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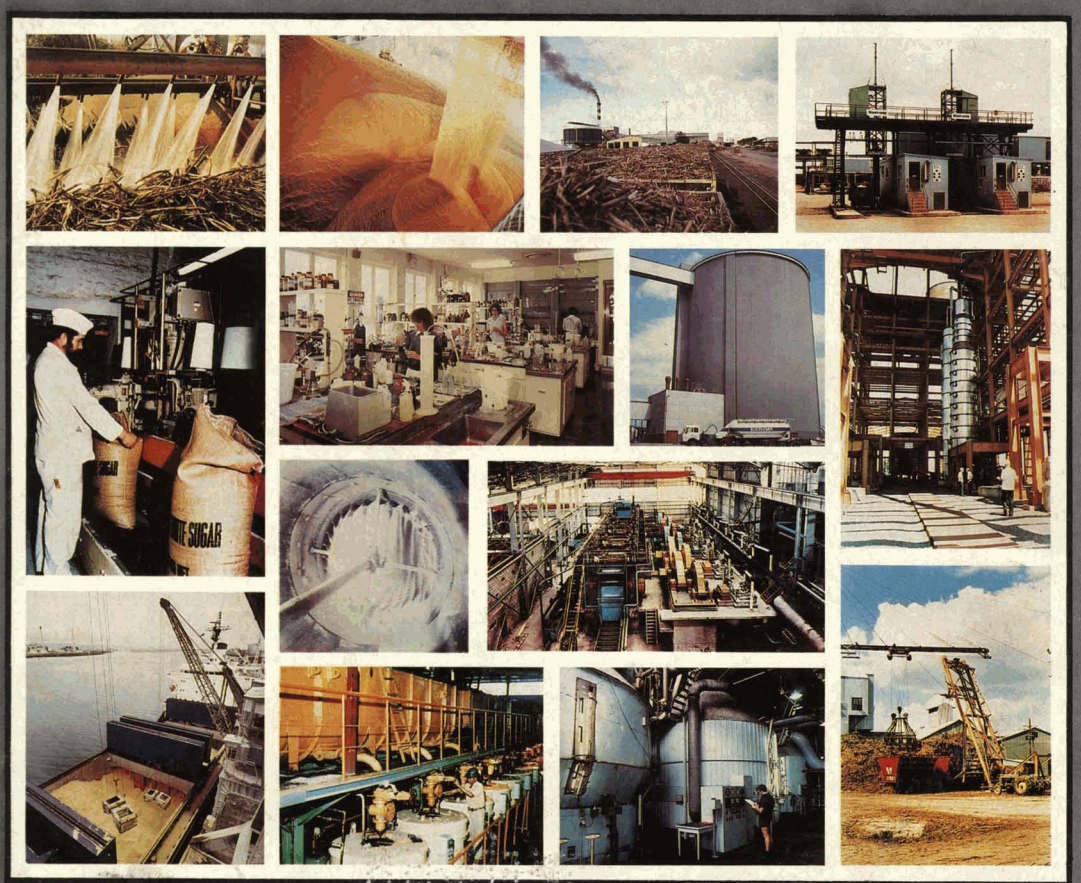

