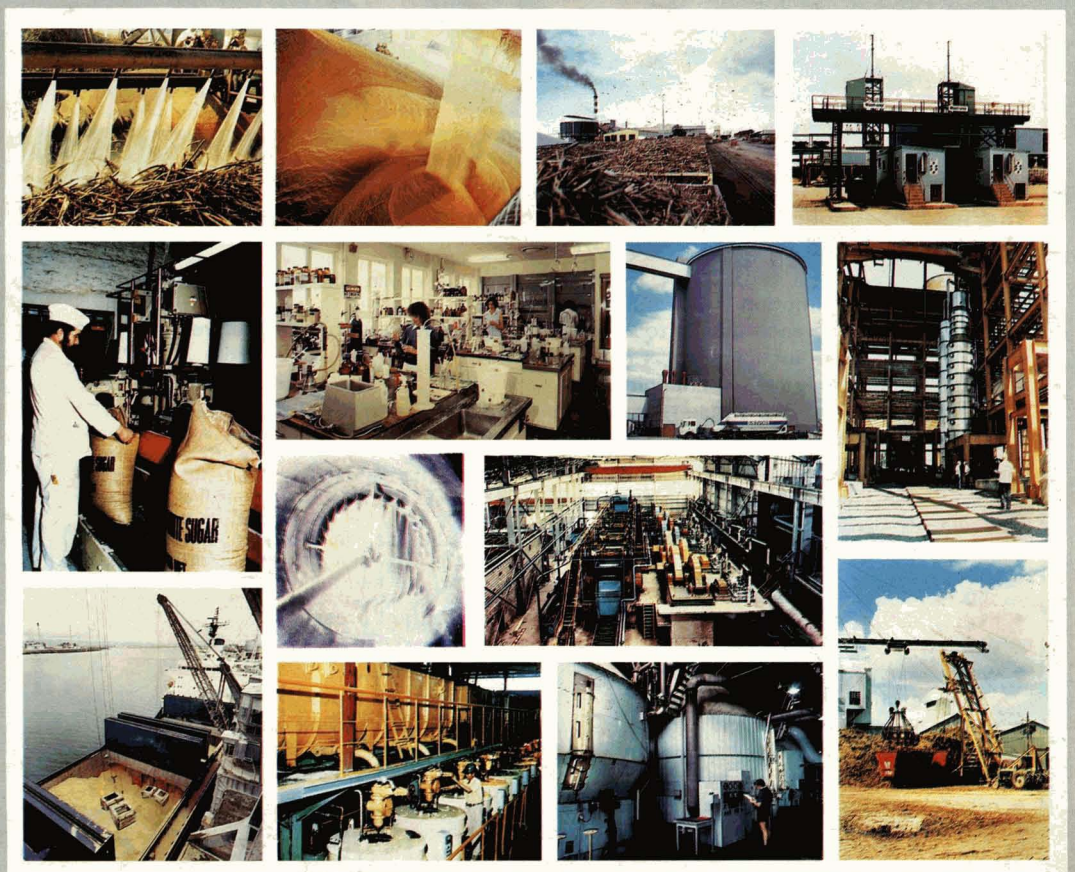
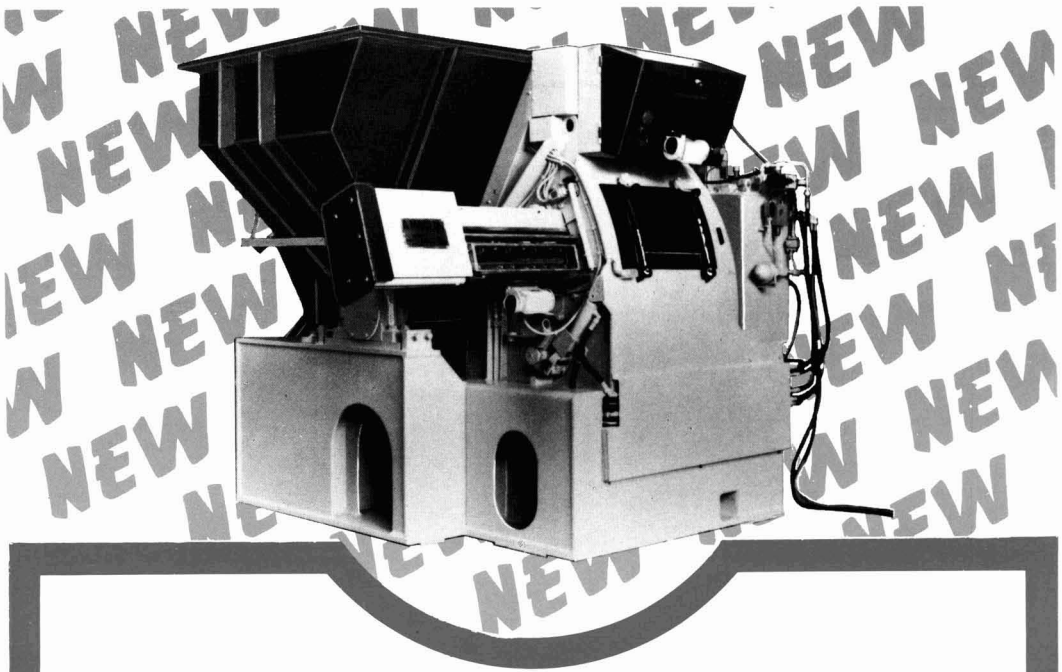
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXVII/ISSUE No. 1039 JULY 1985



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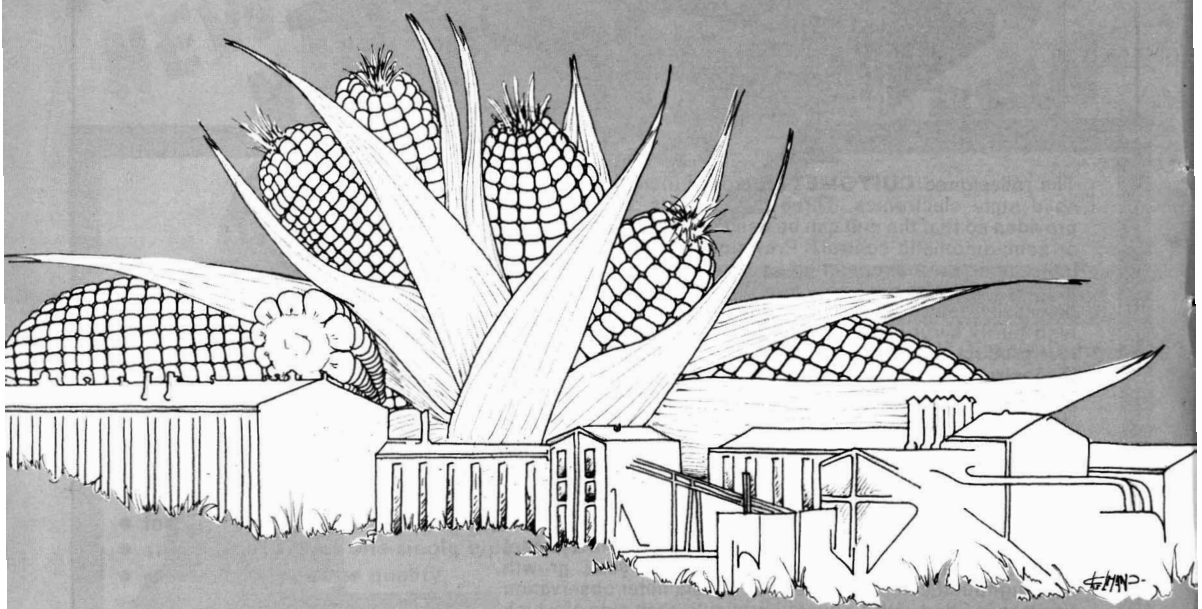

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UK ISSN 0020-8841

Annual Subscription:
£40.00 post free

Single Copies
£4.00 post free

Airmail: £24 extra

Published by
The International Sugar Journal Ltd.,
23A Easton Street, High Wycombe,
Bucks., England HP11 1NX
Tel: 0494-29408 *Telex:* 21792 REF 869

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

INTERNATIONAL SUGAR JOURNAL

Volume 1039
Issue No. 1039

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Published by

The International Sugar Journal Ltd.

23A Easton Street, High Wycombe, Bucks., England HP11 1NX.

Telephone: 0494-29408 *Telex:* 21792 REF 869

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Notes and comments

International Sugar Organization

A full meeting of the Council of the I.S.O. was held in London on May 23 and it was agreed that its statistical role should be expanded, with preparation of reports on market developments and estimates of world sugar production and consumption, demand and availability, with publication of summaries of the May and November estimates. The Council currently estimates 1985 world production at 99.0 million tonnes, raw value, consumption at 97.5 million tonnes, export availability at 24.2 million tonnes and demand at 16.7 million tonnes. The I.S.O. is to step up its activities in promotion of sugar consumption.

Peru sugar price policy

The potential for damage to the industry of rigid governmental control is illustrated by an article in F. O. Licht's *International Sugar Report*[1] on sugar pricing in Peru. In 1968 prices were frozen at 5.65 soles per kilogram of white sugar and 5.00 soles per kg of raw sugar. The losses which resulted were compensated by high world market prices for sugar which reached a peak in 1973 and 1974. As prices subsequently decreased, they did not compensate for the low domestic prices and the cooperatives sank deeper in debt. Price increases have been permitted in recent years, the latest in February after another in August of last year.

World sugar production, 1984/85

F. O. Licht GmbH have recently published their third and latest estimate of world sugar production for the crop year September 1984/August 1985[2]. Since their second estimate in January last, estimates for Yugoslavia, the Soviet Union, Cuba, Mexico, Brazil, Thailand, Pakistan and Australia have had to be raised significantly and their new total is 100,851,000 tonnes, raw value, against the January total of 98 million tonnes and the 1983/84 figure of 96.4 million tonnes.

"Although part of the production increase can be attributed to better weather this season, the increase shows that so far no efforts have been made to reduce sugar output in spite of excessive stocks overhanging the market since 1982/83. On the contrary, some cane producers continue with their expansionist sugar policies apparently unrelated to the world market situation." Against this background it can hardly come as a surprise that prices have fallen below 3 cents/lb.

World sugar balance, 1984/85

F. O. Licht's latest estimates of the world sugar balance for 1984/85 were recently published and are reproduced below:

	1984/85	1983/84	1982/83
		tonnes, raw value	
Initial stocks	40,186,000	38,605,000	33,219,000
Production	99,649,000	98,112,000	100,610,000
Imports	27,754,000	29,398,000	282,851,000
	167,589,000	166,115,000	162,680
Consumption	97,869,000	96,215,000	94,383,000
Exports	28,347,000	29,714,000	29,692,000
Final stocks	41,373,000	40,186,000	38,605,000
Production change	1,537,000	—2,498,000	—228,000
,, ,, , %	1.57	—2.48	—0.23
Consumption change	1,654,000	1,832,000	2,210,000
,, ,, , %	1.72	1.94	2.40
Stocks % consumption	42.27	41.77	40.90

The production increase is largely expected to occur in Europe, both West and East, and in Africa. North and Central America, Asia and Oceania are expected to produce almost the same as in 1984/85, while the South American figure shows a fall, in spite of better crops in Argentina, Brazil and Venezuela.

Consumption growth is expected from the developing countries of Asia and South America, small increases being forecast elsewhere except for North and Central America where a continuing decrease is expected. World trade — imports and exports — continues its decline and, while the final stock figure is only an approximation, it is clear that earlier hopes for a reduction in stocks will not come about; indeed, stocks are expected to rise by more than a million tonnes and this overhanging surplus is likely to result in continuing low world market prices.

Impact of Chinese sugar policy on imports[3]

Growing domestic demand for sugar and a devolution of purchasing authority to end-users should keep China as a net sugar importer for the future, according to foreign agricultural attachés in Beijing. Demand can be managed quite easily by the government because sugar is not common in traditional Chinese diet but current policy is to increase consumption, which is now an estimated 4 kg per head, less than a tenth of the level in some western countries. Total demand is estimated at about 5½ million tonnes, against an officially reported output of 4 million tonnes, refined value, in the 1984/85 season, ending in May.

1 1985, **117**, 122.
2 *International Sugar Rpt.*, 1985, **117**, 269-277.
3 *Reuter Sugar Newsletter*, February 14, 1985.

Imports fell last year but there are several factors which could easily raise import requirements again. The most important of these is the weather; the main sugar producing area is Guangdong where one-third of the Chinese sugar is obtained from cane and this region is vulnerable to typhoons. Guangdong is officially expected to produce 1.4 million tonnes of refined sugar in 1984/85, a 22% rise over the 1983/84 output which was hit by bad weather. Record sugar output this season arose through good weather in the south and an unexplained jump in beet sugar output in the north-east to 600,000 tonnes after stagnation at 150,000 tonnes for many years.

The total area planted last year fell by 13% to 1,040,000 hectares; both cane and beet farmers reduce their sugar areas in order to plant grain when, as happened last year, they do not receive needed grain supplies from local authorities. A combination of bad weather and reduced areas could easily cut future seasons' sugar output, according to the attachés.

Inefficient sugar factories and poor sugar content in the crops are other factors likely to sustain imports; it has been reported that at the end of 1983 there were 494 factories with a total capacity of 4.75 million tonnes a year of sugar, refined value. The factories are not running at full capacity but are near it.

A factor which could increase China's purchases is its growing sophistication in buying cargoes from international operators, coupled with the low prices for sugar. The bulk of Chinese sugar imports still come from Cuba and Australia, and purchases from Cuba in 1984 were well below those of 1983. Purchases from Australia also fell up to the middle of 1984 but a sharp rise in the latter half could point to a resurgence in imports. There have also been unconfirmed trade reports of purchases from Brazil, the Philippines and Thailand. The government is likely to keep a close eye on trends, however, as high imports two years ago actually cut into traditional domestic markets of Guangdong producers, leading to complaints and cuts in planted area.

Brazilian sugar exports reduction[3]

It has been announced by the Brazilian Sugar and Alcohol Institute that sugar output in the season June 1985/May 1986 would be limited to 7,896,000 tonnes, raw value, against the 8,850,000 tonnes target of 1984/85. From the new crop, 2.46 million tonnes have been designated for export. The shipment of 2.2 million tonnes in calendar 1986 has already been agreed under contract, so that further sales next year will be relatively small unless there is an unexpected production increase in 1986/87.

So far as the current year is concerned, Brazil will remain out of the market as contracts for 3.1 million tonnes have already been signed for shipment by the end of 1985. In order to ensure that the 1985/86 production limitation is strictly adhered to, producers will have to reduce the tonnage of cane they may cut, while the production of alcohol from cane will be increased to 11,000 million litres — an increase of 1700 million litres from the output from the 1984/85 crop.

South African sugar crop, 1984/85[4]

The South African 1984/85 season started at Darnall on April 2, 1984 and ended when Mount Edgecombe stopped crushing on March 3, 1985. This was one of the longest seasons in recent years. The old Felixton mill was gradually phased out during the season which also saw the start of the new Felixton II mill.

Heavy rains at the beginning of 1984 and well-distributed rainfall during the season enabled a record crop of 22,355,591 tonnes of cane to be harvested (against 13,422,876 tonnes in 1983/84). Sugar production, at 2,370,040 tonnes, tel quel, also broke all South African records and compared with 1,378,465 in the previous season. Sucrose % cane at 12.27 was the lowest ever recorded but fibre in cane was also relatively low at 15.62%. Average extraction rate at 97.42% broke all records and boiling house recovery at 88.23% was influenced by the good mixed juice purity (85.69). Overall recovery at 85.96% was well above the long-term average, and the good processing quality of the cane was reflected in the relatively low molasses loss (9.40%) and undetermined losses (1.73%).

World sugar prices

The weakening tendency of the raw sugar market continued during the first three weeks of May, with no constructive features to counteract a series of estimates by the USDA, FAO and various market observers which indicated a larger surplus of production over consumption in the current season. As a consequence, the LDP, which started the month at $96 per tonne, had declined to $84 by May 17. There had been a number of purchases of white sugar by India during the period, however, and the LPD(W) had not fallen so far; as a consequence the premium over the LDP had widened to more than $40 and since this permits profitable tolling operations (purchase of raw sugar and sale of refined sugar produced from it), China and South Korea became active and the raw sugar market was heartened. The LDP rose to $90 and stayed about this level through the rest of the month, ending it at $89. The LPD(W) was also firmed by more enquiries for white sugar supplies and rose to $136.50 on May 31, higher than the $133 level with which it started the month.

3 C. Czarnikow Ltd., *Sugar Review*, 1985, (1737), 55.

4 F. O. Licht, *International Sugar Rpt.*, 1985, 117, 288-289.

Dextran analysis of raw sugar—an alternative method

By D. F. Day and D. Sarkar

(Audubon Sugar Institute, Louisiana State University, Baton Rouge, Louisiana 70803, USA)

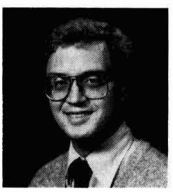
Introduction

With the introduction of "dextran" penalties to raw sugar contracts it has become increasingly important for the sugar analyst to have a reliable, specific method for measuring dextran in raw sugar. Technology currently dictates that any analysis for dextran in raw sugar requires the preliminary separation of the dextran from the sugar and then some method for quantifying the amount of dextran separated.

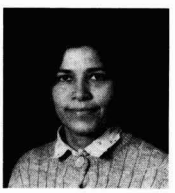
At present there are two generally accepted methods for routine analysis of dextran in raw sugar. They are the alcohol "haze" method of Keniry *et al.*[1] and the copper-dextran method of Roberts[2]. Both analytical methods rely on the differential insolubility of polysaccharides in alcohol to separate dextran from raw sugar. Specificity for dextran in the haze test is based on the limited solubility of dextran in 50% ethanol compared with the solubility of other polysaccharides that may be present. The Roberts method uses 70% ethanol to separate "all" polysaccharides from the sugar and then selectively precipitates the dextran as a copper-dextran complex. Measurement in the "haze" test is based on the concept that the amount of alcohol precipitate formed is directly proportional to the dextran concentration. The Roberts method measures the amount of copper complex carbohydrate precipitated as total carbohydrate by a Molisch reaction (phenol-sulphuric acid)[3].

Several other methods for dextran analysis have been put forward but have not, for various reasons, been generally adopted. They range from measurement of viscosity changes on dextranase treatment[4] to immunoprecipitation with dextran specific antibodies[5].

We propose an alternative method for dextran analysis in raw sugar which, in our laboratory, has proven to be more reliable than the "haze" test and less tedious than the Roberts procedure. Advances in clinical instrumentation have made commercially available centrifugally driven ultrafiltration membranes. We have adapted this equipment to the separation of polysaccharides from raw sugar, thus avoiding some of the problems inherent in alcohol separations. Measurement of the dextran present in these polysaccharides is then based on determining the amount of glucose produced by the action of dextranase and α-glucosidase on the sample. The details of our procedure are given in this report.



D. F. Day



D. Sarkar

Experimental

Materials

Separation—Centricon 10 ultrafiltration units (10,000 M.W. cut-off) were purchased from the Amicon Corp., Danvers, MA, USA. After use, the membrane units were washed and stored wet, at 4°C. The centrifuge used was capable of operating at an RCF of 4500 *g* (Sorvall RC-5, E. I. duPont de Nemours & Co., Doraville, GA, USA).

Enzymes—The enzymes utilized were purchased from the Sigma Chemical Co., St. Louis, MO, USA. They were α-amylase (crude from *Aspergillus oryzae*), dextranase (chromatographically pure, from *Penicillium* sp.) and α-glucosidase (partially purified, from bakers yeast).

Chemicals—All other chemicals were of the best commercially available grade. Dextran standards were obtained from the Sigma Chemical Co., St. Louis, MO, USA and from Pharmacia Fine Chemicals, Piscataway, NJ, USA.

Reagents

α-glucosidase—A stock solution containing 34 IU/ml in 0.1M potassium phosphate buffer, pH 6.0.

Dextranase—A stock solution containing 50 IU/ml in 0.1M potassium phosphate buffer, pH 6.0.

Buffer—0.1M potassium phosphate, pH 6.0.

Nelson-Somogyi test reagents[6].

Copper reagent A — 25 g anhydrous Na_2CO_3, 25 g Rochelle salt, 20 g $NaHCO_3$ and 200 g anhydrous Na_2SO_4, made up to 1000 ml with water.

Copper reagent B — 15% $CuSO_4,5H_2O$ acidified with 1-2 drops concentrated H_2SO_4 per 100 ml.