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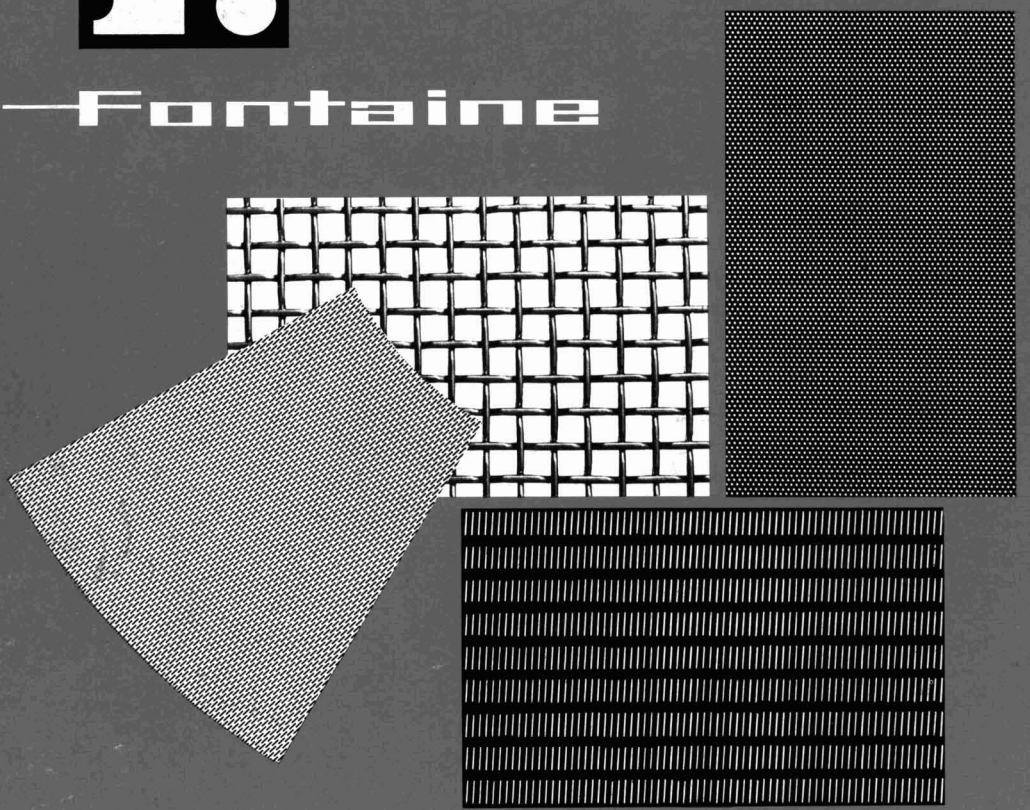

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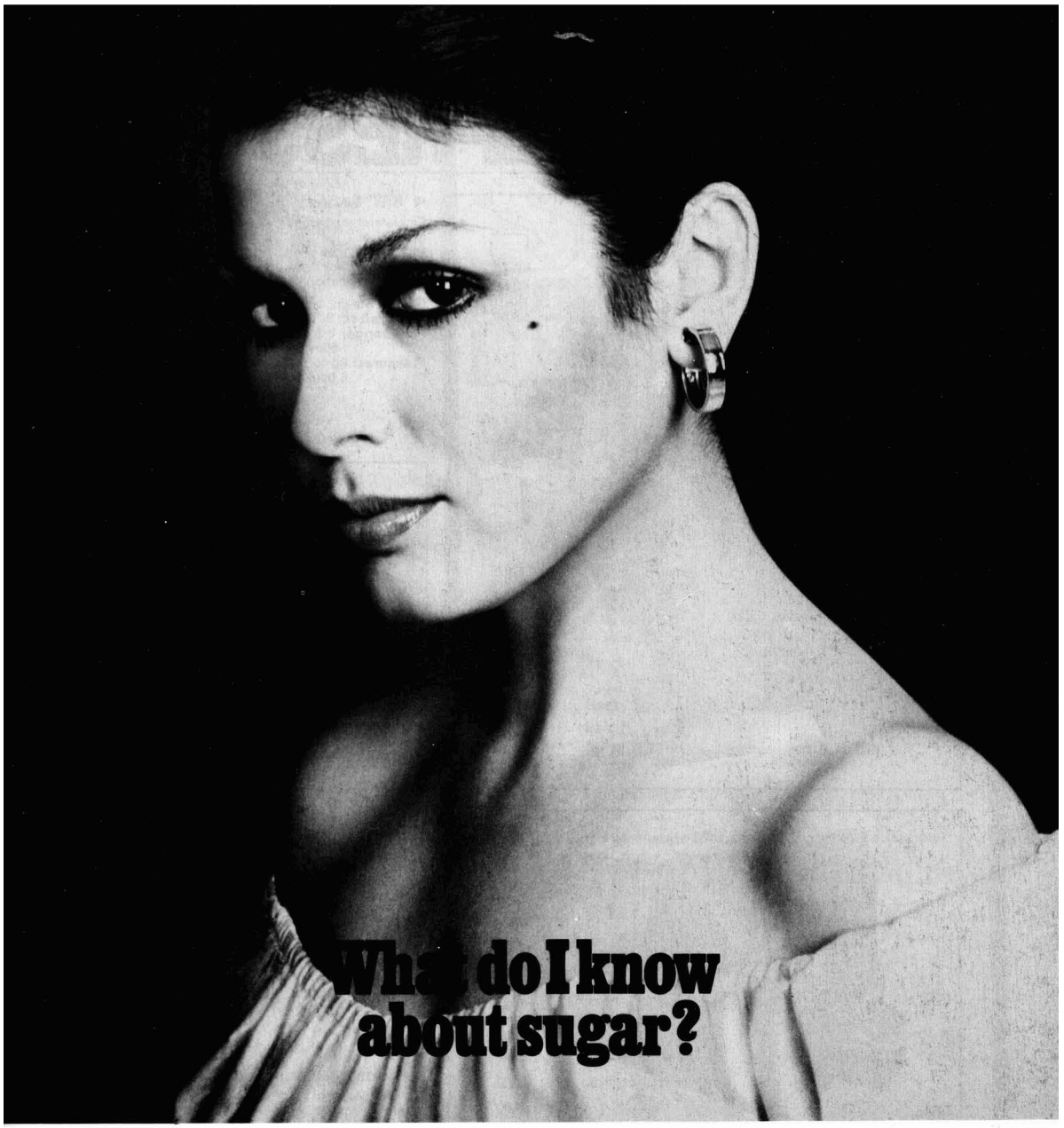