Arsenomolybdate reagent — 25 g of ammonium molybdate dissolved in 450 ml of water and 21 ml of conc. H_2SO_4. To this is added 3 g of $Na_2HAsO_4,7H_2O$ dissolved in 25 ml of water.

Analytical

1. Sample preparation—Raw sugar (20.00 g) is dissolved in 50 ml of water in a beaker, and 0.05 g of α-amylase added. The beaker is covered with a watch glass and incubated at 55°C, with occasional stirring, for 1 hour. The amylase-treated sample is made up to 100 ml and filtered through a 0.45 micron filter (Millipore Corp., Bedford, MA, USA).
2. Polysaccharide separation — A 2.0 ml aliquot of the filtered sample is pipetted into a Centricon tube and centrifuged for two hours at an RCF of 4500 *g*; at the end of two hours the volume in the Centricon is checked, when there should be no more than 1-2 drops of retentate left. If the volume is greater, centrifugation is continued

1 *I.S.J.*, 1969, **71**, 230-233.
2 *Proc. 41st Ann. Mtg. Sugar Ind. Tech.*, 1982, 298-307.
3 Dubois *et al.*: *Anal. Chem.*, 1956, **28**, 350-356.
4 Greenfield & Geronimos: *Proc. Australian Soc. Sugar Cane Tech.*, 1979, 151-156.
5 Goodacre & Martin: *Proc. 40th Ann. Mtg. Sugar Ind. Tech.*, 1981, 103-128.
6 Nelson: *J. Biol. Chem.*, 1944, **153**, 375-380.

until the appropriate retentate volume is obtained. When a volume of 1-2 drops is reached, 2 ml of water is added and the sample is centrifuged for one hour. This step is repeated once more, making an average centrifugation time of 4 hours. It is desirable that washing should not be excessive, in order to leave some background sugar for enhanced sensitivity (for reasons which will be explained later).

About 0.5 ml of water is added to the retentate and it is then transferred to a 2.0 ml volumetric flask. The Centricon is washed with a second amount of water which is transferred to the volumetric flask. A third amount of 0.5 ml of water is added, the retentate cup of the apparatus is mounted, and the Centricon inverted and centrifuged at 1000 *g* for 2 minutes to remove all traces of the wash. This wash is also transferred to the volumetric flask and the volume made up to 2.0 ml with water. If required, at this point, samples can be frozen for later analysis.

3. Dextran analysis—Two 0.8 ml aliquots are withdrawn from the 2.0 ml volumetric sample. One aliquot is the sample, the other a blank. To the sample is added 0.1 ml of α-glucosidase stock solution and 0.1 ml of dextranase stock solution. To the blank is added 0.1 ml of α-glucosidase solution and 0.1 ml of phosphate buffer. The blank and sample are both incubated at 37°C, in capped tubes to minimize evaporative losses, for two hours.

At the end of the incubation time 1 ml of Nelson-Somogyi reagent (A+B) is added to each tube and the tubes are heated for 20 minutes in a boiling water bath. After cooling, in water, for 10 minutes, 1 ml of arsenomolybdate reagent is added and the reaction is allowed to go to completion (20 min.). Then 10 ml of water is added to each tube and the samples are clarified by centrifugation (800 *g* for 10 min.).

The absorbances (A_{500} nm) of the supernatants are determined using a suitable spectrophotometer. The amount of dextran is determined from a standard curve by the difference in absorbance between the sample and the blank tubes.

An outline representation of the complete analysis is shown in Table I.

Table I. ASI dextran analysis for raw sugar

SAMPLE PREPARATION
1. Make a 20% w/v raw sugar solution
2. Treat with α-Amylase to hydrolyse starch
3. Pass through a 0.45 micron filter

REMOVAL OF SMALL MOLECULES
4. Concentrate 2.0 ml of prepared sample using Centricon
5. Wash residue twice with water
6. Resuspend residue into 2.0 ml of water

DEXTRANASE TREATMENT
7. Split sample residue, half to be used as blank
8. Treat sample with dextranase and α-glucosidase to produce glucose from the dextran and treat the blank with α-glucosidase

GLUCOSE DETERMINATION
9. Measure glucose produced, by the Nelson-Somogyi method
10. Determine dextran levels from amount of glucose produced using standard curve

Results

Sample preparation and pretreatment

20% sugar was found to be the maximum concentration which would still permit adequate volume reduction in the Centricon within a two-hour centrifugation period (Figure 1). The sugar concentration could theoretically be increased for samples with very low dextran levels, but the centrifugation time required would increase markedly.

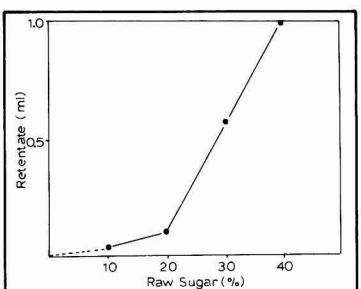


Figure 1. Retained volumes of raw sugar solutions after 2 hours centrifugation at 4500 *g* in Centricon 10's as a function of % w/v sugar

Amylase treatment was also found to be necessary as the presence of starch in the sugar produced a false high value in the final dextran analysis (Table II). This is because dextranase has a degree of amylolytic activity and hence would produce some glucose from any starch present. α-Amylase is preferred over β-Amylase because, like dextranase, β-amylase is not absolutely substrate specific, but has a limited degree of activity on dextran.

Table II. The effect of amylase pretreatment on dextran levels measured in raw sugar*

Sample	*"Dextran" detected (ppm on sugar)*
No pretreatment	296.4
Amylase added	262.1

*Raw sugar containing 29 ppm of starch by I_2/KI Method[7].

Centrifugal separation

The Centricon separation is the most time-consuming part of the analysis. An initial centrifugation time of two hours was found to reduce the volume of retentate in raw sugar samples sufficiently to produce adequate dilution upon washing and recentrifugation (Fig. 2). Washing the retentate to avoid high background levels of simple sugars which would be detected by the Nelson-Somogyi test is required. Two washes were found to be sufficient to reduce the background to

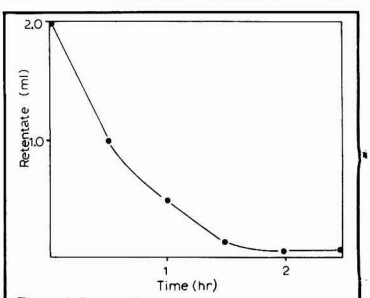


Figure 2. Retained volume of a 20% w/v raw sugar solution as a function of time of centrifugation at 4500 *g* in a Centricon 10

7 Hale & Rawlins: *Cereal Chemistry*, 1951, **28**, 49-58

satisfactory levels. A certain small amount of background is desirable as it brings the absorbance values on the glucose test into the working range of the spectrophotometer when samples with very low dextran levels are analysed.

Enzymatic analysis for dextran

The assay system requires the use of a combination of dextranase and α-glucosidase to hydrolyse the dextran present to glucose. A concentration of dextranase of 5 IU/ml was found to reduce dextran completely within the desired time period (Fig. 3). The glucose produced is measured by a

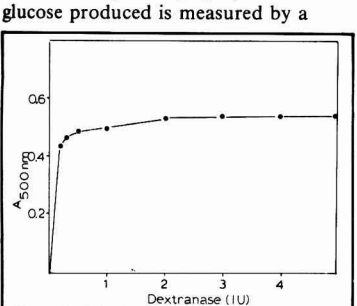


Figure 3. Relationship of A_{500} to International Units of dextranase used in the assay, after 2 hours of incubation with a sample containing 250 µg/ml of T-2000 dextran

Nelson-Somogyi test[6] and the amount of dextran is determined from a standard curve. Dextran T2000 was used as a standard in order to be consistent with existing assay procedures. However equally valid standard curves were obtained with other dextrans (Fig. 4).

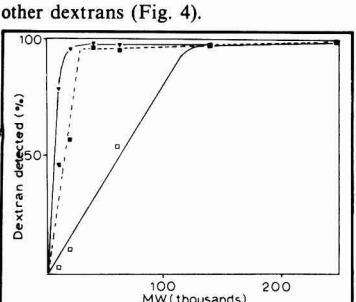


Figure 4. Standard curves using dextran T_{10} (●), T_{40} (■) and T_{2000} (○). The differences in slopes are probably due to variations in degrees of branching of the dextran standards

Analytical reliability and sensitivity

As would be expected, this particular procedure showed a reduced reliability for very small dextrans, in the vicinity of 10,000 M.W. and lower. A comparison of this method with the Roberts method shows a molecular weight sensitivity to the test dextran similar to, but not quite as good as, the Roberts method. Both the Roberts and the ASI procedure show significant improvement over the "haze" analysis in terms of molecular weight sensitivity (Fig. 5).

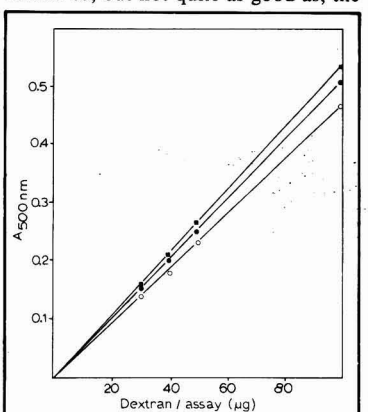


Figure 5. The measurement of a standard weight of dextran as a function of molecular weight by the haze (○), Roberts (●) and ASI (■) procedures

Values obtained with this procedure tend to be intermediate in range between the values obtained with Roberts and haze procedures on the same sugars (Table III). The precision of a single analysis is not quite as good as that reported for the Roberts method. However, because of the ease of analysis, we normally run all samples in triplicate. The recovery of dextran added to raw sugar samples is excellent, illustrating the reliability of this procedure (Table IV). The sensitivity of the procedure is limited by the required dilution of the raw sugar sample and the small volumes of the Centricon. We feel confident of measuring accurately samples containing greater than 40 ppm of dextran on sugar.

Discussion

Current methodology for the analysis of dextran in raw sugar necessitates the

Table III. Comparison of methods

	Haze		*Roberts*	*ASI*[c]	
Sugar sample[a]	*MAU*	*ppm*[b]	*ppm*	*ppm*	*n*[d]
1	158	134	487	325±27	4
2	580	496	775	720±39	13

[a] Raw sugar samples from same factory taken on different days
[b] Calculated as approx. ppm from MAU values
[c] Value±standard error
[d] Number of replicates

Table IV. Recovery of dextran added to raw sugar

Sample[a]	*Dextran concentration* (µg present)	*Dextran measured*[b] (µg)	*% Difference*
1	32.1	32	(-)0.3
	37.7	39	3.4
	54.3	54	(-)0.6
	64.3	64	(-)0.5
2	42	41.5	(-)1.2
	49	51.6	5.3
	59	57.7	(-)2.2
	89	93.1	4.6
		Average difference	1.1

[a] A 20% raw sugar sample of known dextran concentration with varying amounts of added T-2000 dextran
[b] Dextran concentration determined by ASI Method

separation of the dextran from sucrose in order to facilitate measurement. Established methods have settled on alcohol precipitation as the initial procedure for dextran (polysaccharide) separation from sugar. Our (ASI) proposed method utilizes a physical method (ultrafiltration) rather than a chemical method (precipitation) for the separation of dextran from sucrose.

Specificity of analysis is provided by the specificity of the enzyme, dextranase (E.C. 3.2.1.11) for the α-1, 6 glucan linkages of dextran. Because starch is removed prior to analysis, trace amylolytic activity associated with dextranase is not a problem. Good correlation can be expected with this assay where the dextran in question is not highly branched. This is the case for most dextrans reported associated with sugar process streams[8].

The ASI assay has a disadvantage in that it is slow in comparison to the "haze" test although, like the Roberts method, it eliminates a number of objections to this method (i.e. molecular weight sensitivity). The actual limitation is in the centrifugation time. The number of samples that can be processed at any one time is dependent upon the number of centrifuge slots available. This assay does free the analyst for other tasks while the centrifugations are run. The method requires an appropriate centrifuge and spectrophotometer, and where the appropriate equipment is available we feel that it is a preferable method to the haze procedure in terms of reliability and to the Roberts procedure in terms of ease of analysis.

Summary

A new technique is described for the measurement of dextran in raw sugars which is more precise than the "haze" method but is less tedious than the Roberts procedure. It employs ultrafiltration as a physical method for separation of the dextran from sucrose, followed by enzymatic hydrolysis to glucose which is measured by the Nelson-Somogyi method. Recovery of dextran added to sugar samples was between 97.8% and 105.3%, averaging 101.1%.

Analyse de dextrane dans le sucre brut — une méthode alternative

On décrit une nouvelle technique pour mesurer le dextrane dans les sucres bruts. Elle est plus précise que la méthode par la nébulosité. Elle est moins fastidieuse que la procédure Roberts. Elle fait appel à l'ultrafiltration comme moyen physique pour séparer le dextrane du saccharose. Ensuite on effectue une hydrolyse enzymatique avec formation de glucose qui est mesuré à l'aide de la méthode Nelson-Somogyi. Du dextrane ajouté à des échantillons de sucre fut retrouvé à raison de 97.8 à 105.3% avec une moyenne de 101.1%.

Dextran-Analyse von Rohzucker — Eine alternative Methode

Eine neue Technik für die Messung von Dextran in Rohzuckern, die präziser ist als die "haze"-Methode und weniger aufwendig als das Roberts-Verfahren, wird beschrieben. Sie wendet Ultrafiltration an als physikalische Methode zur Trennung von Dextran von Saccharose und anschließend enzymatische Hydrolyse zu Glucose, die mit der Nelson-Somogyi-Methode gemessen wird. Die Wiedergewinnung von Dextran, das Zuckerlösungen hinzugeführt wurde, betrug zwischen 97.8 und 105.3%, durchschnittlich 101.1%.

Análisis del dextrano en azúcar crudo — un metodo alternativo

Se describe una nueva técnica para medir el dextrano en azucares crudos. Es más preciso que el método "calina" pero menos aburrido que el procedimiento de Roberts. La técnica emplea ultrafiltración como modo físico para separar el dextrano de la sacarosa, y después de esta etapa se efectua un hidrólisis enzimático para formar glucosa que es medido por el método Nelson-Somogyi. El porcentaje de recuperación de dextrano, añadido a muestras de azúcar, se halla entre 97.8% y 105.3%, con un promedio de 101.1%.

8 Covacevich & Richards: *Proc. 41st Conf. Queensland Soc. Sugar Cane Tech.*, 1974, 171-177.

Brevities and statistics

South Africa sugar exports, 1984[1]

	1984	1983	1982
	tonnes, raw value		
Canada	161,011	158,983	212,286
Israel	60,262	65,212	16,846
Japan	287,977	140,631	452,019
Korea, South	104,363	91,434	136,348
Portugal	0	39,389	27,218
USA	62,236	59,787	34,832
Unknown	11,291	13,709	4,024
	687,140	569,145	883,573

Mexico sugar expansion program[2]

The Mexican administration has approved a program calling for the erection of four new sugar factories in the states of Veracruz, San Luís Potosí and Chiapas, and extension of ten major factories in the state-owned sector, viz. Ingenios Atencingo, El Higo, El Modelo, Hermenegildo Galeana, Huixtla, La Glória, San Francisco Ameca, Tala, Tres Valles and Zapoapita.

Bagasse paper factory in India[3]

The first bagasse-based paper factory in India has begun production at Pugalur in Tamil Nadu state. Samples of newsprint supplied for trials were of much better quality and whiter in colour than that previously produced in India. They were slightly more porous than desirable, so that pictures reproduced were slightly fuzzy; it was expected that this would be corrected when commercial production began at the beginning of 1985. Raw material used by the factory includes mechanically chopped-up bagasse, chemically-treated bagasse and conventional hardwood pulp.

French sugar factory closure[4]

At the end of December the Goussainville sugar factory, north-west of Paris, was closed. It was one of the smallest of the Beghin-Say Group, slicing 3400 tonnes of beet per day. Farmers in the supplying area will deliver beets for the future to Chevrières factory.

1 *I.S.O. Stat. Bull.*, 1985, **44**, (2), 37.
2 F. O. Licht, *International Sugar Rpt.*, 1985, **117**, 162.
3 *Indian Sugar*, 1984, **34**, 600-601.
4 *Zuckerindustrie*, 1985, **110**, 252.

Sugar refinery liquor desalting by a new ion exchange process

By Fumio Maekawa and Kohji Kawasaki

(C. Itoh Sugar Co. Ltd., 3-Tamatsuura-cho, Hekinan-shi, Aichi-ken, Japan)

Introduction

The decolorization of impure sugar liquor by ion exchange is conventionally practised with strongly basic anion exchange resins having quaternary ammonium functionality. Such ion exchange resins are usually regenerated with caustic soda or sodium chloride, the latter being the preferred technique.

It is well known that the reverse ion exchange system is applicable in sugar refining. This system is superior in both desalting and decolorization of sugar liquor; however, fouling of the resin used is a serious problem[1-6]. This fouling is caused by both inorganic substances, such as alkaline earth metals, iron and silicon compounds, and organic substances, such as colouring matter. Most of the colouring matter which remains on the resin is that formed by the reaction of the resin and invert sugar originally in the treated liquor and is not easily desorbed by the ordinary regeneration technique[1-6].

Hitherto, when solutions containing colorants, silicic acid compounds and the like have been refined by this method, the anion exchange resins, especially strongly basic resins, have been regenerated with alkali solution. This can remove anions but is less successful in removing colorants and various compounds containing silica and the like which seem to be mainly adsorbed physically on the resin.

Some physicochemical properties of the colouring matter concerning its gel-filtration chromatography and adsorption have been examined by Fujii *et al.*[3,6,7,8]. Gel filtration on Sephadex G-50 showed that colouring matter eluted from strongly basic anion exchange resin consisted of three major components (Pa, Pb and Pc) differing from each other in their affinities for the gel. Both Pa and Pb were sodium salts and their elution curves overlapped over a broad molecular weight range. They could not be separated by an ultrafiltration technique and their molecular shapes were probably changed with the solvent used. Pc was the free acid form of Pa and Pb and was adsorbed strongly on the gel. The adsorbed Pc could not be desorbed with pure water but was eluted with sodium chloride or with water when sodium chloride or sodium hydroxide was present in the chromatographic sample.

After decationization, the colouring matter was insoluble in strongly acidic medium but soluble in some organic solvents and on titration with alkali gave a pKa value of 4.8; it showed the same behaviour on gel filtration as the component Pc. On a basis of these facts, Fujii *et al.* discuss the effective desorption of the colouring matter from the resin with a mixed solution of sodium chloride and sodium hydroxide.

The present paper results from a search for an economical restorative agent, as a result of which we concluded that the most effective method is one where the fouled resin is regenerated at 70°C with 10% NaCl solution containing 1% NaOH, after a pre-treatment with 4% HCl solution at 70°C. The hot HCl solution is used not only for the elution of inorganic salts but also for desorption of colouring matter. Development of this method as the "Mixed bed-Two bed" or MAK system was undertaken in order to overcome the fouling of the strongly basic anion exchange resin on an industrial scale.

This work was undertaken in order to provide a process for refining sugar liquor containing a large quantity of impurities by use of anion exchange resins. The MAK system can also be used for dark coloured sugar liquor.

1 Maekawa *et al.: Proc. Research Soc. Japan Sugar Refineries Tech.*, 1978, **28**, 78.
2 Kawasaki *et al.: ibid.*, 86.
3 Maekawa *et al.: ibid.*, 1984, **33**, 1.
4 Idem: *Nippon Shokuhin Kogyo Gakkaishi*, 1977, **24**, 366.
5 Idem: *ibid.*, 1978, **25**, 219.
6 Fujii *et al.: ibid.*, 1983, **30**, 379.
7 *I.S.J.*, 1980, **82**, 199.
8 *Nippon Shokuhin Kogyo Gakkaishi*, 1975, **22**, 78.