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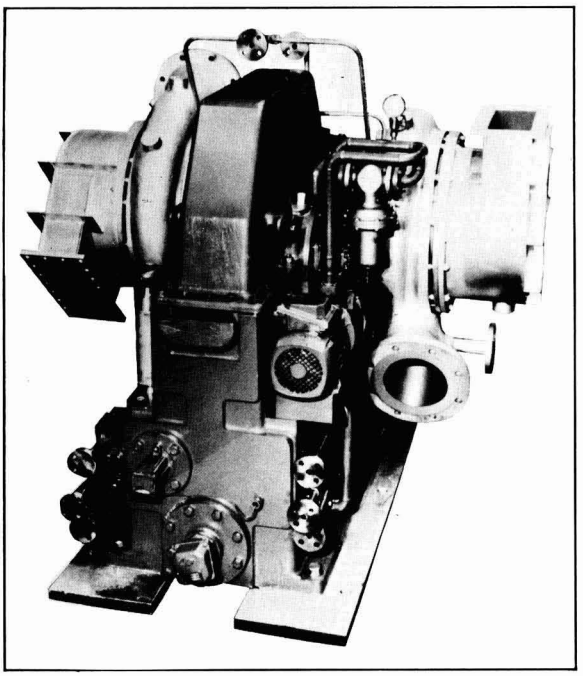

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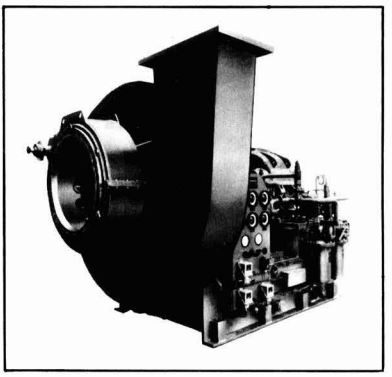

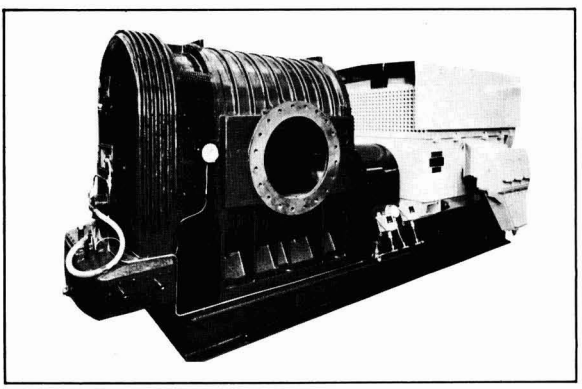

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NOTES AND COMMENTS

UN sugar conference

The conference in Geneva, held under UNCTAD auspices for negotiation of a new International Sugar Agreement, opened on May 2 and concluded its first session on May 20. Spokesmen later referred to better understanding of other countries' views, which usually means that deadlock prevails because of adherence to entrenched positions, and it appears that this was the case regarding some matters, such as the inclusion of Cuban exports to other Comecon countries in a new ISA. The EEC showed more flexibility but still insisted that stocks should be used as the regulatory mechanism instead of quotas, a view not accepted by the other sugar exporting countries. Little support was offered by the US, whose administration is basically opposed to commodity agreements, and the importing countries were opposed to measures which would involve their contribution to the cost of holding stocks designed to maintain prices on the world market. Prospects for a new Agreement seem uncertain, therefore, although a consultative group of exporters and importers are to meet in London in July to try to explore further the possibility of compromises, while UNCTAD has been asked to convene a second conference in Geneva in the autumn.