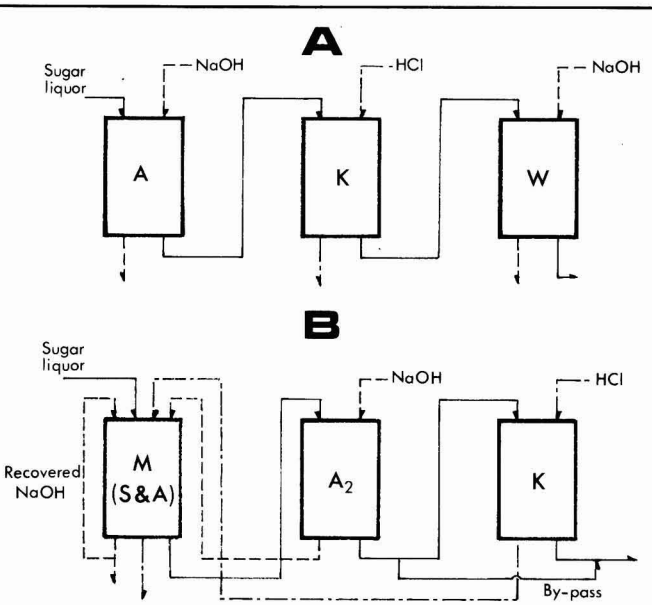


Fig. 1. Flow sheets of the (A) conventional reverse system and (B) improved reverse (MAK) system. Columns A_1, A_2, strongly basic anion exchange resin; columns K, weakly acidic cation exchange resin; column W, weakly basic anion exchange resin; and column M, strongly basic anion exchange resin plus strongly acidic cation exchange resin. By-pass is 1:50 to 1:500

The MAK process

Flow sheets of the conventional and MAK processes are given in Figure 1. In the conventional process, sugar liquor is first admitted to tower (A), filled with a strongly basic anion exchange resin, then to a tower (K) filled with a weakly acidic cation exchange resin, and then to a tower (W) filled with a weakly basic anion exchange resin. A small quantity of colour bodies and anions such as carboxylate, chloride and sulphate are removed from the sugar liquor in tower (A) and cations such as K^+, Ca^{++} and the like are removed in tower (K).

The primary tower (M) in the MAK process contains 6 m^3 of a strongly basic anion exchanger in the OH^- form and 3 m^3 of a strongly acidic cation exchanger in the Na^+ form. The secondary tower (A_2) contains 3 m^3 of the strongly basic anion exchanger in the OH^- form and the final tower (K) contains 3 m^3 of a weakly acidic cation exchanger in the H^+ form. The mixture of resins in tower (M) removes colour bodies and anions and also polyvalent metal cations such as Mg^{++}, Fe^{+++}, Zn^{++}, Ca^{++} and the like which cause contamination of the anion exchange resin. The sugar liquor, after being processed in tower (M), passes to tower (A_2) where anions and colour bodies leaking from the first tower are removed. The liquor then passes to tower (K) where remaining metal cations are removed.

Regeneration in the MAK process

Regenerants should include only monovalent anions because, when they contain divalent or polyvalent anions, divalent metal cations form insoluble salts with these anions which accumulate physically on the resin surfaces, reducing their capacities. Furthermore, divalent anions have a great affinity for strongly basic anion exchange resins so that they hinder conversion of the resins into the OH^- form during regeneration.

Figure 2 shows a regeneration flow sheet for the MAK process. This involves two stages: pre-regeneration and main regeneration. The resin in the third tower (K) is regenerated with a 4-8% aqueous hydrochloric acid solution at 70°C. This gives an effluent comprising sodium chloride containing hydrochloric acid which is used for pre-regeneration of the resin mixture in tower (M). The mixture of NaCl and HCl replaces adsorbed anions with Cl^- and removes them as soluble Na salts. At the same time it replaces cations from the cation exchange resin with Na^+ ions and removes them as soluble chlorides.

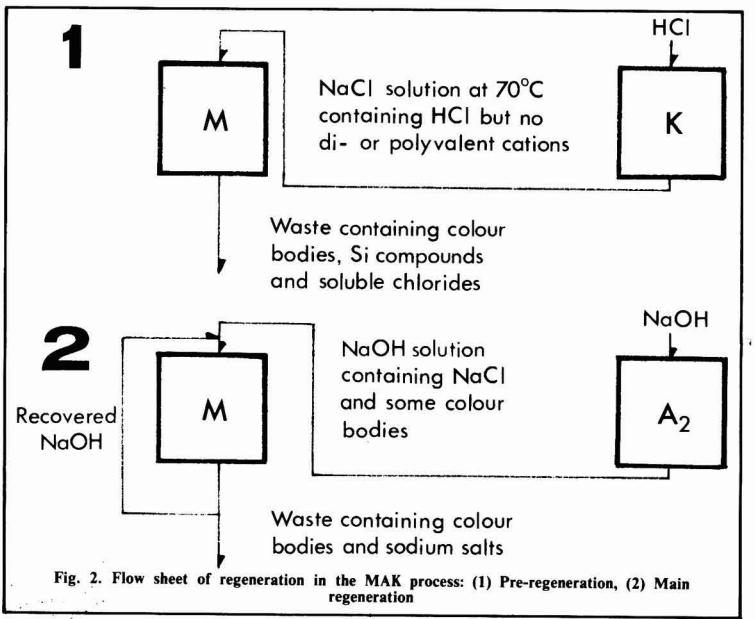


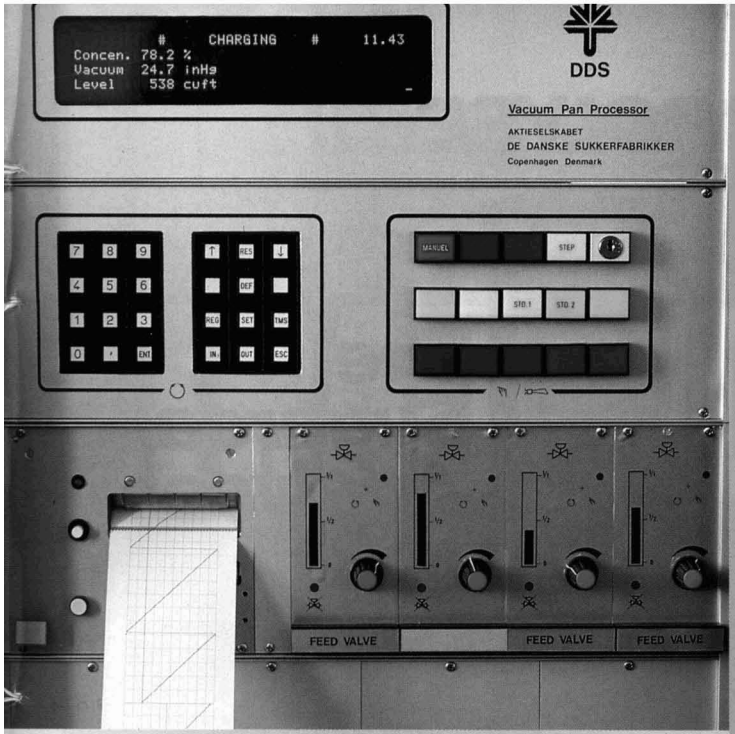
Fig. 2. Flow sheet of regeneration in the MAK process: (1) Pre-regeneration, (2) Main regeneration

The strongly basic anion exchange resin in the tower (A_2) is subjected to treatment with a 4-6% caustic soda solution and the effluent is then used for main regeneration of the tower (M). This main regenerant for the tower (M) resin is supplemented with further NaOH which may be recovered from the effluent and recycled. The treatment converts the anion exchange resin to its OH^- form and the cation exchange resin to its Na^+ form.

The MAK system has solved the problem of fouling of the strongly basic anion exchange resin. By contrast with the conventional refining system, the new process permits treatment of cane sugar liquor without pre-processing with bone char. Economical handling of ion exchange effluent is a deciding factor in determining the ion exchange system to be used in today's sugar refining industry.

Figure 3 shows the long-term variation in capacity of the strongly basic anion exchange resin used in the MAK process, while Figure 4 shows the variation in capacity of this resin in tower (M) after 20 cycles. The influent liquor was brown liquor of 60°Bx, E.C. 250 and 872 RBU colour containing 57 ppm SiO_2.

Since not all commercial weakly acidic cation exchange resins have proved consistently successful in respect of both physical (pressure drop) and chemical (cation leak) properties, it was thought advisable to develop a good quality resin in order to apply the MAK process satisfactorily. It was necessary that the resin should have



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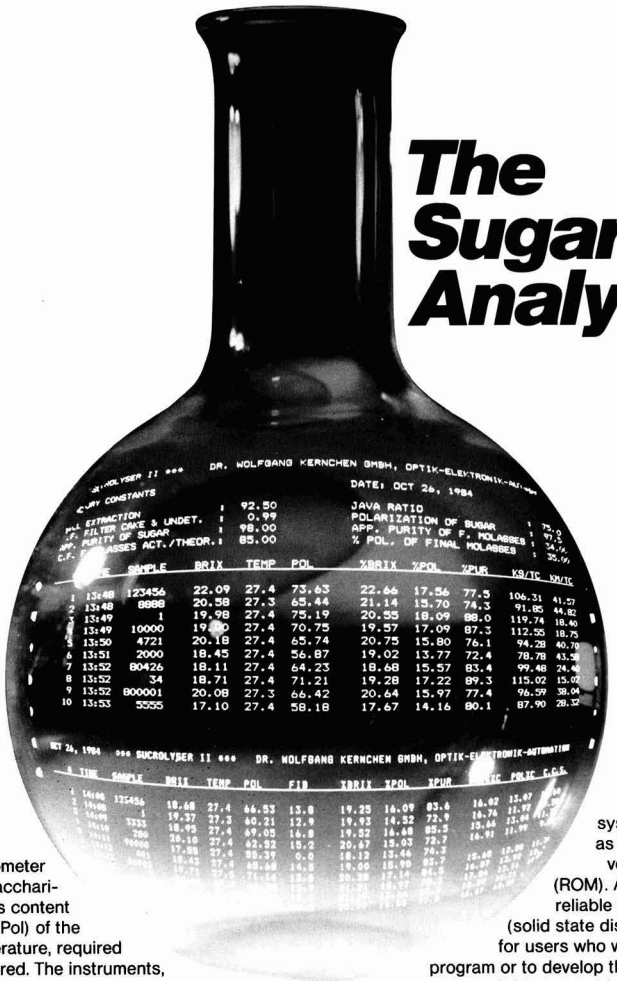

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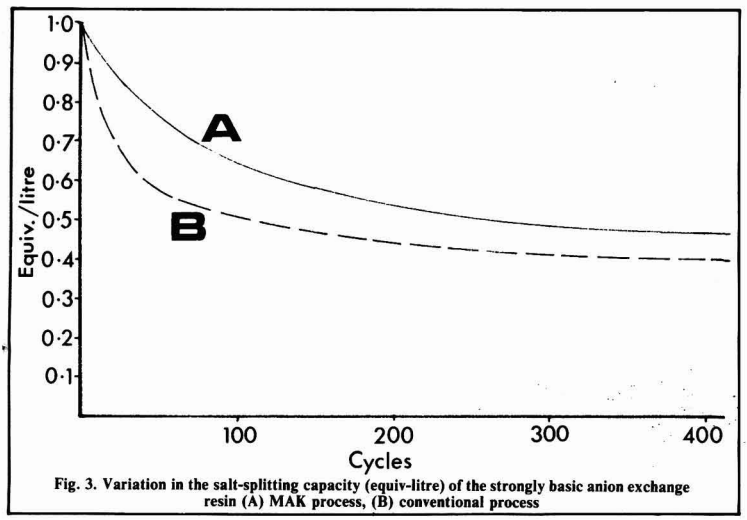

Fig. 3. Variation in the salt-splitting capacity (equiv-litre) of the strongly basic anion exchange resin (A) MAK process, (B) conventional process

high and consistent capacity, and such a resin was developed in collaboration with Mitsubishi Kasei Co. Ltd. in Japan[9]; it is now being manufactured by that company. Fouling of this cation exchange resin in the MAK process has not proved a problem in practice, even though the resin has now been used for more than 1000 cycles.

Sugar loss

In an effort to determine the mutual colorant formation and sugar destruction in liquor in contact with strongly basic anion exchange resin, the actual quantity of sugar destroyed under various conditions was studied using synthetic 50% sucrose solution and two resins (IRA 900 and PA 312) of 0.4 equiv./litre salt-splitting capacity, regenerated with NaOH. The temperatures chosen were 45° and 55°C, flow rates were 2 and 4 S.V., and initial reducing sugars contents were 0.2 and 0.4%. Colouring matter was desorbed from the resin after 20 cycles using NaCl solution and was correlated with reducing sugars loss.

The most important factor in reducing sugars loss was found to be temperature, followed by the level of reducing sugars content in the treated solution, and then the kind of resin. In respect of the amount of colour substance eluted, the resin had the greatest effect, and then the temperature.

In practice we have found that the reducing sugars loss is below 0.05% in normal operating conditions, so that sugar loss in contact with the strongly basic anion exchange resin is insignificant as an effect on yield.

pH adjustment in the MAK process

Previously, it has been difficult to maintain a desired pH in the deionized sugar liquor. In the MAK process, polyvalent cations in the treated liquor are replaced by Na^+ ions in the tower (M) so that the effluent from the tower (A_2) contains only sodium cations and is thus of low buffer capacity.

The pH in the MAK process can be easily adjusted, however; a portion of sugar liquor from the tower (A_2) by-passes the tower (K) and is added to the effluent from the tower (K) (see Fig. 1). The proportion of effluent from tower (A_2) to that from tower (K) is roughly 1 part in 200 in order to provide a normal pH (7.4) in the deionized solution.

Sugar quality

From sugar liquor desalted by the MAK process refined sugars of

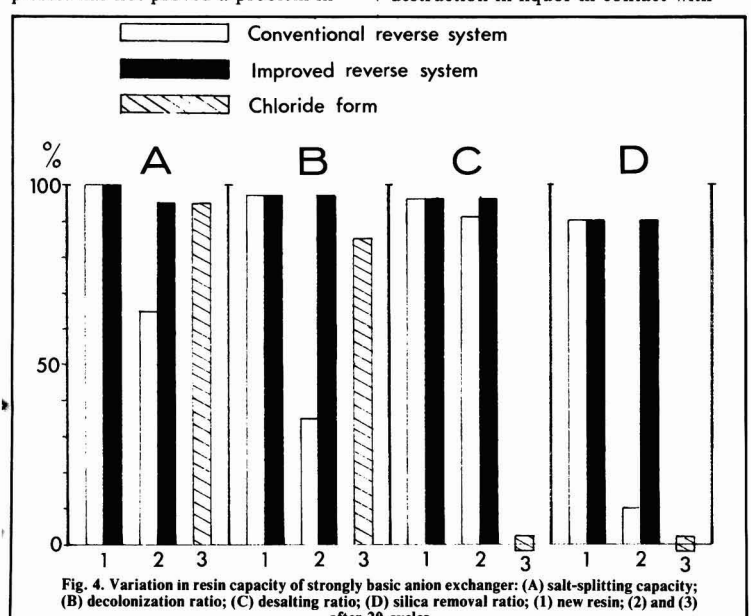

Fig. 4. Variation in resin capacity of strongly basic anion exchanger: (A) salt-splitting capacity; (B) decolonization ratio; (C) desalting ratio; (D) silica removal ratio; (1) new resin; (2) and (3) after 20 cycles

9 Maekawa & Kawasaki: *ibid.*, (In press).

excellent quality have been produced, having high purity, low colour, low ash and an extremely small content of Si compounds (under 1 mg per kg of sugar). Most importantly, they have shown a low colour increase on heating during processing of finished goods and absence of floc formation in beverages.

Industrial results with the MAK process

The C. Itoh sugar refinery process involves mingling and affination of the raw sugar (typically of 1500-8000 RBU colour, 0.3-1.0% ash and 30-200 ppm silica). The affined sugar is melted and carbonatated (giving 500-1000 RBU colour, 0.1-0.25% ash and 10-65% silica), and the liquor treated with granular carbon which reduces colour to 100-200 RBU, while leaving the ash and silica unaffected. Prior to 1980 the liquor was passed through bone char and then an ion exchanger station using the conventional AK process and giving a 50°-55°Bx granulated sugar liquor of 5-15 RBU colour, 0.01% ash and 10-30 ppm silica. Since adoption of the MAK process in 1980, the bone char treatment has been eliminated and a granulated sugar liquor is obtained of 55°-60°Bx, 5-15 RBU colour, 0.01% ash and only 5-10 ppm silica.

The MAK process has simplified the overall refining system; elimination of the most troublesome bone char process has reduced the material and labour cost and decreased the amount of sweet water. Contamination of the strongly basic anion exchange resin has been reduced satisfactorily, while the refined sugar liquor is of consistently good quality. Figure 5 shows the total flow and the most important quality (colour value of the deionized sugar liquor) for cycles governed by using a conductivity of 10 μS/cm in the effluent from tower (K) as a break-point in the actual process in 1980.

The sugar liquor refining capacity of the MAK process is 2.91 times that of the conventional ion exchange process in respect of decolorizing capacity and 1.21 times its desalting capacity as a consequence of preventing contamination of the resins and increasing the efficiency of regeneration, while the concentration of the treated liquor has risen from 54.5% to 58.8% owing to the decrease in sweet water.

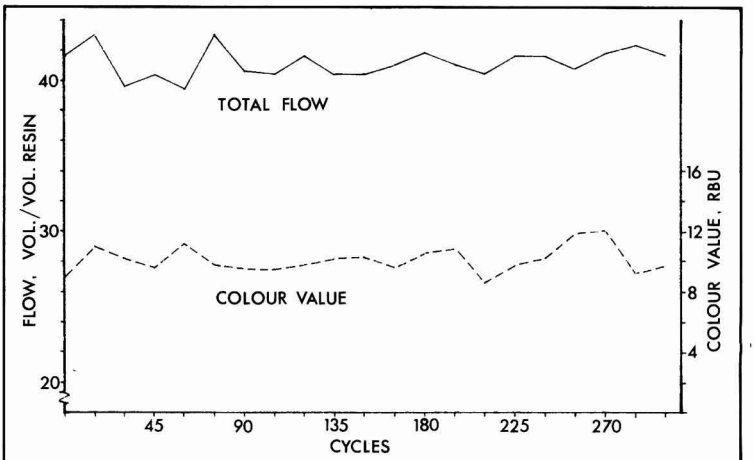

Fig. 5. Total flow and colour of liquor treated by the MAK process

Most of the advantages in industrialization of the MAK process result from shortening of the refining system by omission of the bone char process. However, decreases in materials consumption are obtained, as noted below, although hydrochloric acid consumption is increased by 18.3%. Overall, the unit cost of production is reduced by 13.4%.

Materials	*% Reduction*
Bone char	100
Kieselguhr	67.5
Fuel oil	53.3
Caustic soda	26.7
Steam	8.9
Electric power	14.9
Water	34.5
Waste water	38.5

Acknowledgements

The authors wish to thank Dr. Masahiko Komoto and Dr. Satoshi Fujii, Faculty of Agriculture, Kobe University, for their many valuable suggestions and much encouragement during the course of this work, and the authors take this opportunity to express their thanks to Mr. Manabu Satoh, Mr. Tadashi Saitoh and Mr. Kazuya Nakano, Successive Directors of C. Itoh Sugar Co. Ltd., for their continuing interest and encouragement.

Summary

An improved ion exchange system for refining sugar liquor is described. In this system (the MAK process), fouling of the strongly basic anion exchange resin is reduced, and the process gives not only good quality refined sugar liquor but also a greater quantity per cycle. Adoption of the process by the C. Itoh sugar refinery in Japan has permitted omission of bone char treatment and has reduced unit production cost by 13.4%.

Déminéralisation d'une clairce de raffinerie par un nouveau système d'échange ionique

On décrit un système amélioré d'échange ionique pour le raffinage de clairces de sucre. Dans ce procédé (procédé MAK) l'encrassement de la résine anionique fortement basique est réduit. Le processus fournit non seulement une clairce de sucre raffiné de bonne qualité, mais le volume par cycle s'en trouve aussi augmenté. En adoptant ce procédé, la raffinerie de sucre C. Itoh au Japon a pu abandonner le procédé au noir d'animal et a réduit son coût de production unitaire de 13.5%.

ISJ Abstracts

Cane sugar manufacture

Cooling of final molasses to avoid spontaneous combustion during storage

N. A. Ramaiah. *Proc. 32nd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1982, (1), BG.11-BG.16.

Cooling of cane molasses to prevent spontaneous degradation is discussed, and suitable types of cooler are indicated.

Studies on the treatment of waste water from a sugar factory

P. K. Goel and S. G. Jadhav. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), M.3-M.11.

Analysis of factory effluent treated by lagooning showed that the process was of low efficiency, reducing the suspended organic matter by only 20% and providing only slight falls in the nitrogen, phosphorus and chloride contents.

Further analysis of undiluted juice lost in bagasse

A. R. Sali. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), M.21-M.24.

See *I.S.J.,* 1984, **86,** 35A.

Analysis of low sugar recovery in Andhra Pradesh during the 1981/82 season

J. Chougule and B. R. Patil. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), M.25-M.32.

The performance data of 20 sugar factories are compared for 1980/81 and 1981/82, and reasons are suggested for the state's lower average recovery in the latter season.