EEC farm prices

It was in December last that the EEC Commission presented its proposals on farm prices to the Community's Agriculture Ministers. They provided for an overall increase of 4.4% but, for produce such as sugar which is in surplus, the increase was limited to 4.0%. Predictably, farmers' lobbies protested at increases which were below the rates of inflation in their countries.

The crisis in the French economy which resulted in a realignment of the currencies in the European Monetary System introduced a further complication, since they affected the relative values of individual national currencies to the E.C.U. or European Currency Unit in which the farm prices are calculated. Theoretically, the common price should apply to all Community members, and the way that member governments have got round this, in order that their farmers shall be kept happy, is the device of the so-called "green" currencies which are different from the real currencies and allow farmers to be paid higher sums than the true equivalents of the E.C.U. prices. The Commission continued to object to higher E.C.U. prices than proposed, and this was backed by the UK and German ministers. However, the recent revaluation of the Deutschmark means that the same E.C.U. price means a fall in terms of the real DM, so the question became one of the green currency changes to be introduced.

Eventually, on May 17, the Council of Ministers agreed to adopt the 4.2% average increase proposed by the Commission. The record crops and surpluses of the past few years, coupled with low prices on the world market, have entailed a substantial cost to the Community's funds so that the price increases for the sugar sector were set a little lower than the average, at 4.0%. Thus the common prices agreed for beet were 40.89 E.C.U./tonne and for sugar 534.0 E.C.U./tonne (equivalent to £25.30 and £330.79 per tonne, respectively), to apply from July 1, 1983, compared with 39.32 and 514.10 E.C.U./tonne (£24.33 and £318.05, respectively) for 1982/83. The actual price paid to UK farmers for their A-quota beet will be £25.76 per tonne, and the intervention price for white sugar will be £338.28 per tonne.

European sugar beet areas, 1983

Only small differences from their initial assessment of 1983 beet areas in Europe are revealed in the second estimates published by F. O. Licht GmbH[1].

The EEC figure is 4000 hectares lower than was expected in March[2], the net result of a further decrease of 15,000 ha in France but an area now expected to be 11,000 ha higher in West Germany. Austria is expected to sow 2000 ha less and Spain 10,000 ha less, giving an overall figure of 2,653,000 ha for Western Europe, a reduction of 4.36%. In East Europe, the figures are unchanged except for the USSR. The official figure for the 1982 beet area has been announced and is 3,526,000 ha instead of the 3,620,000 ha of Licht's first estimate. Consequently, the new estimate for the 1983 area, 3,550,000 ha, represents an increase of 0.7% on 1982 instead of a reduction.

Apart from East Germany, weather conditions in East Europe have favoured early sowing of the crop. In West Europe and East Germany, however, abundant rains have resulted in flooding and waterlogged fields so that sowing has been very much delayed. This is likely to result in a further reduced area and lower crop, and much depends on the continuing weather. However, it seems likely that the excellent growing conditions of the past two years are not to be repeated, so that a smaller outturn is to be expected in Western Europe, compared with 1981/82 and 1982/83.

International Sugar Organization

The Council of the ISO, meeting during the Geneva conference, agreed to adopt a new estimate of world free market requirements for 1983 of 19,330,000 tonnes, as against the estimate in November 1982 of 18,340,000 tonnes. Estimated net exports by East Germany are said to remain at 110,000 tonnes, non-ISO member exports are set at 5,737,000 tonnes and small exporter tonnages at 491,000 tonnes, leaving a 1983 global quota of 12,990,000 tonnes, raised from the 12 million tonnes of the earlier estimate.

The Executive Committee is reported to have deferred again[3] the application by Norway for increased imports from non-members, while consideration was given to allegations of excess imports from non-members by Egypt, Iraq, Mexico and the USSR.

US re-export of refined sugar

As expected, the US administration has agreed to the waiving of import duties on raw sugar imports for refining and re-export. This operation, known as tolling, was the reason why US refined sugar exports expanded greatly in 1980 and 1981 but fell again in 1982 when duty could not be reclaimed.

According to the rules published in the *Federal Register,* licences will be issued for the import of quota-free raws up to 25,000 short tons which must be re-exported within three months. The amount of sugar and

[1] *International Sugar Rpt.,* 1983, **115**, 217-220.
[2] *I.S.J.,* 1983, **85**, 129.
[3] *ibid.,* 161.

its pol content must be certified for setting against the licence and a bond must be posted to ensure that the sugar is only used for tolling. Once a licence has been used, the refiner may apply for another and there is no limit to the number issued in succession. The refined sugar exported must correspond to the raws imported, but it does not have to be the same physical sugar, and the exporting may even take place before entry of the corresponding raw sugar.

The proposals were open for public comment up to May 9 after which revisions would be incorporated if necessary before bringing them into effect, probably in June. However, it has been reported that one trade house has already made a transaction with a refiner for re-export of a quantity variously mentioned as between 60,000 and 150,000 tons.

World sugar prices

Unsettled weather in Europe, with a great deal of rain, has continued through much of the spring of 1983 and has caused considerable delays in sowing of beet seed. Most countries have completed sowings by early May and do not consider it worthwhile planting after mid-May because of the consequent shortness of the growing period. During May 1983 it became clear that delays in sowing and the poor conditions were going to result in a crop much lower than expected earlier.

At the same time there have been continuing reports of other weather-affected crops in the Southern Hemisphere where drought was the principal cause of cane yield reductions. It was announced that the South Africans were trying to persuade Japanese refiners to seek supplies elsewhere owing to their diminished output, and that Cuba too was advising its customers to seek sugar elsewhere because of a production level variously estimated at 1-2 million tonnes below the original planned figure. The market consequently enjoyed a period of increasing values, the LDP rising from £128 on May 1 to £152 on May 19. The climb was reversed the next day when Japanese trade houses ceased buying but resumed at an even greater pace during the remainder of the month, reaching £187 per tonne on May 31, its highest level for two years and an almost 50% rise during the month. This spurt was influenced by a number of sales to countries such as the USSR, Canada and South Korea, covering their requirements which would otherwise have come from Cuba and South Africa, as well as new pessimistic forecasts of production in EEC member countries.

White sugar values were affected equally with those of raw sugar, and the LDP(W), which started the month at £149 per tonne, rose to no less than £207 by March 31.

US quota cut for Nicaragua[1]

On May 10, President Reagan announced changes in the quota of US sugar imports for four Central American countries. Nicaragua's quota of 58,000 short tons, raw value, was cut to 6000 tons, with effect from October 1, the difference being reallocated to Honduras, which receives 52%, Costa Rica which receives 30% and El Salvador 18%. According to a White House press release, the action had been taken to help relieve enormous problems in the three recipient countries caused in large part by Nicaraguan-supported subversion. The quota transfer will represent a benefit of some $14 million to the three countries and a corresponding loss to Nicaragua which, the President hoped, would reduce the resources available to that country for financing its military build-up.

The move was denounced by Nicaragua at the International Sugar Conference in Geneva and elsewhere as a breach of the ISA and of the principles of the GATT; later, it was announced that Nicaragua had received assistance by contracts for sugar sales to Algeria and Libya.

World sugar balance, 1982/83

F. O. Licht GmbH recently published[2] their third estimate of the world sugar balance for the period September 1982/August 1983 and, by comparison with the second estimate[3], have raised the production figure by some 400,000 tonnes. A much larger jump in consumption, is now expected, however, to more than 3 million tonnes over that for 1981/82. Nevertheless, the new figures, reproduced below, show a surplus production of 4.3 million tonnes and a record final stock figure of 36,660,000 tonnes.

	1982/83	1981/82	1980/81
	tonnes, raw value		
Initial stocks	32,824,000	24,339,000	25,176,000
Production	99,056,000	100,499,000	88,070,000
	131,880,000	124,838,000	113,246,000
Imports	29,021,000	31,708,000	28,671,000
Exports	− 29,499,000	− 32,085,000	− 28,219,000
	131,402,000	124,461,000	113,698,000
Consumption	94,742,000	91,637,000	89,359,000
Final stocks	36,660,000	32,824,000	24,339,000

Discussing the future outlook, Licht writes: "Much of the current optimism stems from the belief that world production next year may fall off in response to lower prices and adverse weather. In fact, the extraordinary accumulation of world sugar stocks that began in 1981/82 is likely to end in 1983/84. Early indications are that world production next year could fall to roughly 95 million tonnes, while consumption could grow to 96 million tonnes. However, even if consumption should overtake production by 1 million tonnes, this would only make a small improvement in the world statistical position following upon annual surpluses of 4.3 and 8.9 million tonnes in 1982/83 and 1981/82, respectively. The worst that could happen to the world sugar economy would be a steep decline in 1983/84 production caused by adverse weather conditions in key growing areas, as this would mask the greatest problems of the world sugar economy, namely over-capacities, and could sow the seed of the next destructive swing of the sugar cycle. Unless major decisions to cut back production capacities are taken there seems little prospect of overcoming the structural surplus problem."