Evaluating the benefits of Busan 881 as a sanitation aid for cane sugar mills

M. L. Pulido. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), M.34-M.48.

A procedure for evaluating the benefits of Busan 881 as a means of controlling bacterial degradation and inversion in mill juice is outlined and details are given of the modified Lane & Eynon method of invert sugar determination as well as of a method for calculating mill inversion losses. (See also Pulido: *I.S.J.,* 1975, **77,** 279.)

Steam economy in a sugar factory

J. D. Wabale. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.1-E.6.

The savings in steam made possible by lagging, correct handling of condensate and use of a quintuple-effect instead of a quadruple-effect evaporator are discussed. Adoption of a quintuple-effect evaporation scheme at the author's factory permitted a 200 tcd increase in crushing rate at the same boiler capacity.

Mill work and imbibition efficiency at individual mills

P. K. More. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.7-E.21.

See *I.S.J.,* 1984, **86,** 185.

The vapour cell—some salient aspects about design and operation

S. K. Ghosh. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.23-E.34.

Aspects of a vapour cell discussed include its capacity and utilization, particularly to provide vapour for pan boiling; size; fouling of the heating surface; steam- and juice-side film resistance to heat flow; the effect of juice velocity; the advantage of juice pre-heating; benefits of long-tube evaporators and of elevated steam pressures; vapour space pressure and sucrose inversion; and juice retention time.

Milling system 2001—a concept of the future mill

M. Anand. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.35-E.45.

See *I.S.J.,* 1984, **86,** 34A.

A dynamic balancing test for components in sugar factories

V. V. Phaduis. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.47-E.61.

Testing the balance of rotary components such as centrifugal baskets, fans, shafts of cane preparation equipment and levellers, and turbine rotors is discussed, and types of imbalance and their effects indicated.

Pressure feeding by inter-carriers

T. M. Karne. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.63-E.74.

Examples of modifications to intermediate carriers at three sugar factories (two in India and one in Kenya) are described; the alterations were made in order to improve bagasse feeding. Details are also given of a patented vertical bagasse conveyor.

Efficient usage of steam in a sugar factory

R. D. Joshi, N. S. Bhate and M. K. Vaidya. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.75-E.87.

In a discussion of steam generation and utilization, the role played by the evaporation scheme is examined as well as the use of vapour bleed for juice and pan heating. Four case studies are cited.

Auto-tracking for feed rate control

M. Wagle. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.89-E.92.

Maintenance of a constant crushing

rate with variation in cane input is briefly discussed, and the benefit of a cane carrier speed control as a function of the thickness of the cane blanket is indicated.

Performance of the fiberizer at Godavari Manar S.S.K.Ltd., Shankarnagar, Taluka Biloli, District Nanded (M.S.)

S. K. Chattarjee and S. A. Banikar. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.93-E.96.

The performance of the shredder at the authors' sugar factory is reported.

The cumulative benefits of surface treatment of mill rolls

N. Maier. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India),* 1983, (1), E.97-E.104.

See *I.S.J.,* 1983, **85,** 23.

A computer program for sugar cane milling and performance evaluation

L. B. Fox. *Sugar y Azúcar,* 1984, **79,** (7), 34-35.

An outline is given of a program devised for use in an Epson HX-20 portable computer and divided into four categories: milling parameters, power parameters, extraction parameters and raw sugar house standards. The inputs in each category are indicated together with the appropriate tasks.

Vertical continuous crystallizer — Victoria mill

W. J. Keast and N. J. Sichter. *Sugar J.,* 1984, **47,** (2), 9-12.

See *I.S.J.,* 1985, **87,** 36A.

Solar energy for corrosion control in idle boilers

R. Hebert. *Sugar J.,* 1984, **47,** (2), 16-17.

A description is given of the system used at St. Martin Sugar Cooperative to keep the temperature in the two 1500-hp boilers above dew point during the off-season. Solar collectors of a total area of approx. 320 square feet (312 sq. ft was the amount found to be necessary to provide about 70% of the required heat) were installed on the roof; heat was carried by silicone fluid and transferred to water in a heat exchanger, from which the water flowed to a 800-gal pressurized vessel. A hydronic coil and fan with thermostat were placed in each boiler; the thermostat indicated the need for heat and transmitted a signal to the heat distribution module, which opened a valve in the water storage vessel and turned on both water pump and heater fan. When the water temperature fell too low to provide sufficient heat, a sensor in the vessel signalled the heat distribution module, and the water was then circulated through a gas-fired heater to the coils in the boilers. It was found that the boilers had to be as airtight as possible. Advantages of the scheme are listed. The only major disadvantage is the capital investment required.

Modern trends in milling

G. K. Chetty. *Maharashtra Sugar,* 1984, **9,** (8), 43-45, 47, 49, 50-53.

A survey is presented (with 69 references to the literature) of modern developments in cane mills and ancillary equipment, and mention is made of bagasse pol determination.

Energy conservation in a 2000 tcd sugar mill

H. M. Wadhwani and K. K. Johri. *Maharashtra Sugar,* 1984, **9,** (8), 55-58, 61-63, 65.

Possible means of reducing energy consumption are examined, including the use of high-pressure boilers, slip-ring motors as cane mill drives, a turbo-set for power generation, mechanical vapour recompression, and heat recovery from sulphur burners. Four evaporator schemes are compared and their relative merits discussed.

The performance of individual mills

P. K. More. *Maharashtra Sugar,* 1984, **9,** (9), 25, 27, 29, 31-32.

The author discusses the merits of pol retention % fibre in bagasse as an indicator of cane mill performance, and describes a procedure for calculating it.

An efficient and stable steam reducing and desuperheating station

K. S. Shah and K. S. Mokha. *Maharashtra Sugar,* 1984, **9,** (10), 75-76.

A brief description is given of a fully automatic steam reducing and desuperheating station installed at Harinagar sugar factory.

The Texas freeze

N. Rozeff. *Sugar J.,* 1984, **47,** (3), 19.

A brief account is given of the adverse effects of a 5-day frost, during which the cane was exposed to 88.5 hours of temperatures at or below freezing. Apart from a substantial drop in pol and purity, there was a considerable rise in fibre content (as a consequence of marked dehydration) and hence the need for frequent replacement of harvester chopper blades. The high juice acidity created corrosion problems in the factory, while efforts to increase the pH with alkaline additives increased evaporator and vacuum pan scaling. Molasses production was so high that extra storage facilities had to be created. It is calculated that 44.4% of the estimated sugar was lost and 15% of the cane tonnage.

Electronic instrumentation systems

W. Keenliside. *Sugar Bull.,* 1984, **62,** (23), 10-11.

Advantages of electronic over

pneumatic control systems in the sugar factory are discussed; they include greater availability of controllers and sensors, lower costs and greater reliability of sensors, ability to site sensors and controllers at great distances (with pneumatic systems, the maximum distance between elements in a control loop is greatly restricted by pressure losses in the signal lines), ready adaptability to centralized control, and greater flexibility of control options as well as the ability to store information. Other factors that have contributed to the greater use of electronic systems are the reduction in size of components, improved reliability, lower costs and the use of such low voltages in digital systems that there is no longer high risk of explosions from electrical sources. However, it is stressed that it is still necessary to provide pneumatic signals to most final control elements such as valves, since advances in electronic control valves have been less rapid than with controllers. On the other hand, the availability of relatively low-cost electronic-to-pneumatic converters reduces the seriousness of the problem.

"HiGrading"

W. Gibson. *Ann. Rpt. Expt. Sta. Hawaiian Sugar Planters' Assoc.*, 1983, 58.

"HiGrading" is defined as preferential loading of the clean upper portion of windrowed cane which then bypasses the wet cleaner, while the rest of the windrowed cane lying on the ground (the "LoGrade" portion) is sent to the wet cleaner. A study was made in cooperation with Hilo Coast Processing Co. (HCPC) of the potential reduction in sugar losses made possible by the method, by comparison with conventional loading and wet cleaning. Samples were taken of conventionally handled cane that had been cleaned, of LoGrade cane after wet cleaning and of HiGrade cane after simulated dry cleaning; they were separated into sound and damaged portions, weighed, chopped and sub-sampled. The chopped samples were analysed for pol and fibre, and the % pol loss calculated. Preliminary results showed that 50% of the HCPC field cane could be treated as HiGrade which, on the basis of the sugar losses found, would give an annual saving of approx. $1.8 million. A cane dry cleaner and additional factory equipment to handle the increased mud load would be required.

Juice recycling test at the Haina factory

K. Onna. *Ann. Rpt. Expt. Sta. Hawaiian Sugar Planters' Assoc.*, 1983, 60-61.

While increasing the amount of imbibition water (within limits) improves mixing of cane and liquid and increases extraction, it also raises the costs of evaporation; however, the amount of liquid added at each mill can be increased without raising the quantity of water by recycling some of the juice from each mill to the blanket entering the mill. The extent of juice recycling is limited by the degree of feed wetness that the mill can handle. Mills equipped with heavy-duty feeding systems are more suitable for imbibition recycling than conventional mills with light-duty or no feeders. Tests at Haina were conducted over a 3-month period; in each test, the streams around the 3rd and 4th mills in the tandem of four 5-roll mills were analysed for pol, refractometric Brix, fibre and moisture after a diverter had been installed at the 3rd mill to allow juice recycling from the two pressure-feed rolls. Results showed that recycling increased extraction from 37.4% to 42.1% at the 3rd mill; however, since this increase left less pol and, moreover, pol that was more difficult to extract, extraction at the 4th mill fell by 2 units, so that the overall net gain was 1.4 units, corresponding to an approximate 0.2 unit increase for the entire tandem. It is considered that this overall increase would have been higher had the initial extraction been lower than 96%. Resetting of the rolls in the 4th mill might help to improve on the results, it is suggested.

Cane preparation and extraction at the Haina factory

K. Onna. *Ann. Rpt. Expt. Sta. Hawaiian Sugar Planters' Assoc.*, 1983, 61-62.

Tests carried out to measure the Displaceability (Preparation) Index of cane that had passed through a set of rotary knives and a Ducasse shredder and to determine the extraction performance of each of the four mills and of the entire tandem at Haina showed that, despite the extraction of 96% (considered good), the Displaceability Index was low at 75.7. It is considered that better preparation would increase the 1st mill performance and, hence, that of the tandem. Replacement of the shredder with one of a different type is being considered in order to achieve a higher level of cell rupture.

Evaluation of crystallizers for commercial strikes

T. Moritsugu and B. J. Somers. *Ann. Rpt. Expt. Sta. Hawaiian Sugar Planters' Assoc.*, 1983, 64-65.

Studies of *A*- and *B*-massecuite cooling in air-cooled crystallizers provided with solid coils rotating at $\frac{1}{3}$ rpm showed that 1 hour's curing gave a molasses purity drop of 0.5 for *A*-massecuite and of 1.6 and 2.1 for two *B*-massecuites; $1\frac{1}{2}$ hours' curing gave a 2.8 units drop in molasses purity with another *B*-massecuite, while 2 hours' treatment gave purity drops of 2.0 and 2.1 for an *A*- and a *B*-massecuite, respectively. Temperature drop was negligible in all cases with one exception, where there was even a temperature rise. The massecuites had Brix values of 92.0-92.5° (*A*-massecuites) and of 93.5-94.0° (*B*-massecuites) at dropping, and the saturation temperatures corresponding to these high values were considered sufficiently high to provide the driving force needed for a significant amount of crystallization.

Beet sugar manufacture

Effect of *C*-massecuite viscosity on its mixing, heat exchange, conveying and centrifugalling

K. Wagnerowski. *Gaz. Cukr.*, 1984, **92**, 53-60 (*Polish*).

The effect of low-grade massecuite viscosity on cooling, flow and curing is discussed on the basis of work carried out by a number of authors including that of the present article. Equations and nomograms are presented which define the various correlations of importance for optimum crystallization and maximum exhaustion. While excessive viscosity can be reduced by decreasing the massecuite crystal content or by dilution with water, both methods must be regarded with some reservation. Conventional crystallizers provided with moving elements do not easily adapt to the viscosity of the cooling massecuite and should operate at a low rotary speed, e.g. 0.4 rpm, rather than the massecuite be excessively diluted to the detriment of crystallization. Automatic control of the rotary speed as a function of viscosity would be of advantage. Pre-curing in centrifugals can play an important role where the crystal content is reduced as a means of decreasing viscosity. A reduction in crystal content from 42% to 38% reduces the viscosity of the final massecuite by some 40%, while the cooling time is increased by only 9%. Where improvement in crystallizer design is not possible, dilution with well-deaerated molasses (to avoid foaming) could be of benefit, as suggested by McGinnis[1]. Where the massecuite is reheated before curing, the supersaturation should be taken to about 1.05 in the case of high-speed, continuous centrifugals, and to approx. 1.0 in the case of traditional machines such as the Weston design.

The effect of sampling equipment and of sample washing on beet acceptance at the sugar factory

L. Rigo. *Le Betteravier*, 1984, **18**, (189), 6-9 (*French*).

A short survey is presented of methods and equipment used for beet sampling and sample washing, and their performances are assessed. Manual sampling (possibly with a fork) is used in West Germany and Austria and causes little damage to the sample, but is only applicable where the beet sugar content is the sole parameter to be determined. In Denmark and Sweden, a narrow pan is used to take samples during unloading; in Belgium and Holland, an articulated arm or small trolley removes samples from the beets on their way to the storage pile. Although these methods cause little harm to the beets, they may not give sufficiently representative samples (a question not discussed in the article). The Rüpro and Cocksedge samplers have a square- and a circular-sectioned probe, respectively; the Cocksedge unit can be provided with a special shutter system that allows an entire column of beets to be extracted plus the dirt on the floor of the vehicle. Both systems cause damage to the beets as they enter the load, the Rüpro being worse in terms of material loss because of its square section. Washers may have horizontal or vertical axles; the former include two continuous units (a single- and a multi-sample type) as well as the Cocksedge multi-stage, batch washer, while the vertical-axle washers are represented by a French and an Italian unit in both of which a rotating plate with undulating surface moves the sample around in a circular tank while spray jets continuously play on the beet (the Italian unit also being provided with brushes). The vertical-axle washers cause more damage to the beets than those with horizontal axles, of which the multi-sample continuous type causes least injury, while the other two are almost equal in terms of damage caused, but in both cases the losses could be reduced by narrowing the gap between the screen baskets. The effects of the sampling and washing on the measured pol have been examined for each type of equipment, and a number of conclusions drawn and recommendations made whereby damage and material loss can be reduced and a more accurate assessment made of the delivered sugar content.

Trial on preparation and dosing of 2nd carbonatation mud to preliming

A. N. Kovtun *et al. Sakhar. Prom.*, 1984, (9), 18-21 (*Russian*).

Laboratory and factory trials showed that addition of a 0.1% polyacrylamide solution (0.0001-0.0002% on beet) before settling gave a considerable increase in the settling rate of 2nd carbonatation juice and a clearer juice. Recycling of the mud to preliming had no adverse effect on juice properties (including those of evaporator thick juice) by comparison with recycled mud containing no flocculant, while the 1st carbonatation juice clarity after settling improved. Optimum recycled mud density as regards pumping and dosing was 1.15-1.16 g/cm^3.

Degradation of betaine and its effect on the colour of sugar solutions

L. D. Bobrovnik *et al. Sakhar. Prom.*, 1984, (9), 23-26 (*Russian*).

In investigations involving model solutions of betaine, decomposition and colour formation were observed after prolonged heating at 100-110°C and a pH >9. A shift in the absorption maximum was evidence of formation of colouring matter. Studies at Yagotin experimental sugar factory over two campaigns showed that the betaine content gradually fell and colouring matter increased with processing from diffusion onwards, the fall being particularly noticeable after carbonatation and evaporation.

Greater attention to selection and correct use of beet pumps

1 *I.S.J.*, 1977, **79**, 219.

G. I. Podvorchanyi and S. F. Timoshenko. *Sakhar. Prom.*, 1984, (9), 27-29 (*Russian*).

Guidance is offered on selection of suitable centrifugal pumps for beet lifting to the washer and adjustment of impeller speed to meet beet delivery requirements at minimum damage to the beets and minimum power consumption.

An automatic unit for counting the finished product

V. V. Kusyak. *Sakhar. Prom.*, 1984, (9), 34-36 (*Russian*).

Details and circuit diagrams are given of an automatic counter for 50-kg sacks of sugar as they pass along the belt conveyors from the sealing machines.

Measurement of pressure drop on the column screens and prescalder of KDA tower diffusers

V. I. Filonenko and V. A. Kovalenko. *Sakhar. Prom.*, 1984, (9), 37 (*Russian*).

A vertical tube connected to a juice sampling cock a short distance above the bottom screens in a tower diffuser and a vertical tube connected to the juice draw-off pipe contain pitot tubes linked to a differential manometer and an indicator on the operator console. In the event of a screen blockage, a pressure drop is registered and water is injected to clear the screens.

A more logical approach to ion exchange sugar technology in the sugar industry

G. Rousseau and X. Lancrenon. *Sugar y Azúcar*, 1984, **79**, (7), 25, 27, 29, 31.

See *I.S.J.*, 1984, **86**, 26A.

A 100 m³ lime kiln

D. Lingerova, I. Varanvek and B. Hart. *Listy Cukr.*, 1984, **100**, 203-210 (*Czech*).

The performance of a lime kiln of 100 m³ rated capacity was assessed in tests in 1982 at Vrdy sugar factory of 1130 tonnes/day nominal beet slice. The results are discussed.

Processing deteriorated beet

R. Stengl and M. Friml. *Listy Cukr.*, 1984, **100**, 210-212 (*Czech*).

The causes and progress of physiological processes taking place in deteriorated beet are indicated, and recommendations made on the handling and treatment of such beet in the factory yard (particularly spraying storage piles with milk-of-lime and disinfectant) and in processing.

Automatic valves

T. Benes. *Hellenic Sugar Ind. Quarterly Bull.*, 1983, (54/55), 15-34 (*Greek*).

A survey is presented of automatic valves and advice given on their selection for use in sugar factory systems for boiler feed water, juice and fresh water, boiler oil fuel and steam throttling. Types covered include single- and double-seat, butterfly, ball and diaphragm valves. Required conditions under which the valves are to operate are given for each task.

Continuous low-grade crystallization at Souppes-sur-Loing sugar factory and distillery. New developments

P. de Bodard and P. Credoz. *Ind. Alim. Agric.*, 1984, **101**, 615-621 (*French*).

An account is given of the continuous low-grade boiling scheme involving a Fives-Cail Babcock pan for which the magma feed is prepared in a batch pan from sugar dust occurring in the granulator section and from affination syrup containing sugar mostly emanating as a damaged crystals from centrifugals preceding affination. The continuous cooling system comprises eight small horizontal crystallizers and two vertical units, while the low-grade centrifugals consist of four FC 1000 continuous machines and three STZ8 continuous affination centrifugals. Comparisons with the earlier scheme involving continuous boiling on a footing prepared in a batch pan showed a higher hourly throughput with the new scheme but almost identical composition of the massecuites when dropped from the pan. There was a saving of 0.075-0.100 tonnes of steam/hr resulting from the absence of massecuite dilution in crystallization but a rise (<1 unit) in molasses purity in the centrifugal station.

Experimental study of moisture limits in crystal sugar

S. Sormova, O. Mikus and V. Kavan. *Ind. Alim. Agric.*, 1984, **101**, 623-627 (*French*).

See *I.S.J.*, 1984, **86**, 89.

Beet delivery data gathering. A new computer-based system at Schleswig-Holsteinische Zucker-AG

M. Gregersen and G. Scholze. *Ind. Alim. Agric.*, 1984, **101**, 628-629 (*French*).

See *I.S.J.*, 1984, **86**, 40A.

Permanent heat balance for sugar factory stations

B. Bonnenfant, D. Bourée and D. Vigneurt. *Ind. Alim. Agric.*, 1984, **101**, 641-644 (*French*).

Since 1965, factories of the Groupement Technique de Sucreries (GTS) have carried out weekly heat balances, independent of an evaporator balance, for analysis of heat consumption at each process station. However, more frequent balances are considered of benefit, and details are given of computerized systems installed at Aulnois, Marle and Souppes sugar factories for data collection, processing, depicting either as screen graphs or as print-out tables, and storage. Capital costs of the systems are given; at Aulnois, an energy saving of some 5% has been achieved after two years' operation of the scheme.

Results of first carbonatation juice filtration on an automatic filter-press

M. André. *Ind. Alim. Agric.*, 1984, **101**, 653-654 (*French*).

Choquenet automatic filter-presses were operated at two sugar factories during the 1983/84 campaign in parallel with existing filter-presses; they were used to treat mud from a Dorr clarifier at one plant and mud from Grand-Pont filters at the other. Results indicated the advantages of the filter-presses over the mechanical filters in terms of increased cake solids and hourly throughput, and reduced amounts of sweetening-off water and filter cake losses. Mention is made of conversion of a Choquenet mechanical filter-press to an automatic unit.

Beet price as a function of its quality: operation of an automatic system

J. P. Vaidherbe. *Ind. Alim. Agric.*, 1984, **101**, 657, 659, 661 (*French*).

Information is given on Philips Science & Industrie automatic beet data handling systems such as installed at various French sugar factories for beet payment and chemical control purposes.

Energy from coal in sugar factories. A strategic choice

Anon. *Ind. Alim. Agric.*, 1984, **101**, 663-664 (*French*).

Reference is made to the adoption of coal as fuel instead of oil by French sugar factories since 1981. By mid-1984, more than 300,000 tonnes of coal were being consumed annually by the sugar industry. At Guignicourt, an annual saving of 10 million francs is being made by comparison with the previous burning of oil, and energy costs have fallen from 12% to 6% of the total production costs.

Effect of lime slaking conditions on lime utilization efficiency and on milk-of-lime reactivity as a function of lime quality

H. I. Cengiz. *Seker*, 1984, **17**, (115), 1-7 (*Turkish*).

Milk-of-lime reactivity, expressed as $Ca(OH)_2$ solubility in water, was determined for limestone of known physical and chemical properties calcined at temperatures of 900-1300°C at 100° intervals, slaked at temperatures of 18° and 60°C and at dilutions of 3-10:1. Results demonstrated the fall in reactivity with increase in calcination temperature and in dilution, and increase in reactivity with rise in slaking temperature; the amount of utilizable CaO can be increased by maintaining an optimum calcination temperature (according to limestone quality) or by minimizing dilution, particularly in the case of limestone over-burning.

Beet diffusion plant

E. Straube. *Sugar y Azúcar*, 1984, **79**, (8), 55, 57, 59-61.

The fundamentals of beet diffusion are outlined, and factors such as cossettes load and size and juice draft briefly discussed. Brief mention is made of the battery diffuser and of continuous diffusers, and details are given of the sequence of operations that take place in a Buckau-Wolf tower diffuser.

Technical changes in some European sugar-producing countries

L. Rosenberg. *Cukoripar*, 1984, **37**, 91-94 *(Hungarian)*.

See *I.S.J.*, 1984, **86**, 27A.

Investigation of anti-foam agents reducing surface tension under laboratory and industrial conditions

M. Tömördi and L. Németh. *Cukoripar*, 1984, **37**, 108-116 (*Hungarian*).

The literature on the effectiveness of anti-foam agents is surveyed (28 references), and results for tower diffusers and the raw juice from them are given in graph form.

Possible ways of saving energy in the sugar factory

P. Wertán. *Cukoripar*, 1984, **37**, 117-120 (*Hungarian*).

Modifications to the pulp pressing process whereby energy usage can be reduced are discussed with references to work conducted in France and particularly West Germany.

The state of mechanization of loading/unloading and transporting/storage operations in the beet sugar industry

R. K. Kazimirov, V. S. Yatsenko and N. A. Emel'yanov. *Pishch. Prom.*, 1983, **29**, 5-8 (*Russian*).

The degree of mechanization of the title operations in Soviet sugar factories in three size categories (daily beet slices of 2000, 2000-3000 and 3000-6000 tonnes) is discussed with the aid of tabulated data.

Zonal processes in diffusion in a trough-type diffuser

R. Wiśniowski. *Gaz. Cukr.*, 1984, **92**, 84-85 (*Polish*).

The diffusion process is divided into three major zones: plasmolysis (de-naturing) of the cossettes, degassing and juice extraction; two zones of lesser importance are the screen and final (exhausted cossettes) zones. While each stage of the overall process affects the properties of the beet tissue, of decisive importance is the movement of the cossettes. Reference is made to modifications to the scroll components so as to improve flow, including replacement of the solid flights with perforated ones. However, the author considers such modifications unnecessary and indeed ineffective, and is of the opinion that the standard diffuser can operate with regular material flow throughout an entire campaign.

Sugar refining

The effect of some factors on steam and lime consumption in the processing of cane raw sugar

L. I. Pankin, V. M. Leshchenko and A. R. Sapronov. *Sakhar. Prom.*, 1984, (8), 36-41 (*Russian*).

Investigations of remelt liquor carbonatation are reported. In conventional treatment of cane raw sugar, up to 80% of *A*-massecuite 1st run-off is included in the remelt liquor, and preliminary tests showed that the amount of water to be evaporated in the boiling house as well as the lime consumption in carbonatation rose sharply with the amount of run-off recycled. In a modified scheme, part of the raw sugar was melted in sweet-water to which half of the total quantity of milk-of-lime was added to give an alkalinity of 4-6% CaO. After carbonatation, the liquor was mixed with remelt liquor made up of the rest of the raw sugar, a minute quanitity of *A*-massecuite run-off and 30% of the total milk-of-lime; after retention for an unspecified time in the liming vessel, the combined liquor was heated, carbonatated, the rest of the milk-of-lime added and the pH adjusted to 9 in a final carbonatation. By comparison with the conventional process, the new scheme increased CO_2 utilization, liquor decolorization and Brix while reducing steam consumption, white sugar colour and molasses purity. By reducing the *A*-massecuite purity, the amounts of *B*- and *C*-massecuite were reduced, but the final sugar quality suffered, so that the original purity of approx. 90 was subsequently used.

Rationalization of cane raw sugar refining

R. Stengl, J. Gebler, M. Friml, V. Valter and J. Janich. *Listy Cukr.*, 1984, **100**, 184-188 (*Czech*).

Investigations were conducted on the quality of cane raw sugar imported by Czechoslovakia for refining in 1972/82 and on modifications to boiling schemes that would bring about an improvement in the refined sugar. A description is given of cane raw sugar refining in the USSR, and details are presented of the boiling schemes used at three Czechoslovakian factories in cane sugar refining. A modified 6-boiling scheme involving 3 white sugar massecuites and 3 recovery massecuites is described, and results achieved in 1983 are reported; these showed the improvement achieved by comparison with 1982 in terms of reduction in molasses sugar and total losses and increase in sugar yield. Results are also briefly discussed of recycling of up to half of the final white sugar run-off to carbonatation together with raw sugar melt; this reduced molasses sugar without affecting sugar quality.

Efficiency considerations in the use of process steam

B. L. Karren. *Sugar J.*, 1984, **47**, (2), 13-15.

In a discussion of the possibility of reducing process steam consumption in a cane sugar refinery, comparison is made with beet sugar factory steam usage and the much higher evaporation efficiency. The ratio of steam to electricity consumption is considered in relation to turbo-generator operation and exhaust steam usage. Two possible solutions are examined: reduction in electricity consumption to more than balance the reduction in steam consumption (if more power is produced than is consumed, exhaust steam may have to be blown off), and the purchase of electricity when the process steam requirement is less than the amount of exhaust from the turbine (purchased electricity being much cheaper than that generated without full utilization of the exhaust steam). While the cane sugar refinery has far fewer uses for waste heat than a beet sugar factory, one major use is in the preheating of process and boiler feed water. Other measures include evaporator feed preheating, recovery of heat from evaporator condensates and expansion of evaporators (many still consisting of only two effects). A case study is described in which a thin-film evaporator effect is added to two effects and the overall steam consumption reduced by approximately 60%.

An update on energy conservation

G. Eng. *Sugar J.*, 1984, **47**, (2), 17.

The question of dual burning capabilities as a means of reducing fuel costs is discussed, with particular reference to oil and natural gas. It is stressed that the cost of switching from one fuel to the other is not always dictated by the cost per Btu of fuel; the burner efficiency of a kieselguhr kiln at the Baltimore refinery of Amstar Corporation is so much higher when gas is used as fuel that the unit rarely burns oil despite its relative cheapness, while control of the oil burners on char kilns is such that it is environmentally advantageous to start up on gas even when oil is the cheaper fuel. However, the chief tool for energy conservation is considered to be the energy unit—increases in process stream densitites and reductions in solids recirculation over the last 10 years have been more a result of energy audits than of process or equipment changes. These audits are based on computerized weekly and monthly reports of energy consumption per lb of melt; the data are monitored at refinery and division level and compared with the 1972 reference point, with an annually set goal and with the performance over the 12 months to the date in question for evaluation of the trends. The proper operation and maintenance of steam traps holds the potential for significant energy savings; a program was recently initiated to identify, tabulate and inspect every steam trap in the four Amstar refineries.

Laboratory studies

The use of soot for treatment of sugar solutions by adsorption

Yu. I. Sidorenko, A. A. Slavyanskii, A. R. Sapronov, V. M. Svirgun and N. V. Kovaleva. *Sakhar. Prom.*, 1984, (8), 34-36 (*Russian*).

Tests are reported on decolorization of sugar solution by contact with various types of soot, 1 g of which was mixed with 100 ml solution for 15 minutes at 80°C; the solution had a Brix of 5.2° and an optical density of 8.3 at 400 nm. An acetylene soot had a decolorizing efficiency of 86% compared with only 11% for lamp-black. Comparison between the acetylene soot and Carboraffin powdered carbon showed little difference in their fractional composition, but the soot proved more effective in lime salts removal from a 10°Bx sugar solution containing 0.065% CaO (45% removal compared with 25%).

Determination of phosphates in sugar cane juice in sugar and alcohol industries

A. A. Delgado, M. A. A. Cesar, L. J. Ferreira and J. A. Michelon. *STAB*, 1984, **2**, (5), 31-34 (*Portuguese*).

The molybdenum method for determination of phosphate in cane juice involves the use of reducing agents to produce the blue colour which is measured and from which the phosphate content is calculated. A series of experiments were made to compare difference reducing agents—stannous chloride, ascorbic acid and "elon"; the results showed that any of these was suitable for the method.

High performance liquid chromatography in the analysis of sugars—a preliminary study

M. T. M. R. Borges, S. E. Ferrari and A. C. Sturion. *STAB*, 1984, **2**, (5), 38, 40-42 (*Portuguese*).

Three samples of cane juice were analysed by HPLC and by traditional methods of analysis (for pol, reducing sugars and total reducing sugars by the Lane & Eynon method). The results by HPLC were obtained rapidly but were not very different from those given by traditional methods which are much cheaper and quite suited to routine analysis. Cane juice contains little in the way of interfering substances, however, and molasses could well have given greater differences.

The kinetic growth of single and twin sucrose crystals

G. Mantovani, G. Vaccari, G. Sgualdino, C. A. Accorsi, D. Aquilano, M. Franchini-Angela and M. Rubbio. *Gaz. Cukr.*, 1984, **92**, 49-52 (*Polish*).

See *I.S.J.*, 1983, **85**, 381.

Determination of colouring matter concentration in products of sugar manufacture

M. García F. and I. F. Bugaenko. *Sakhar. Prom.*, 1984, (9), 21-23 (*Russian*).

The optical density D of a solution of colouring matter is given by KCl, where $K = 1000\ \varepsilon / M$, ε = molar adsorption index (mole/cm/litre), M = molecular weight of the colorants, C = concentration (mole/litre) and l = thickness of solution layer (cm). An ion exchange method for colorants separation from a molasses solution is described, and adsorption spectra are reproduced. The concentration of colouring matter was established for raw and white sugar and beet and cane molasses by calculation coupled with measurement of the optical density. Values are tabulated.

Sugar crystal hardness

J. Gebler and J. Bauer. *Listy Cukr.*, 1984, **100**, 197-203 (*Czech*).

After a general discussion of crystal hardness and its association with deformation, the authors describe methods of determining hardness, and then discuss the subject in regard to the sucrose crystal. Of the methods described, that of Vickers using a microsclerometer using a diamond tip was chosen. Preliminary studies showed that the surface hardness and scatter of the measured values were inversely related to the dimensions of a given face; subsequent investigations concentrated on the $\bar{1}00$ face, for which the measurement error was smallest. Results showed that the relationship between hardness and crystal dimensions was valid for a lineal size of 0.4-2.00 mm at a moisture content of approx. 0.01%.

High-performance liquid chromatography of sugars

J. Copikova, H. Hanzlova and S. Vozka. *Prumysl Potravin*, 1983, **34**, (5), 243-246; through *Food Sci. Tech. Abs.*, 1984, **16**, (7), 7A555.

A procedure for HPLC determination of sugars using a Separon-NH_2 column and 80:20 or 75:25 acetonitrile:water as mobile phase is described, together with its application to determination of sugars in various products including beet molasses and cane molasses. Sample preparation is fully described. Chromatograms are presented. Mean values (% by weight), with standard deviation for five samples each, are tabulated for sucrose, fructose, glucose, xylose and rhamnose as well as reducing sugar values and polarimetric values for sucrose and lactose.

Change in the electrical conductivity of beet tissue during the diffusion process

L. A. Fedorenchenko *et al. Pishch. Prom.*, 1983, **29**, 14-17 (*Russian*).

Laboratory investigations of the effect of temperature and heating time on the electrical resistance of beet cossettes in a 5-cell diffuser are reported. The resistance was measured rather than conductivity, measurement of which proved difficult under the conditions. Results indicated a more rapid and sharper fall in resistance with higher temperature (in the range 30-70°C) which was associated with faster

denaturation of the protoplasm. With prolonged heating at 70°C there was a rise in resistance as a result of the fall in concentration of electrolyte in the extracted cossettes; at the lower temperatures there was a slower and a shallower fall in resistance to minima after 80 minutes, while the juice resistance started to climb after this time, with little difference between the curves for 30, 40 and 50°C. There was also little difference in the curves of juice resistance *vs.* Brix, which had little effect at values in the range 6-16°Bx, whereas there was a sharp rise in the resistance of juice of <4°Bx.

The effect of the surface structure of crystals on the kinetics of sucrose mass crystallization under heterogeneous conditions

B. V. Kuz'menko, V. O. Shtangeev, I. S. Gulyi, I. P. Pobyvanets and N. I. Shtangeeva. *Pishch. Prom.*, 1983, **29**, 17-20 (*Russian*).

A study of the effect of the ratio between the number of molecules in the crystal that react with those in the dissolved solids and the total number of molecules in the crystal on mass crystallization kinetics showed that this effect was considerable at the start but diminished by the end of the process. This behaviour is examined mathematically and the results given in graph form.

Thermo-physical properties of a sucrose crystal

D. E. Sinat-Radchenko and O. Yu. Kozhanov. *Pishch. Prom.*, 1983, **29**, 20-22 (*Russian*).

Using formulae already published and newly presented formulae, the authors have obtained values for both isotropic and anisotropic thermo-physical properties of the sucrose crystal and, by generalizing and averaging, have compiled a nomogram from which values can be read for each of eight properties at temperatures in the range 0-120°C at 10° intervals.

Some interferences in the alkaline copper method of reducing sugar analysis

E. Coruslu and B. Pekin. *Starch/ Stärke*, 1984, **36**, 361-363.

In analysis of glucose solutions for reducing sugars using the Nelson method[1] it was found that boric acid and Cl^- ions suppressed the reducing power of glucose and maltose. While boric acid did not affect the linearity of absorbance *vs.* concentration curves, Cl^- can cause non-linearity. The limit of validity of the method was re-assessed and found to be no higher than 175 μg/ml in contrast to the generally accepted value of 300 μg/ml.

Tests for estimating frost damage on sugar beet roots (conductimetric method)

G. Alcaraz. *Proc. 47th Winter Congr. Inst. Intern. Recherches Betterav.*, 1984, 53-68; through *S.I.A.*, 1984, **46**, Abs. 84-1234.

A study of root tissues from sugar beet at temperatures below 0°C revealed that great changes in membrane permeability occurred. It was shown that a fall in temperature to that corresponding to frost induced, after return to temperatures above zero, an increase in ion exchange between cells. Passage of a small direct current, produced by an experimental apparatus, enabled the soundness of the roots and the reversibility of the effects of frost to be estimated.

Electrodialysis and transport depletion de-ashing studies

D. Hsu. *Ann. Rpt. Expt. Sta. Hawaiian Sugar Planters' Assoc.*, 1983, 62-63.

Electrodialysis (ED) and transport depletion (TD) are both membrane processes of possible application in syrup ash removal so as to increase sugar recovery; unlike the conventional ED process, which uses both cation and anion membranes, TD uses cation and neutral membranes. Results of studies showed that, in the case of ED, the limiting current density, i.e. the maximum permissible current per unit effective membrane area for a given syrup at a given flow rate, did not increase with the syrup solids concentration (and ash concentration) as had been assumed earlier, so that the economics of the process are not as good as previously predicted and profitability is only marginal. The optimum syrup concentration appeared to be about 40-50%. In the case of TD, the permissible current densities can be much higher than with ED, but at the cost of current efficiency, so that the economics are much poorer than those of ED, even at 80% ash removal in contrast to an optimum of 40% for ED (at 40% ash removal, TD would have shown a loss). Because of the poor economics, no further work was planned with either process, although improvements in the characteristics or costs of membranes could change the situation.

Elimination of dextran in mixed juice

D. Hsu. *Ann. Rpt. Expt. Sta. Hawaiian Sugar Planters' Assoc.*, 1983, 63-64.

In laboratory tests, Enzeco Dextranase (supplied by the Enzyme Development Corp.) removed between 24.6% and 91.5% of the dextran present (at levels of 0.10-0.90%) in mixed juice, depending on enzyme dosage, retention time and pH. A limited number of tests on Sucrozyme (supplied by Fabcon Inc.) gave results approximately the same as those given by Enzeco Dextranase, but investigations were discontinued since the manufacturers have no plans to register the product.

IR spectroscopic studies on iron-phenol complex polymer and an oxidized phenol product

S. C. Sharma and P. C. Johary. *Zuckerind.*, 1984, **109**, 921-923.

Hydroquinone and phloroglucinol were

1 *J. Biol. Chem.*, 1944, **153**, 375.

oxidized and polymerized in the presence of iron at pH 8.0, the polymers then isolated by paper chromatography and dried. Their infrared spectra were compared with those of molasses polymers and showed a number of similarities, from which it was concluded that cane molasses contain phenol-derived polymers.

Determination by a conductimetric method of the ash content in beet, sugar and products of sugar manufacture

A. Ya. Zagorul'ko, A. I. Levitskaya, L. A. Korobeinikova, A. A. Petrenko and A. E. Arkhipets. *Sakhar. Prom.*, 1984, (10), 42-45 (*Russian*).

Existing conductimetric methods for ash determination are associated with considerable error and so cannot be recommended. Three regression equations have been developed for calculation from conductimetric measurements of carbonate ash in white and refined sugar having ash contents in the ranges of 0.02-0.05% and 0.05-0.08% (by weight); for 5 mg/100 ml solutions the errors were found to be ±0.0006-0.01% by weight (r=0.9968-0.9989).

Relationships between density, temperature and dry substance of commercial corn syrups, high-fructose corn syrups and blends with sucrose and invert sugar

A. M. Wartman, T. D. Spawn and M. A. Eliason. *J. Agric. Food Chem.*, 1984, **32**, 971-974.

A study has been made of the relationship between dry solids (determined from the refractive index at 20°C and product composition), density (determined pycnometrically) and temperature for a variety of commercial corn syrups, including 42%, 55% and 90% fructose syrups and blends with sucrose and invert sugar. The densities were measured at 15.55°C (60°F), 20°C, 40°C and 60°C. The results are tabulated for 18 product types and are used to derive model equations relating composition and the three parameters mentioned above. The refractive index and specific gravity are also tabulated for sucrose solutions of up to 66.79% by weight. Also given are density values converted to °Bé for corn syrups of 28-95% dry solids.

Specific volume (density) of saccharide solutions (corn syrup and blends) and partial specific volumes of saccharide-water mixtures

J. L. Maxwell, F. A. Kurtz and B. J. Strelka. *J. Agric. Food Chem.*, 1984, **32**, 974-979.

A thermodynamic model is proposed for specific volume (reciprocal of density), based on apparent specific volumes of the saccharide solutes, for aqueous solutions containing dextrose, fructose and other oligosaccharides. Density data from the study described in the preceding abstract are analysed by the multiple linear least-squares method. For binary mixtures of water with a saccharide, partial specific volumes of the two components are derived and are used as a diagnostic tool for examination of the model. Extrapolated values of the partial specific volumes for dextrose and sucrose are compared with data given in the literature. It is shown that the variations in partial specific volume with composition and temperature depend on the saccharide in question.