India sugar crop reduction measures

India, the world's second largest sugar producer this year after Brazil, is to make an attempt to reduce surplus output by encouraging farmers to switch to oilseeds or pulses, according to a spokesman at the Agriculture Ministry[4]. The government, he said, hopes to stabilize output at around 7 million tonnes annually. This compares with an expected 8 million tonnes this season and 8.4 million tonnes last season. As domestic consumption is in the region of 6 million tonnes, stocks are reaching unacceptably high levels.

The government has held its white sugar from the market because of low prices and in 1982 exports, at some 500,000 tonnes, were below the ISA export entitlement of 650,000 tonnes. A series of export tenders is expected to be held soon by the State Trading Corporation and some 250,000 tonnes is thought to be on offer.

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1 *Sugar Bull.*, 1982, **61**, (17), 6.
2 *International Sugar Rpt.*, 1983, **115**, 257-261.
3 *I.S.J.*, 1983, **85**, 66.
4 *Public Ledger's Commodity Week*, March 26, 1983.

A comparison of media used in the bacteriological analysis of sugar

By R. P. MURPHY
(Research & Development Dept., Irish Sugar Co. Ltd.,
Carlow, Ireland)

Introduction

In the bacteriological analyses of white sugar using the officially recommended Canners test procedure for mesophilic bacteria[1,2], it was noticed that the ability to establish the size of the microbial population in any sample depended completely on the medium used. It could also be shown that the reproducibility of results improved when using media on which the total counts were consistently higher than on other media. Variations of more than ± 50% from the mean of replicate results have been accepted by various authors when assessing total viable count by the plate count method[3,4,5].

An examination of the results shown in Table I in which ten replicates were analysed show that, when a general purpose medium was used, the greatest deviation from the mean did not exceed ± 33% while that obtained with the more apparently selective medium exceeded ± 55% expressing both as a percentage of the mean. If we consider the actual spread of these results, it is seen that the highest result shown in column 2 of Table I is slightly less than twice the lowest, whereas in Column 3, the highest result is over three times the lowest.

As it is not usual to examine ten replicates of each sample tested in routine analyses, it will be seen that even when two samples are analysed, one could be in error by over 300% of the declared result. These considerations have indicated the desirability of the work described below.

Table I shows the results of measurements at 37°C using this medium (Oxoid, Nutrient Agar) and Dextrose Tryptone Agar. The ten sugar samples were taken from a 1 kg bag and were thoroughly mixed before being resampled as detailed below. The results of this examination showed that the Dextrose Tryptone Agar suppressed the growth of a high proportion of the organisms present.

Methods

The method used is the Canners' test procedure recommended by ICUMSA, i.e. 20 g of sugar is dissolved aseptically in 100 ml sterile water. After thorough shaking, 1 ml is pipetted into each of five Petri dishes for each temperature. The test medium is added, mixed and allowed to solidify. The inverted plates are incubated at 22°C for 72 hours, 30°C for 72 hours, 37°C for 72 hours, 37°C for 48 hours and 55°C for 24 hours.

R. P. Murphy

Combined counts of the five plates, multiplied by 10, should give the total mesophilic count per 10 g of sugar.

Table I

Sample No.	Nutrient Agar	Dextrose Tryptone Agar
1	360	80
2	300	60
3	280	40
4	240	100
5	400	120
6	380	80
7	220	110
8	420	140
9	360	120
10	340	90
Average	330	94

The media used had the following formulae:

(1) *Dextrose Tryptone Agar*

Tryptone	10 g
D (+) glucose	5 g
Bromocresol purple	0.04 g
Agar	15.0 g

(2) *Nutrient Agar*

Lab Lemco Beef Extract	1 g
Yeast extract (Oxoid 30)	2 g
Peptone (Oxoid 37)	5 g
Sodium chloride	5 g
Agar	15 g