Hydrochloric acid/resorcinol *versus* phenol/sulphuric acid for monitoring trace sugars

T. A. Chorn and A. Hugo. *Proc. 58th Ann. Congr. S. African Sugar Tech. Assoc.*, 1984, 64-67.

Advantages and disadvantages of three methods developed for determination of sugars in condensate are indicated. The HCl/resorcinol method has a wide linear range and an excellent linear correlation between sucrose concentration and absorbance at 520 nm; its response to fructose is much greater than to glucose, a fact which should be remembered when samples such as effluent are analysed, since there may be significant quantities of glucose polymers present which could otherwise be recorded as sucrose. Disadvantages include the need for heating in a boiling water bath, which adds to the complexity, the sensitivity of colour development to changes in temperature, and slowness of change in the reagents with time, so that a calibration curve has to be drawn for each analysis. The phenol/sulphuric acid test is simple to perform and gives an excellent linear relationship between sucrose concentration and absorbance at 490 nm; it has a lower linear range than the HCl/resorcinol method (0-60 compared with 0-200 ppm), but the reagents are stable for long periods. Since all carbohydrates will form colour in this test, care must be taken to ensure that the method is applicable to the sample to be analysed. The cysteine hydrochloride/carbazole method has two major disadvantages, viz. greater scatter in the correlation between sucrose concentration and absorbance at 558 nm than with the other two methods, and the need for daily preparation of the reagents, so that it was not evaluated further. Wide differences found between the results given by the other methods for some condensate samples were due to interference by volatile compounds in the HCl/resorcinol test, whereby a distinct pink coloration occurred instead of the normal reddish-brown. Since the absorption maximum of the pink colour occurred at 555 nm, close to the recommended wavelength of 520 nm, a previously recommended wavelength of 480 nm is proposed for the method; there was a dramatic improvement in the correlation when tests were conducted at this value. Both methods gave values in close agreement with sucrose determination by HPLC, but the phenol/sulphuric acid method is considered more suitable.

By-products

Effect of contaminating micro-organisms on alcoholic fermentation in micro-distilleries

F. Alterthum, M. R. M. Cruz, M. L. R. Vairo and D. M. Gambassi. *STAB*, 1984, **3**, (1), 42-46, 49 (*Portuguese*).

It has been shown experimentally that loss of alcohol yield in a micro-distillery can be between 20 and 98%, depending on the species, when contaminating micro-organisms are present to a level above 10^8 cells/ml. In order to counter these, the bacteria have to be isolated and then tested against different biocides so as to establish conditions where they might be controlled without interference with the fermentative process. The principal contaminants are gram-positive bacteria, some of which are controlled by penicillin V-acid. Juice extracted with a diffuser generally contained fewer contaminating micro-organisms than juice obtained by milling.

Sugar extractor for alcohol micro-distilleries

J. G. de Lima. *STAB*, 1984, **3**, (1), 50 (*Portuguese*).

The Instituto de Pesquisas Tecnológicas (Technical Research Institute) of the State of São Paulo has developed a device which employs "lixiviation under pressure" for the extraction of juice from cane for fermentation in a micro-distillery (up to 5000 litres alcohol per day). A pilot plant has been constructed and is illustrated; at a throughput of 986.6 kg/hr it achieved 81.25% pol extraction without using any solvent, giving a bagasse of 52.33% moisture and consuming 17.7 hp. When a solvent was used, the machine obtained 88.66% extraction from 907.3 kg/hr of cane and the bagasse was of 52.83% moisture.

A note on microflora of filter cake

A. S. Salunkhe. *Proc. 33rd Ann. Conv. Deccan Sugar Tech. Assoc. (India)*, 1983, (1), A.127-A.129.

As a contribution to assessment of the value of filter cake as a fertilizer, qualitative determination was made of the fungi, bacteria and actinomycetes in factory samples; the role they could play in decomposing the organic matter present in filter cake is mentioned.

The possibility of producing ethanol in Greece

G. Papatheodorou. *Hellenic Sugar Ind. Quarterly Bull.*, 1983, (54/55), 59-82 (*Greek*).

The costs of ethanol production from grain and ethylene are discussed, and the possibility of setting up a fermentation industry for anhydrous alcohol manufacture from sweet sorghum and for industrial-alcohol manufacture from beet molasses is discussed.

Bioconversion of beet pulp and washer waste

J. P. Lescure and P. Bourlet. *Ind. Alim. Agric.*, 1984, **101**, 601-607 (*French*).

After laboratory trials on three methods of treating beet pulp and solid waste from a beet washer, a pilot plant was set up which comprised two interconnected vessels, of 50 m^3 total effective capacity; the first vessel was used for hydrolysis, acidification and partial conversion to methane, while the second was used for fermentation only. Results showed about 88% conversion of the pulp to gas at an average daily throughput of 7 kg/m^3, but considerable losses meant that the calorific value of the gas actually received was only 54% on pulp dry solids; about 77% of the washer waste was converted to gas at a daily throughput in the range 30-38 kg/m^3, but the gas losses were very much lower. Because of other more favourable methods of treating pulp, including pressing to a high solids content, ensilage and low-temperature drying, anaerobic treatment is considered to have little future; for washer waste, heavy investment required for a suitable large-scale system could be repaid.

Treatment of waste water from a yeast plant

H. R. Rüffer. *Seker*, 1984, **17**, (115), 43-48 (*Turkish*).

After an outline of the basic process of yeast fermentation on molasses, the author indicates the amount of water used in processing and the quantity and composition of vinasse. A survey is presented of vinasse treatment methods, with mention of systems developed by various firms specializing in waste water treatment.

Betaine — a valuable constituent of sugar beet

N. El-Rakabawy and J. Trzebiński. *Gaz. Cukr.*, 1984, **92**, 79-80 (*Polish*).

Aspects of betaine discussed include its typical content in the root and leaves, its biosynthesis and physiological role, methods of determining it, its properties and its value as a raw material for the pharmaceutical industry, as a fodder component and for vitamin B_{12} production by fermentation. A laboratory method for isolation of betaine from vinasse in the form of its crystalline hydrochloride is described.

Brevities and statistics

Yugoslavia sugar production, 1984/85[1]

A record sugar production of 978,264 tonnes, raw value, was achieved in Yugoslavia in the 1984/85 campaign. The 23 sugar factories sliced 6,730,000 tonnes of home-produced beet and 212,000 tonnes imported from Hungary.

Cuban sugar port expansion[2]

Pastelillo, a port in Nuevitas Bay, Camagüey Province, currently the most important for raw sugar shipment from Cuba and handling 500,000 tonnes/year, is to be expanded at a cost of about 200 million pesos ($180 million). Studies for this project are being conducted by Soviet, East German and Spanish firms.

Sweden beet sugar production, 1984/85[3]

In the 1984/85 campaign, the seven beet sugar factories of Sockerbolaget sliced a total of 2,533,603 tonnes of beet to produce 295,411 tonnes of white sugar and 69,396 tonnes of raw sugar, as well as 89,649 tonnes of molasses, 79,732 tonnes of molassed dried pulp and 79,224 tonnes of pulp pellets.

Continued from previous page

Zuckerraffinerie-Kläre-Entsalzung mit einem neuen Ionenaustauschersystem

Ein verbessertes Ionenaustauschsystem für Raffinationskläre wird beschrieben. Bei diesem System (dem MAK-Verfahren) wird das Zusetzen des stark basischen Anionenaustauscherharzes verringert. Das Verfahren ergibt nicht nur Klären guter Qualität, sondern ermöglicht auch einen größeren Durchsatz je Zyklus. Die Anwendung dieses Verfahrens in der C. Itoh Zuckerraffinerie in Japan ermöglichte das Knochenkohleverfahren wegzulassen und die Produktionskosten je Einheit um 13.4% zu reduzieren.

Desmineralización por un nuevo sistema de cambio iónico en licores de la refinería de azúcar

Se describe un sistema mejorado para refinación de licores de azúcar. En este sistema (el proceso MAK), ensuciamiento de la resina aniónica fuertemente básica es reducido. El proceso produce no solamente un licor de azúcar refinado de buena calidad, sino una cantidad mayor por ciclo. Adopción del proceso en la refinería de la sociedad C. Itoh en el Japón ha permitido la eliminación de tratamiento con carbón animal y ha reducido el costo unitario de producción en 13.4%.

Swaziland sugar exports, 1984[4]

	1984	1983	1982
	tonnes, raw value		
Angola	0	0	108
Canada	60,129	101,134	29,619
China	0	0	26,657
EEC	110,298	136,659	128,763
Finland	0	0	42,102
Malaysia	0	0	13,329
Morocco	0	0	15,868
Mozambique	10,880	32	0
Portugal	78,904	20,494	34,305
South Africa	60,681	79,869	0
Sri Lanka	0	398	5,424
USA	70,088	34,797	42,508
Yemen, North	0	0	5,424
	390,980	373,383	344,107

West Germany sugar production, 1984/85[5]

West German sugar production in the 1984/85 campaign totalled 2,880,000 tonnes, white value, against 2,490,000 tonnes in 1983/84. Of this amount, raw sugar output was 447,584 tonnes, expressed as white sugar equivalent, compared with 433,940 tonnes the previous campaign. Beet deliveries totalled 20.02 million tonnes and average sugar content 16.24% in 1984/85, against 16.25 million tonnes and 17.16% sugar content in 1983/84. The crop was grown on 423,294 ha, against 403,104 ha in 1983, and the yield averaged 47.3 tonnes/ha in 1984 against 40.3 tonnes/ha a year earlier.

Sugar refining in Trinidad[6]

Trinidad has asked its Commonwealth Caribbean neighbours to allow it to refine their raw sugar as part of efforts to rehabilitate its sugar industry. The region's sugar producers are discussing the offer which could see Usine Ste. Madeleine operating at its full capacity of 60,000 tonnes of refined sugar per year. In 1984 it processed 47,000 tonnes of raw sugar from Brazil, Dominican Republic and Guatemala.

Fiji sugar production, 1984[7]

A record 4,289,929 tonnes of cane was crushed in the 1984 season by the four sugar factories in Fiji. The combined hourly crushing rate of 964 tonnes was also a record. Sugar production amounted to 480,106 tonnes, giving a TCTS ratio of 8.9.

Likely closure of Australian sugar factory[8]

Mr. G. E. Mitchell, representing Bundaberg Sugar Co. Ltd., told a hearing of the Central Sugar Cane Prices Board in Queensland that the future of Qunaba Mill was "increasingly critical". It is Australia's smallest sugar factory and, although an efficient unit in a highly productive area, it is landlocked so that further capital investment cannot be justified.

Belize sugar exports, 1984[9]

Exports of sugar from Belize fell to 101,540 tonnes, raw value, in 1984 against 115,619 tonnes in the previous year. As previously, the principal market was the EEC with 47,123 tonnes *vs.* 44,947 tonnes in 1983, while Canada received only 12,402 tonnes in 1984, compared with 42,195 tonnes the previous year. Exports to the USA rose from 28,477 tonnes in 1983 to 36,943 tonnes, while Ecuador took 5072 tonnes in 1984 (nil in 1983).

Guyana sugar expansion plans[10]

Guyana aims to boost sugar production by 10% in 1985 to 267,000 tons after 242,000 last year, according to the Chairman of the state-owned Guyana Sugar Corporation (Guysuco). Guysuco experienced a serious deterioration in production costs which have increased by 22% since 1982.

Thailand sugar exports, 1984[11]

	1984	1983	1982
	tonnes, raw value		
Algeria	0	0	10,276
Bangladesh	58,182	0	0
Bulgaria	13,077	0	0
China	277,918	90,020	549,243
Ecuador	18,182	0	0
Egypt	5,943	48,125	0
Hong Kong	3,844	3,464	2,171
Indonesia	3,198	49,439	68,959
Japan	511,895	572,280	370,001
Korea, South	215,674	152,142	96,675
Laos	523	494	3,355
Madagascar	0	10,776	0
Malaysia	118,175	85,336	102,972
Morocco	37,460	73,761	70,603
Mozambique	48,482	0	0
New Zealand	0	20,714	15,547
Philippines	62,035	52,452	0
Saudi Arabia	0	22,635	38,697
Singapore	12,357	1,683	0
Sri Lanka	0	71,753	7,356
Tunisia	13,059	12,989	0
USA	38,910	15,427	285,493
USSR	4,124	126,420	423,467
Other countries	600	760	0
	1,443,638	1,410,670	2,044,815

Franco-Nigerian barter agreement[12]

A barter deal is reported under which France is to exchange 100,000 tonnes of white sugar for oil, to be supplied by Nigeria. It is reported that export credit would be provided by the French agency COFACE.

1 *World Sugar J.*, 1985, **7**, (8), 25.
2 *Amerop Westway Newsletter*, 1985, (136), 10.
3 *Zuckerindustrie*, 1985, **110**, 254-255.
4 *I.S.O. Stat. Bull.*, 1985, **44**, (2), 39.
5 *Reuter Sugar Newsletter*, February 28, 1985.
6 *Financial Times*, March 22, 1985.
7 *Fiji Sugar*, 1985, **10**, (1), 14.
8 *Australian Canegrower*, 1985, **7**, (1), 11.
9 *I.S.O. Stat. Bull.*, 1985, **44**, (3), 4.
10 *S. African Sugar J.*, 1985, **69**, (2), 38.
11 *I.S.O. Stat. Bull.*, 1985, **44**, (2), 43.
12 *Reuter Sugar Newsletter*, March 26, 1985.

Dust control in a beet sugar factory

By J. J. Gilbert

In most industrial processes the presence of dust, which can originate either from the raw materials or be created by some manufacturing operation, has existed as long as industry itself. Although the problems created are not new the whole industrial environment is altering. If not controlled dust can cause contamination, bad working conditions, fires and explosions. Steadily growing investment by industry in dust control equipment, which amounts to millions of pounds annually, indicates the high standards now demanded and nowhere is this more important than in the sugar industry.

We must accept the growing sensitivity of our social system to effluent contamination of air, earth and water and this has its impact on all manufacturing processes. In the beet sugar industry, this fact, allied with more stringent conditions of hygiene and the reluctance of labour to work in conditions below the best obtainable, make the need to control dust unavoidable.

The requirements for dust control fall into two basic categories:

1. Nuisance dust control
2. Process dust control

Nuisance dust control

This is primarily concerned with dealing with dust produced by mechanical handling equipment in its broadest sense, and is concerned with controlling the dust at its source. This dust is produced from equipment such as conveyor transfer points, elevators, screens, packing machinery, bag filling and discharge points for the bulk loading of road tankers.

Process dust control

In this category air is introduced as an essential part of the process such as in pneumatic conveying, airswept mills, dryers, coolers and granulators.

Figure 1 shows a simplified process diagram with particular reference to those processes where dust collection equipment is required. It will be seen

J. J. Gilbert

that dust collection is required in three main categories: pulp, lime and sugar. In addition there is a fourth category requiring dust collection referred to as "ancillaries". This includes processes such as the addition of filter aid and beet knife sharpening and use of equipment in the machine and woodwork shops.

Pulp

Pulp handling plants require dust collection at the following: dryers, conveyors, magnetic separators, elevators, coolers, screens, weighers, extruders and bagging machines.

Source: DCE Group Ltd., Thurmaston, Leicester.

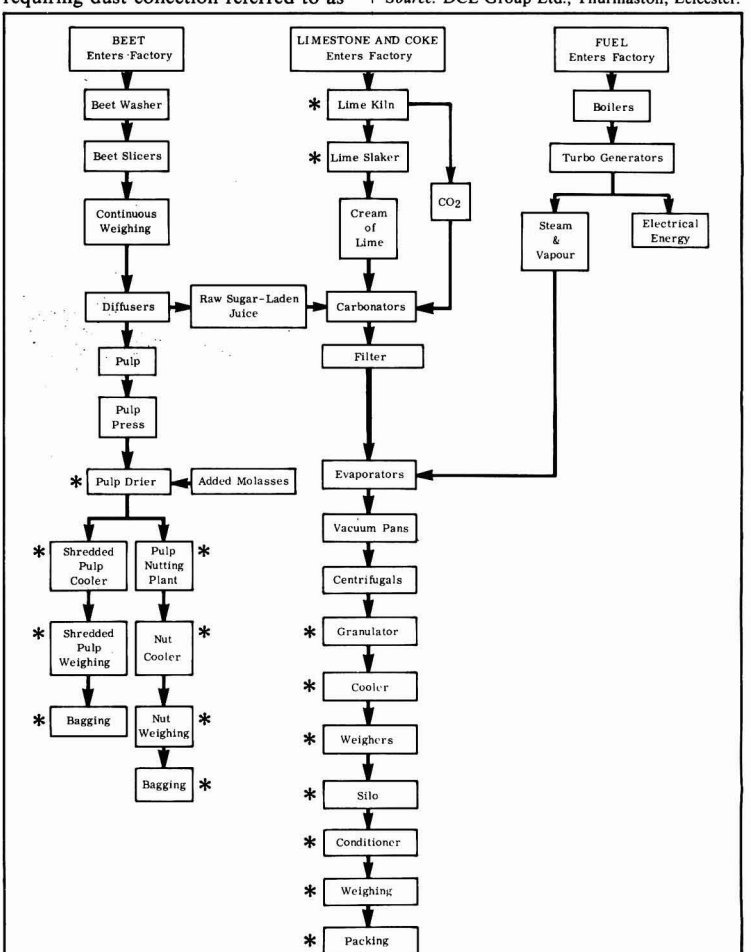

Fig. 1. Flow diagram of a beet sugar factory. Processes requiring dust extraction are distinguished by an asterisk*

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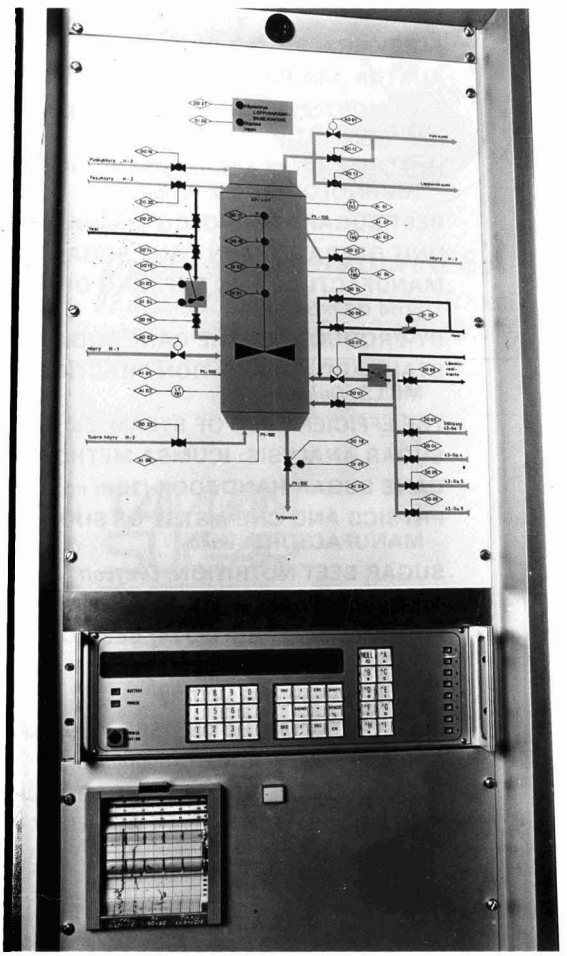

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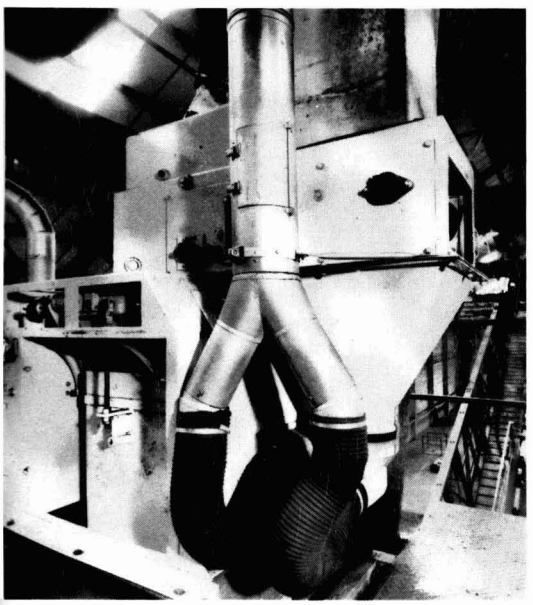


Fig. 2

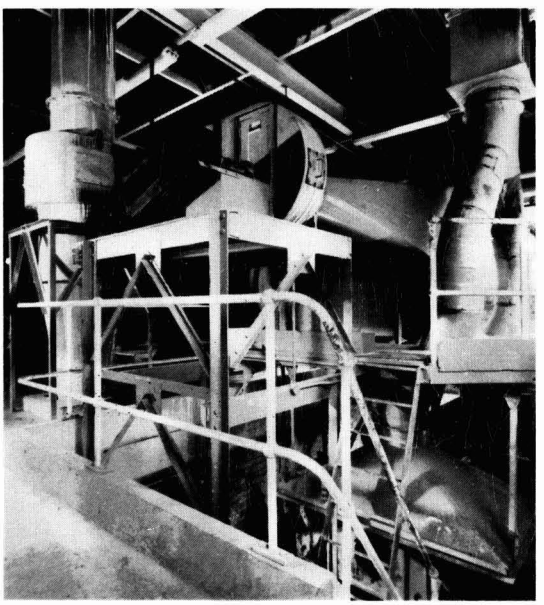


Fig. 3

High-efficiency cyclones are the most suitable collector for pulp dryers primarily owing to the high temperatures but also since they enable the collected fibrous material to be fed back into the system without further process when desired. When considering the best type of collector for the remaining processes, initial cost of the equipment has to be balanced against the value of the collected dust. For most installations high-efficiency dry cyclones have been found satisfactory and it is not economical to go for the higher collection efficiencies of fabric filtration although legislation in the future may necessitate higher collection efficiencies

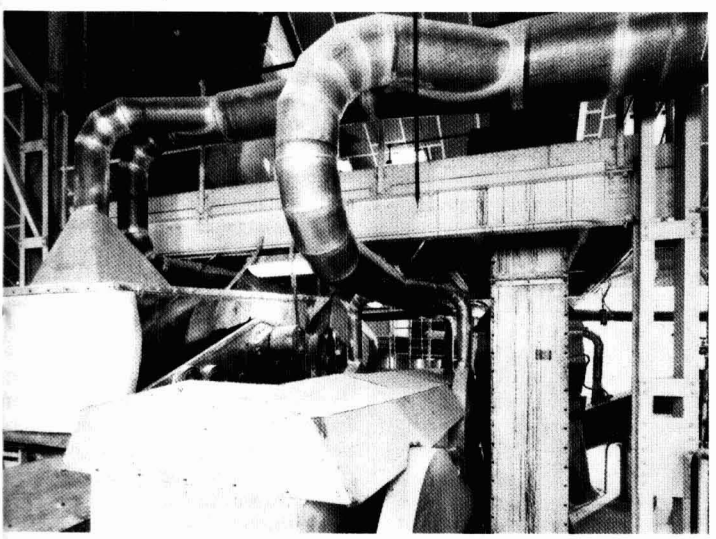


Fig. 4

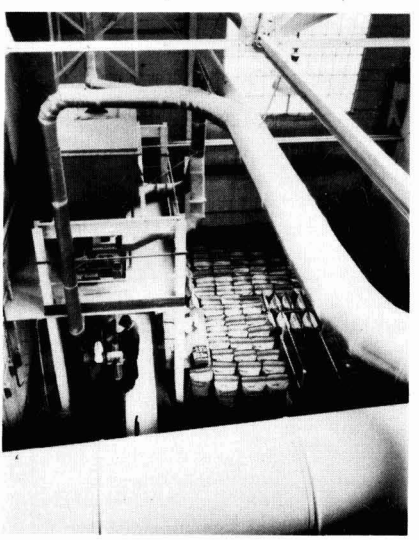


Fig. 5

than that obtained from a centrifugal type of collector. Figure 2 shows the connexions to an automatic pulp weighing machine (inspection covers have been removed to show some of the mechanism). When making exhaust connexions to enclosed weighing machines, care must be taken so as not to affect the accuracy of weighing. On pulp coolers the criterion is the air volume required to cool the product effectively bearing in mind the retention time of the product in the cooler and the limiting air velocities to ensure that the product is not removed by the cooling air. It is important that vapour produced at the nutting machines is not allowed to enter the general extraction system as this will condense in the ducting and cause subsequent blockages.

Lime

Limestone is burnt in lime kilns producing burnt lime and CO_2. The burnt lime is then slaked and the resulting cream of lime and CO_2 produced at the lime kiln are used in carbonatation. Dust extraction is required on the equipment handling the burnt lime up to the slaker. This dust is dry and hot and high-efficiency irrigated cyclones have been found to be the most suitable means of collecting the dust. The liquor from the base of the cyclones can be used in the process for pH correction. It has been found from experience that it is best to collect the dust and vapour from the slaker at the feed-out end. The action of drawing air through the slaker not only controls the dust at the feed but ensures that at least some of this dust is slaked on its passage through the slaker. High-efficiency irrigated cyclones have been found to be the most suitable for this purpose. It is essential that ducting runs should be kept to a minimum and facilities provided for cleaning the hoods and the inside of the ducting. On no account should the dry dust collected be mixed with the vapour extracted as this invariably leads to unacceptable build-ups in the ducting.

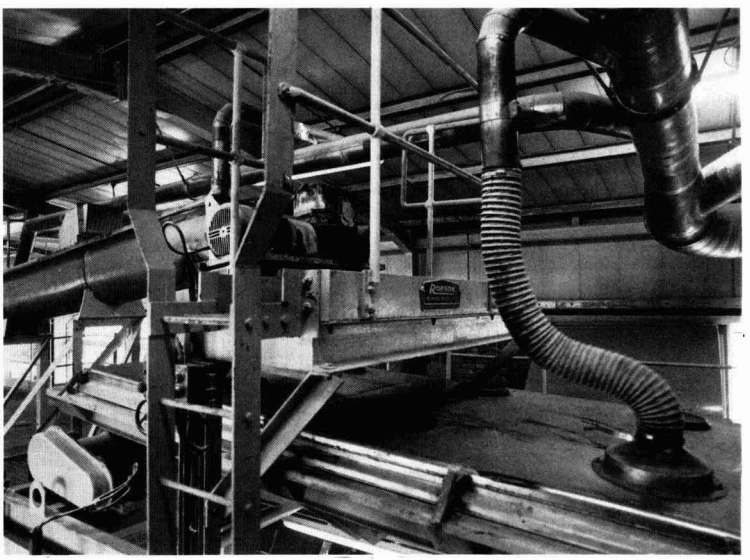


Fig. 6

Figure 3 shows a typical installation where the irrigated high efficiency cyclone is connected to the discharge end of the slaker. Underneath the slaker, screens are provided to remove stones, etc. At this operation no dust is produced and a canopy hood is connected to an axial flow fan and the vapour discharged direct to atmosphere.

Sugar

In Figure 1, it will be seen that the need for dust collection commences immediately the sugar is in a dry state. White sugar is discharged from the centrifugals to the granulators. These are revolving drums where the sugar is dried by passing warm clean air through the cascading sugar. When the air is passing through the granulator it picks up fine sugar dust which has to be collected. This equipment is only used during the campaign. Wet collectors of the self-induced spray type have been found to be most suitable for this process, giving high collection efficiencies on the soluble dust without problems due to the moisture content, and ease of disposal of the collected liquor for re-processing during the campaign. Equipment similar to the granulator is used for cooling the sugar prior to storage and re-conditioning after storage. In these cases the equipment can be used out of campaign and consequently wet collection is not suitable owing to the problem of storing large volumes of liquor. The Dalamatic reverse-jet filters have been found very suitable for collecting the dust from these processes with high efficiency. The collected dust can be fed back into the process during campaign or stored in bags for re-processing during the following campaign.

Dust collection equipment is required on conveyors, conveyor transfers, elevators, screens, conditioners, silos, weighers, packing stations and bulk road tanker loading points. Figure 4 shows a multiplicity of connections to screens, conveyors, elevators and discharge chutes. It will be noticed that the screens, whilst almost totally enclosed, use plastic side sheets to enable the operators to observe the functioning of

Fig. 7

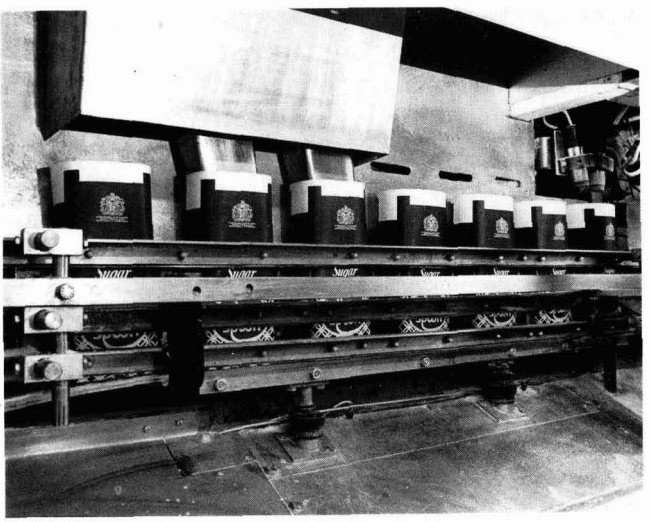


Fig. 8

the equipment and at the same time maintain a negative pressure within the enclosure to prevent the escape of dust. The plastic sheeting is in fact being pulled in by the inward flow of air. Figure 5 shows a bagging station with weighing equipment above, fed by overhead conveyors. Figure 6 shows a totally enclosed screen being fed by a screw conveyor. Connections are made to the screw conveyor itself to ensure that there is no build-up of an explosive dust/air mixture and it will be noted that there is a flexible connection to the movable part of the screen to ensure that this is kept under negative pressure, preventing the escape of dust to atmosphere. Figure 7 shows a series of weighing machines which are connected to the dust extraction plant to ensure that the weighing mechanism is not contaminated by sugar dust, rendering this inaccurate, and also at the filling of the weigh pans prior to discharge to the packing machine below. Figure 8 shows a close-up of the actual bag-filling operation where it is essential to collect the small amount of displaced air as the sugar is fed into the individual bags as well as dust released as the bags are vibrated and closed. The entire operation is enclosed and the enclosure kept under a negative pressure to ensure that there is no escape of dust into the workroom.

Icing sugar is produced by grinding granulated sugar. Figure 9 shows an installation where the mills are vented to a Dalamatic continuously-rated filter. As the product becomes finer the risk of an explosion is greater and it is interesting to note that explosion protection and suppression equipment is fitted throughout the installation. Icing sugar handling, such as weighing and packing, requires similar dust extraction equipment to that previously described.

Ancillary equipment

When filter aid is introduced to the manufacturing process it is generally carried out periodically by tipping sacks into a receiving hopper, screw etc. and fed automatically into the process.

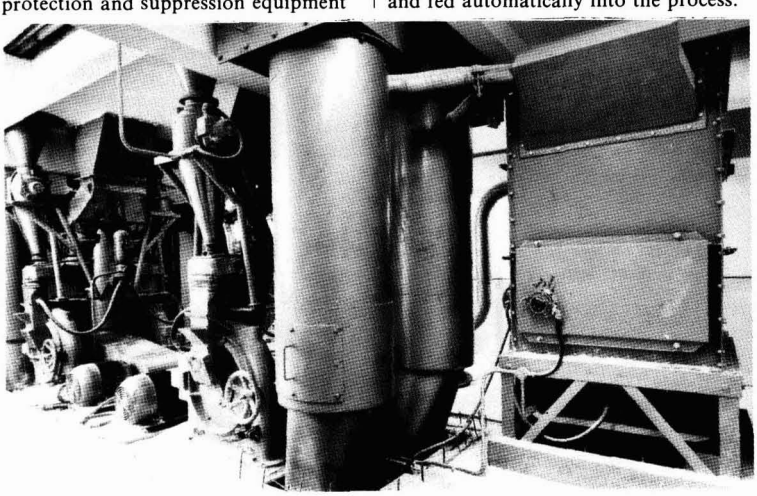


Fig. 9

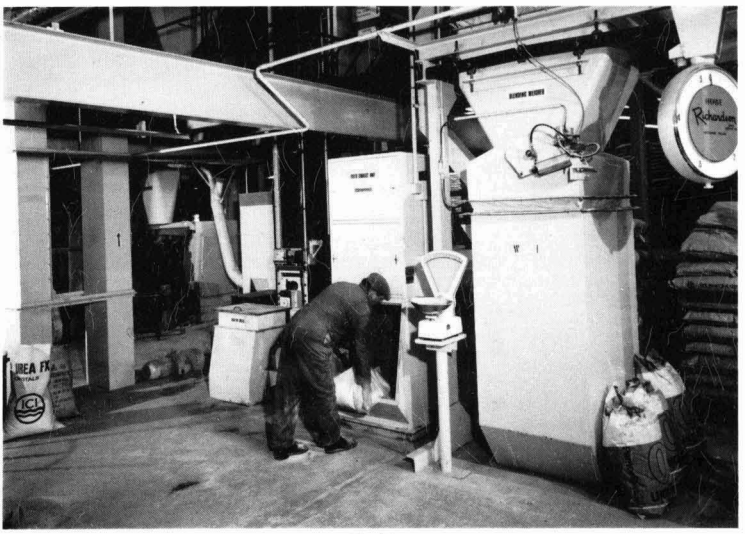


Fig 10

Dust collection can be satisfactorily carried out at this process by using a self-contained DCE sack-tipping unit which comprises an intermittently-rated high-efficiency fabric filter complete with its own fan and motor and a suitable base to enable dust-free tipping operations to be carried out as shown in Figure 10.

The engineering and joinery workshops also have machines which require dust collection such as grinding machines and various woodworking machines, all of which can have satisfactory dust collection attached by using one of the many other Unimaster dust control units, such as the model illustrated in Figure 11.

Fabric filtration

When considering the type of dust extraction filters to use on sugar dust collection it is important to realise that the majority of the processes are of a continuous nature and therefore require dust collection filters that will operate on a continuous basis without loss of performance. On a single compartment filter the resistance built up on the filter material increases gradually with time until the airflow is reduced to an unsatisfactory level. It is then necessary to switch off the installation and clean the filter under no-airflow conditions. Figure 12 illustrates airflow through this type of filter where the volume is reduced

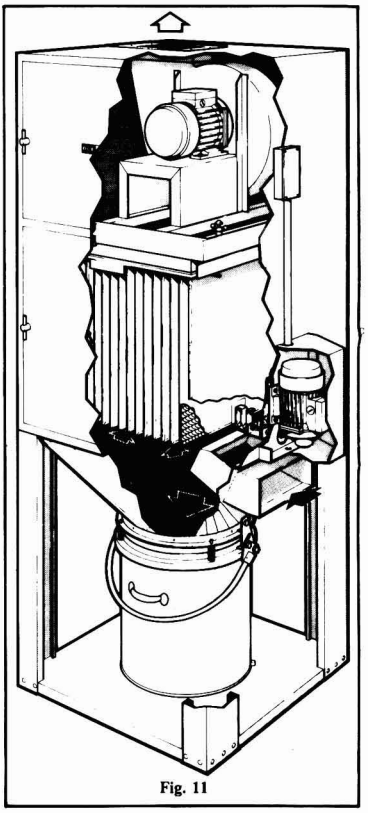
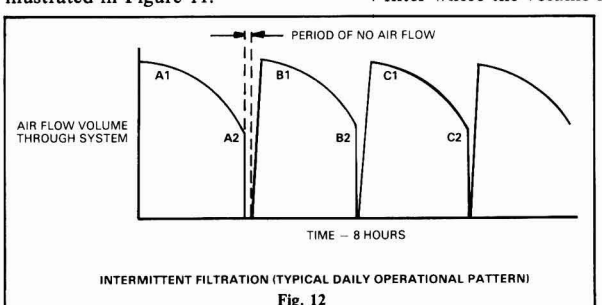


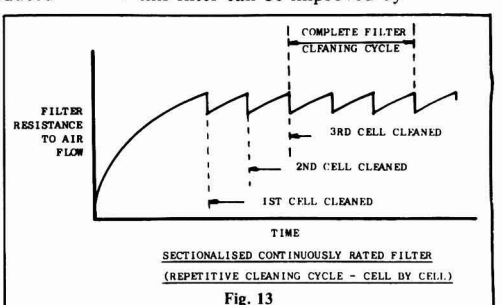
Fig. 11

throughout a period of time from A1 to A2. The filter is then cleaned, during which time there is no airflow at all, and the filter brought back onto line at B1 with a gradual reduction in airflow to B2 and so on. The airflow pattern of this filter can be improved by



INTERMITTENT FILTRATION (TYPICAL DAILY OPERATIONAL PATTERN)

Fig. 12



SECTIONALISED CONTINUOUSLY RATED FILTER

(REPETITIVE CLEANING CYCLE - CELL BY CELL)

Fig. 13

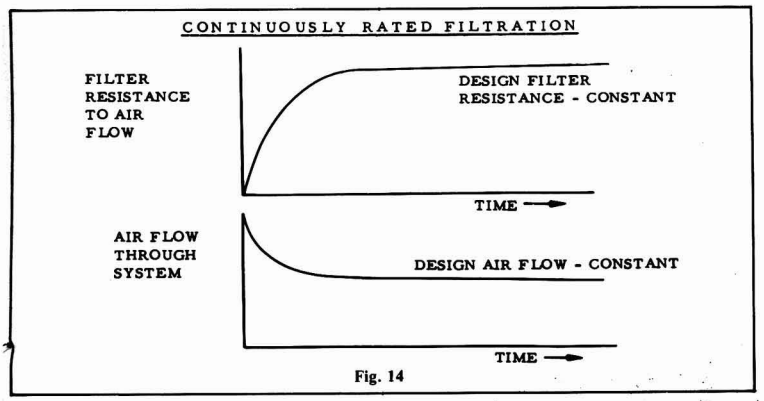


Fig. 14

sectionalizing the filter into various compartments and cleaning each one in turn to produce a form of continuously rated filter. A typical curve of filter resistance, and hence airflow, is shown in Figure 13 which gives a sawtooth curve as each compartment is cleaned and brought back onto line. This type of filter has a number of disadvantages such as varying filtration velocities through the filter media and the valve gear required to facilitate cell isolation. Figure 14 shows the design characteristics of a truly continuously-rated filter such as the Dalamatic which gives a constant airflow once an inherent build-up of resistance on the filter has been reached. Figure 15 shows a cut-away view of a Dalamatic reverse jet filter. The black arrows illustrate a most important feature of the collector showing the dust-laden air entering at the top of the collector, the air gradually migrating through the filter media on its passage down to the hopper beneath. This ensures when the filter is cleaned the coagulated dust is carried down to the receiving hopper by the natural flow of air in the collector itself. Figure 16 shows a typical site photograph of a series of Dalamatic reverse-jet filters installed in a beet sugar factory collecting the dust produced from various processes in the works.

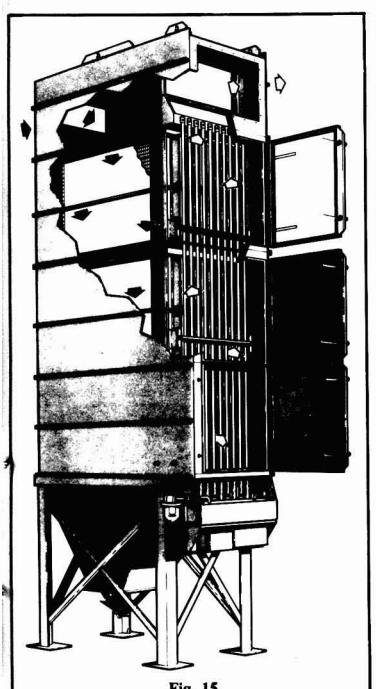


Fig. 15

Explosion protection

The Dalamatic reverse jet filter is fully protected against an internal explosion within the collector itself by means of an explosion relief panel fitted with DCE Membrex material. Depending on the filter configuration this panel can be fixed on either the back or top of the collector to vent a possible explosion to atmosphere. Figure 17 shows back explosion vents through the factory wall which are generally more convenient in practice than venting the filter through the roof owing to the

Fig. 16

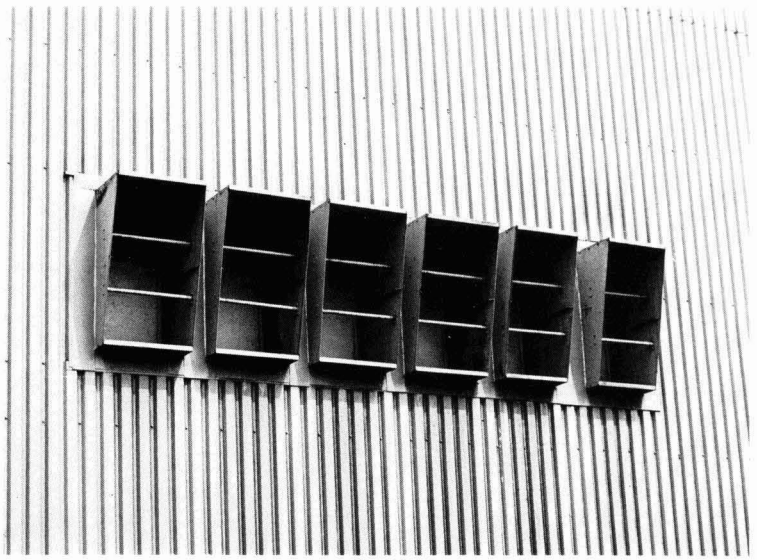


Fig. 17

difficulties of weathering. In many cases roof venting is impossible when filters are fitted in multi-storey buildings. DCE Group Ltd., manufacturers of the Dalamatic range of filters, have carried out extensive research into the effects of internal explosions in the filter itself both at Cardington and Buxton. Figure 18 shows three site photographs of a Dalamatic filter taken before, during and after an explosion. It is important to note the absence of any significant damage to the filter and that no missiles were liberated by the explosion itself.