(3) *Special Agar*

Lab Lemco Beef Extract	1 g
Yeast extract	2 g
Peptone (Oxoid 37)	5 g
Sodium chloride	5 g
Agar	15 g
Bromocresol purple	0.04 g

(4) *Shapton Medium*

Peptone (Oxoid 37)	5 g
Tryptone (Oxoid 42)	2.5 g
Lab Lemco (Oxoid 29)	3.0 g
Yeast extract (Oxoid 20)	1.0 g
Dextrose	1.0 g
Bromocresol purple	0.025 g
Agar No. 3 (Oxoid 13)	15.0 g

1 "Sugar analysis - ICUMSA Methods" Ed. Schneider. (ICUMSA, Peterborough) 1979, p. 150.
2 *ibid.*, p. 157.
3 "Microbiological Specifications for Dry Soups". (Assoc. International de l'Industrie des Bouillons et Potages).
4 Murphy: *Paper presented to the Inaugural Meeting, Irish Inst. Food Technology.*
5 Mallette: "Methods in Microbiology" Ed. Norris & Ribbons. (Academic Press, London) 1969, pp. 521-566.

In a second method using the above media, 25 g of sugar is dissolved in 75 ml sterile Ringers solution and 2 ml of this solution is used per Petri dish. Duplicate dishes are incubated at the above temperature. The combined counts per temperature are multiplied by 20 to give the approximate counts per 10 g.

Results

In Table II, three commercially available media are compared as regards their ability to grow bacteria in the middle of the mesophilic range. It is shown that at both 30°C and 37°C, both of the media containing bromocresol purple suppress some of these bacteria. As medium containing this dye has been recommended for the enumeration of thermophilic and/or spore forming organisms, the temperature range was increased to include both the lower mesophilic and the thermoduric range.

Table II

	Nutrient Agar		Dextrose Tryptone Agar		Shapton Medium	
Sample	30°C	37°C	30°C	37°C	30°C	37°C
1	360	440	170	280	160	210
2	360	490	260	280	200	270
3	410	370	170	190	140	170
4	350	270	250	360	280	190
5	330	380	210	240	310	180
6	300	380	160	140	140	280
7	270	340	210	150	90	220
8	270	330	250	250	190	200
9	210	250	200	240	130	220
	320	360	210	240	170	210

A special agar was prepared by adding a small amount of bromocresol purple to Nutrient Agar to see if, as suspected, it was the presence of the dye which inhibited some of the organisms.

The results are presented in Table III.

Table III

Temperature	Special Agar	Shapton Medium	Dextrose Tryptone Agar	Nutrient Agar
22°C	250	300	400	875
30°C	675	575	450	1250
37°C	1000	625	825	1600
55°C	625	1100	625	2325

The figures given in this table are individual results from a selection of samples of sugar taken from the same source. These show the range of the population measured and a comparison of three of the media used.

In Table III are compared the performance at four temperatures of the four media under test. For this test, 2 white sugars were used. Each result shown is an average of the relevant tests on both sugars.

As the adverse effect of bromocresol purple when included in the growth medium has been demonstrated, its effect when poured on Petri dishes after the organisms had been grown was tested. The results are shown in Table IV. In this the acid-producing organisms are estimated on Dextrose Tryptone Agar as recommended and compared with organisms grown on Nutrient Agar which was overlaid after incubation with 1.5 ml of 0.04% bromocresol purple in distilled water. It is shown that acid-producing bacteria can be demonstrated by this method and, as expected, the amounts exceed those shown by the conventional method. As each plate contains approximately 15 ml of agar, the relative proportion of bromocresol purple has been maintained.

Table IV

	Nutrient Agar		Dextrose Tryptone Agar	
Sample No.	30°C	55°C	30°C	55°C
1 Sugar	20	5	7	nil
2 Sugar	5	15	2	nil
3 Sugar	10	15	2	nil
4 Sugar	10	10	1	nil
5 Sugar	15	5	1	nil

Discussion

Bromocresol purple has been recommended[1] for the enumeration of thermophilic aerobic spores and for "flat sours" and for the determination of total mesophiles[2]. The foregoing shows that not only does it inhibit a high proportion of the organisms but that it has a very adverse effect on the reproducibility of the counts. Table I compares the reproducibility of results obtained using the recommended medium Dextrose Tryptone Agar and Nutrient Agar. Table II shows the inhibition due to bromocresol purple by comparing results obtained on two media containing this compound with those using Nutrient Agar. Table III demonstrates that the effect is definitely due to the dye by comparing not only the commercially available media containing it, but two media made up in the laboratory which differs only in the fact that one (Special Agar) contains the dye. The results in this table also show that the inhibitory effect of the dye is spread over a very wide temperature spectrum. This is interpreted as suggesting that the effect is not confined to a single type or variety of organism.