Acknowledgements

The author wishes to thank British Sugar plc for their help and co-operation in preparing this paper and for their permission to use photographs taken in their works.

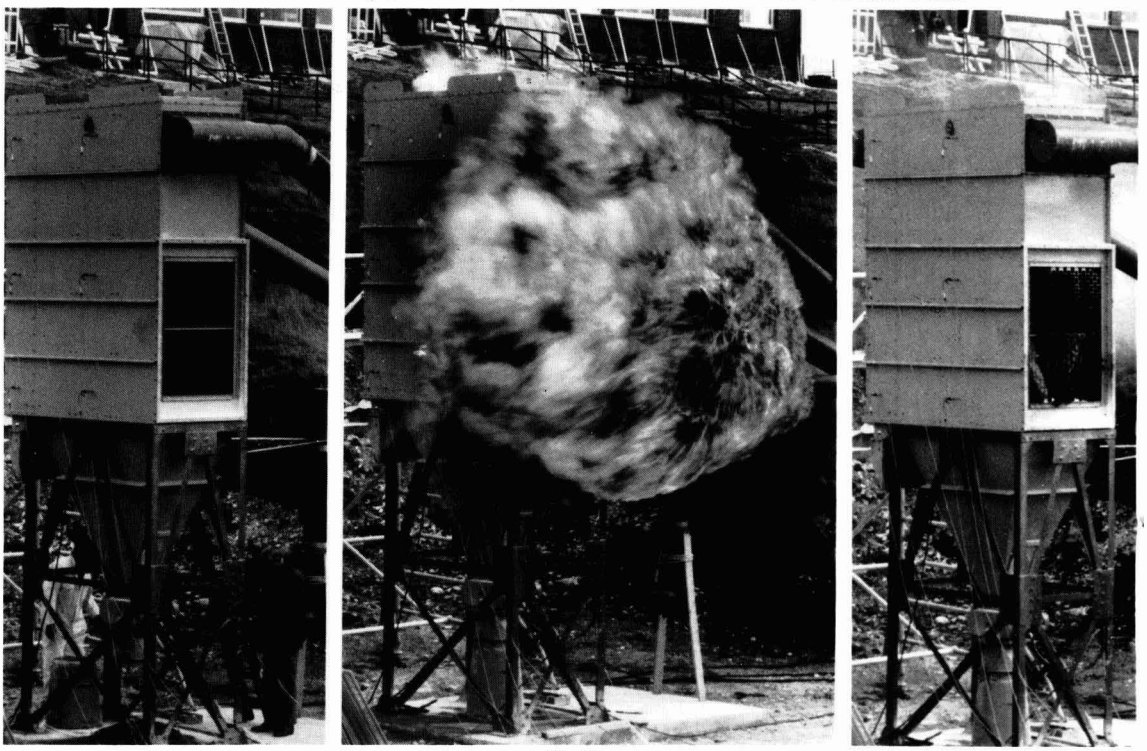


Fig. 18

Trade notices

Continuous centrifugal

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

The new K1300 continuous centrifugal from BMA is particularly suited to high-purity massecuites as well as affination in the beet and cane sugar industries. It was tested with great success in West Germany and Ireland during the 1984 campaign on affination of low-grade massecuite and on B-massecuite. The maximum speed of the 1300-mm basket is 1755 rpm.

Tube cleaning equipment

Goodway Tools Ltd., Unit 3, The Cordwainers, Temple Farm Industrial Estate, Southend-on-Sea SS2 4BR, England.

Catalogue No. 1083A from Goodway Tools provides details of the company's range of pneumatic and electric tube cleaning machines which operate with simultaneous vacuum or water flushing and are designed for use in the cleaning of fire- and water-tube boilers, condensers, heat exchangers, etc.

Prebreaker

Apex Construction Ltd., Apex House, London Road, Northfleet, Kent DA11 9NX, England.

The Apex Series 555 prebreaker is designed to break lumps of moderately hard materials, especially those that tend to agglomerate in drying and storage, including sugar and chemicals. It is available in a range of feed aperture sizes, and screens of various perforations can be incorporated in order to provide more accurate particle size control. The flanged design of the prebreaker makes it easy to install in existing or new process systems, and the unit has been made available as an integral unit with an Apex comminuting mill — the prebreaker carries out first-stage reduction of large material, while the mill is responsible for final reduction.

Weighbridges

Solidate Ltd., Sandy Lane, Moston Road, Sandbach, Cheshire CW11 9HT, England.

Literature from Solidate describes the Lynx road vehicle weighbridge which is fabricated in 5-, 6- and 7.5-m sections for coupling together to take loads of up to 100 tonnes. The Lynx has a low profile for surface-mounted applications, being only 275 mm above the ground, while it has a depth of only 390 mm when used for shallow pit applications.

Bulk handling

Universal Conveyor Co. Ltd., Humberstone Lane, Leicester LE4 7JT, England.

A new 48-page brochure from Universal Conveyor gives details of the company's static troughed belt conveyors, portable and self-erecting mobile units, radial conveyors for stockpiling or shiploading, screenloaders, steep-angle sidewall conveyors, bins, structures and complete bulk handling schemes, as well as belt conveyor components and other types of conveyor, including screw, vibrating, drag link, chain scraper, and steel slat types, apron feeders and bucket elevators.

PUBLICATIONS RECEIVED

Turbo-generators

Coppus Engineering Corporation, 344 Park Avenue, Worcester, MA 01610, USA.

A new 12-page catalogue (250D) gives details of the Coppus-Murray line of single- and multi-stage turbo-generator sets available for standby power and cogeneration in standard and custom-built systems of between 1 and 10,000 kW ratings, based on steam, compressed air or gas expansion. Specific sections describe and illustrate various applications of the units.

Pressure regulators and safety valves

David Auld Valves Ltd., Cowlairs Industrial Estate, Finlas Street, Glasgow G22 5DQ, Scotland.

A 4-page brochure from Auld contains information on the company's product range, covering control valves, safety valves, valve desuperheaters, and pressure regulators available for use in a number of industries.

Centrifugal manual

The McIlvaine Company, 2970 Maria Avenue, Northbrook, Ill. 60062, USA.

The McIlvaine Co. has published a manual containing information on centrifugals and centrifuges. This loose-leaf publication is updated monthly with the latest information on the equipment for use in process and pollution control applications, and is intended to help in purchasing and engineering decisions, in cost estimation and in determination of the applicability to specific problems. Data on performance and industrial problems are included for each application. A 55-page directory is included which identifies the leading manufacturers of centrifugals and centrifuges and types of equipment used in 250 specific processes and pollution control applications in North America. Among the 31 manufacturers are companies well known in the sugar industry, including BMA, Thomas Broadbent & Sons Ltd., The Western States Machine Co. and Dorr-Oliver Inc. The manual costs $310 per year, while the directory is available either as part of the manual or can be purchased separately at $40.

Equipment from Sulzer-Escher Wyss

Sulzer-Escher Wyss Ltd., CH-8023 Zürich, Switzerland.

Literature available from Sulzer-Escher Wyss describes a wide range of machinery applicable in many different industries, including the well-known Escher Wyss push-type centrifugals developed many years ago, as well as fluidized bed dryers and centrifugal decanters (the latter comprising a solid-bowl centrifuge with screw conveyor designed for waste water mud treatment).

Ball sector control valve

NAF AB, S-581 87 Linköping, Sweden.

A new heavy-duty ball sector valve, the NAF Setball, has been launched. It has a solid stellite seat ring held in contact with the hard-chromed stainless steel ball sector by a spring washer, which enables the valve to provide a tight seal even at low pressures, backlash being eliminated by use of a splined connexion between the ball sector and drive stem, while the one-piece stainless steel body ensures no body joint leaks. Operating torque is low, so that small actuators can be used and the overall costs minimized. The valve can be supplied fitted with electro-pneumatic positioners or electric actuators. A 4-page brochure describes the valve.

Corrosion-resistant valves

Asahi/America Inc., Dept. T, 425 Riverside Ave., Medford, MA 02155, USA.

A 7-page brochure gives data on Asahi/America thermoplastic valves of various types, including ball, horizontal swing check, gate, globe, butterfly and diaphragm valves. The ball and diaphragm valves are available with electric or pneumatic actuators, details of which are also given.

Hydrocyclones

Carter Industrial Products Ltd., Bedford Road, Birmingham B11 1AY, England.

A leaflet newly available from Carter Industrial Products describes the manual or automatic Carter Doucet DSA hydrocyclones for removal of suspended solids such as sand, dust and scale components that are heavier than water. The units will operate at temperatures in the range 4-200°C and pressures in the range 1.8-16 bar, and are designed to protect piping, valves and equipment.

Centrifugal pumps

Tangie Engineering Ltd., Blandford Heights Industrial Estate, Blandford, Dorset, England.

Literature from Tangie Engineering describes the company's various types of close- and long-coupled end-suction pumps (available in horizontal or vertical forms and, in the case of the horizontal unit, possibly made of polypropylene to handle severe chemicals), high-pressure multi-stage pumps, mixed/axial-flow propeller pumps, tank/sump mounted pumps, self-priming pumps, single-screw positive-displacement pumps, lubrication pumps and a range of pressure-boosting packaged pump sets.

Dome valve

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

Bulletin 900A describes the Macawber dome valve, which is a single-action, pressure-tight valve designed for bulk materials and abrasive slurries. It provides an automatically applied pressure seal when closed and is available in two standard versions: for attachment to process vessels or bulk storage hoppers, and for installation in pipelines or bulk conveying lines.

Hitachi Zosen involvement in the sugar industry

Hitachi Zosen Corporation, 6-14 Edobori 1-chome, Nishi-ku, Osaka 550, Japan.

The latest available copy of *Hitachi Zosen News* (November, 1984) includes a feature article describing the company's activities in the construction of complete sugar factories, covering a period stretching from 1956 (with the erection of two plantation white sugar factories for the Burmese government) to the completion in 1984 of the Medan factory in Sumatra (Indonesia) and of the Loukkos sugar factory/refinery in Morocco.

Rotary shunt meter

Kent Industrial Measurements Ltd., Flow Products, Oldends Lane, Stonehouse, Glos. GL10 3TA, England.

A recently published colour brochure features the Kent rotary shunt meter for use with steam (although the unit is also applicable to metering of water, air and clean gas flow). Since 1924, more than 75,000 of these robust, relatively inexpensive mechanical meters have been sold in many countries for a wide range of applications. The meter is available in three sizes (50, 75 and 100 mm) for direct installation in horizontal pipelines (a bypass arrangement is used for larger main sizes and vertical pipelines); a self-contained 5-digit counter calibrated to customer requirements is included, although provision is made for an optional micro-switch output for use with a remote electro-mechanical counter or for connexion to control equipment.

Screw press

The Dupps Company, Germantown, OH 45327, USA.

The Pressor screw press from Dupps provides rapid, high-capacity moisture removal in the processing of various raw and waste materials. It is available in three capacity ranges, providing up to 1500, 2000-3000 and 4000-7000 lb of press cake per hour, respectively.

Microcalorimeter

Microscal Ltd., 79 Southern Row, London W10 5AL, England.

A recently published brochure describes the FMC-3S and FMC-3V (standard and vacuum models, respectively) Microscal flow-type microcalorimeters for use in measuring heats of interactions involving particulate solids immersed in flowing liquids or gases, or two merging fluid streams.

Cane crane order from Mauritius

John Smith (Keighley) Ltd., a West Yorkshire-based member of the Norcros Group, has been awarded a contract to supply a £70,000 electric overhead travelling crane to Mon Désert-Alma Ltd. in Mauritius. The crane will be used for cane grabbing and will have a lifting capacity of 10 tonnes; it will incorporate special weather covers and anchor clamps for protection against strong winds and the humid conditions encountered on the island. Since the 70-ft span crane will be working under demanding conditions, the suppliers have been asked to incorporate high-hoist and cross travel speeds of 120 and 150 ft/min in addition to a normal long travel speed of 250 ft/min. John Smith has built grabbing cranes for many applications in different countries.

Molasses pumping

Twelve Bredel heavy-duty peristaltic pumps supplied by Alpha Technical Services Ltd., of Harrow, Middx., England, have demonstrated their ability to handle molasses used in the manufacture of animal fodder. The pumps, Model SP 40, transfer the molasses at ambient temperatures and 6500 cp viscosity to storage and from storage at closely controlled metered quantities to mixers for blending with dry products. Typical pump output is 2000 litres/hr at 1.3 bar pressure. Major factors in the choice of the pumps included the glandless construction inherent in the design of peristaltic pumps and the ability to provide precise, accurate, repeatable flow rates within limits of ±1%. A variety of other rotary positive-displacement pumps had failed to provide the required accuracy and had suffered from gland leakage. Each pump is fitted with a Bredel pulsation damper to ensure pulseless flow (a necessary requirement because of the molasses delivery through flow meters). The construction of the hose tube (the only pump component in contact with the molasses) is of great importance; it consists of an inner core of soft natural rubber and an outer covering of hard rubber reinforced with braided nylon. The hose travels through a sealed housing containing a glycerine/glycol mixture that cools and lubricates it, thus maintaining elasticity and prolonging life. Operating intermittently throughout a 24-hour working day, some pumps at the plant have required only one hose in two years.

Steam/water separators

Under normal conditions, the steam produced at South African sugar factories for power generation and mill drive applications is of high quality and contains no moisture or entrainment. However, in abnormal situations, water may occur in the steam, and Kelburn KSS line cyclone steam separators have proved of value at a number of factories in removing such water from the steam line. Designed in collaboration with Peter Brotherhood PLC, of Peterborough, England, the separator is capable of handling a full-bore water slug using a drain leg of sufficient capacity to ensure that any risk of damage to steam turbines is minimized. Since the separators are cyclones, pressure drop is minimal, and the units are easily installed in existing steam ranges. The manufacturers, Kelburn Engineering, are represented in Southern Africa by Craigie Engineering Sales & Services, P.O. Box 749, Kloof, Natal, South Africa 3640.

Data capture system

A £2 million scheme is being implemented by British Sugar plc following the success of a pilot scheme at its King's Lynn sugar factory[1]. By 1986, all the factories will have an automatic beet delivery control scheme (developed by Data General Ltd., Hounslow House, 724-734 London Road, Hounslow, Middx. TW3 1PD, England), with data entry at the weighbridges, beet sample point and tarehouse using bar code readers. Three levels of hierarchical resilience are provided so as to prevent data loss and weighbridge traffic delays resulting from hardware failure. Data will be stored in the memories of Data General MP100 microcomputers; should one of these units fail, it can be replaced with a spare by factory staff. The data are communicated by a Data General Eclipse S/20 computer to an IBM 8100 minicomputer in the factory office. If this or the communication link fails, the Eclipse will log data to an IBM diskette unit. At the end of each day, the minicomputer prints end-of-day management reports compiled from the collected data; when they have been cleared, the data are then transmitted to a central mainframe computer in Peterborough via the telephone network.

1 See *I.S.J.*, 1985, **87**, 50-55, 66-70.

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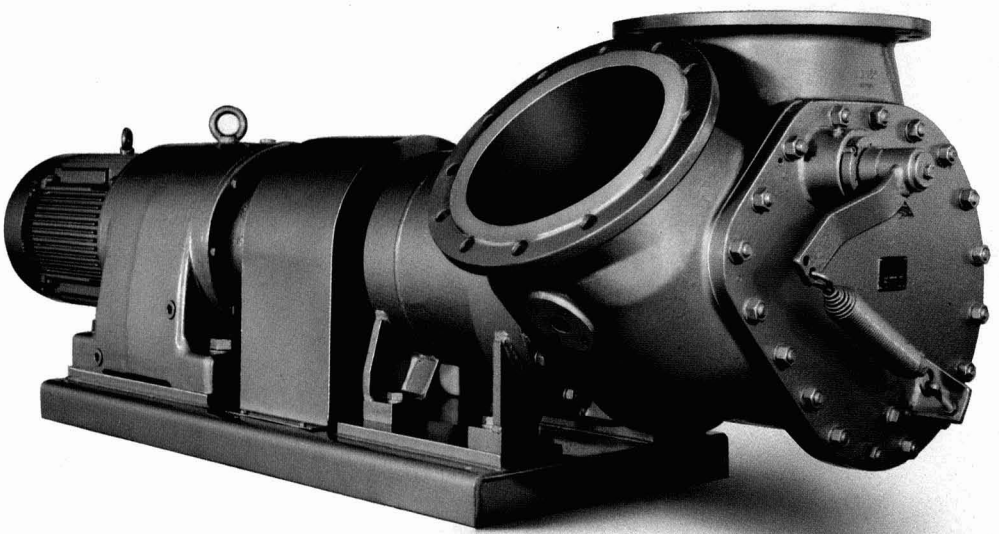

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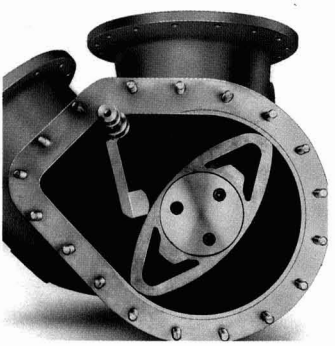

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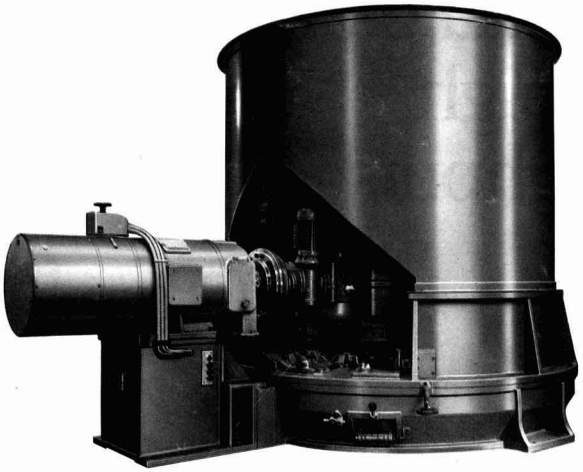

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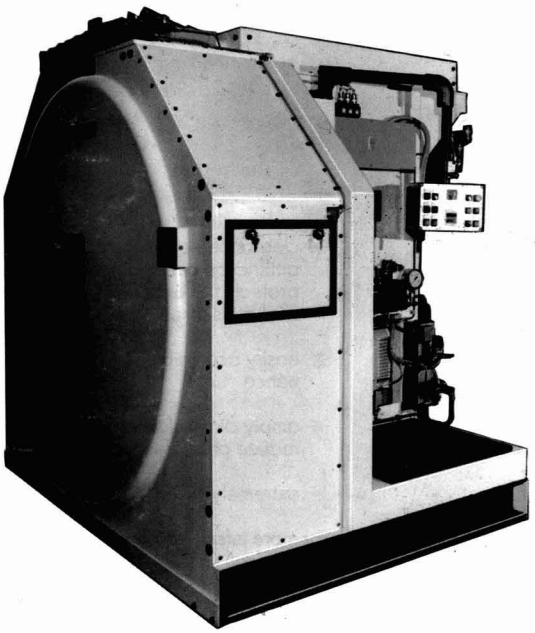

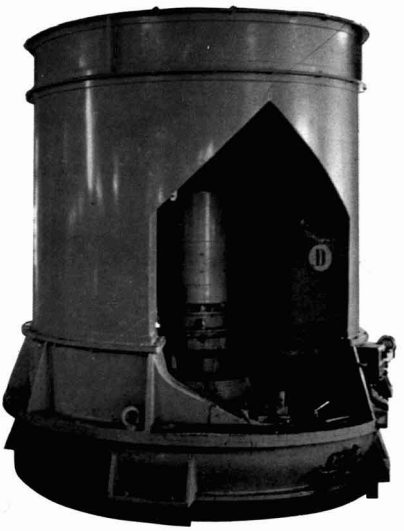

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