As the results described above indicate that flat sours cannot be enumerated by the simple inclusion of a dye in the nutrient medium the effect of adding a pH indicator after incubation was investigated. This technique works well in other types of bacterial determinations[6] and the counts shown in Table IV indicate that flat sours can be counted by this method.

In conclusion, it is interesting to note that the majority of counts produced when using Dextrose Tryptone Agar are below the standard of 200 per 10 g required by Canners while nearly all of the counts found on Nutrient Agar are far in excess of this figure. It seems that the standard of 200 organisms per 10 g used by Canners is unreasonable as it is based on figures produced by a growth medium which has been shown to inhibit growth.

Acknowledgements

I would like to thank my assistant Miss F. Anderson who carried out all the work described above. I would also like to thank Mr. N. Nolan, Director of this Department, for his advice in the preparation of this paper.

Summary

During the routine bacteriological examination of white sugar, it was noticed that the medium which was officially recommended for this purpose, i.e. Dextrose Tryptone Agar, gave results which were very considerably lower than results obtained by the use of Nutrient Agar No. III. An investigation into the cause of this discrepancy indicated that the dye used in Dextrose Tryptone Agar, viz. Bromocresol purple, inhibited considerable numbers of bacteria. It was concluded that

[6] Blair, Emerson & Tull: *Amer. J. Clin. Path.*, 1967, **47**, 30-39.

media containing this dye are unsuitable for bacteriological enumeration.

Comparaison de milieux nutritifs utilisés pour l'analyse bactériologique du sucre

Au cours de l'examen bactériologique de routine des sucres blancs, on a noté que le milieu officiellement recommandé à cet effet, à savoir Dextrose Tryptone Agar, donna des résultats considérablement moins élevés que ceux obtenus en utilisant le Nutrient Agar n° III. En examinant la raison de cette différence, il est apparu que le colorant utilisé dans le Dextrose Tryptone Agar, c.-á-d. le pourpre de Bromocrésol, inhibait un nombre considérable de bactéries. On est arrivé à la conclusion que les milieux renfermant ce colorant sont impropres pour des comptages bactériologiques.

Vergleich von Mitteln, die zur bakteriologischen Analyse von Zucker verwendet werden

Bei der routinemäßigen bakteriologischen Untersuchung von Weißzucker wurde festgestellt, daß das für diesen Zweck offiziell empfohlene Mittel, Dextrose Trypton Agar, Ergebnisse aufwies, die beträchtlich unter den Ergebnissen mit dem Nährboden Agar Nr. III lagen. Eine Untersuchung der Ursache dieser Diskrepanz zeigte, daß der in Dextrose Trypton Agar verwendete Farbstoff, Bromkresolrot, beträchtliche Mengen von Bakterien inhibierte. Daraus wurde geschlossen, daß Mittel, die diesen Farbstoff enthalten, für die bakteriologische Keimzählung ungeeignet sind.

Un comparación entre medios empleados en el análisis bacteriológico del azúcar

Durante el examen bacteriológico rutinario del azúcar blanco, se ha observado que con el medio recomendado oficialmente para este fin, es decir Dextrosa-Triptona-Agar, se obtuvieron resultados muy notablemente menos que ellos obtenido por uso de Agar Nutriente No. III. Un investigación de la causa de esta discrepancia indicó que el tinte usado en Dextrosa-Triptona-Agar, a saber Púrpura Bromocresol, inhibió poblaciones notables de bacterias. El autor saca la consecuencia que medios que contienen este tinte no estan apropriados para enumeración bacteriológica.

Removing insoluble matter from standard liquor

By N. R. TWAITE, M. SHORE and A. J. RANDALL
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PART II

Economic evaluation of alternative systems

As indicated earlier, Schenk filters have been used in all recent installations. Taking this system as the base case, the alternatives are considered from an economic standpoint as follows, with figures based on a 5000 tonnes/day factory as at King's Lynn.

(a) Capital costs

Centrifuge system costs are based on recent quotations from Alfa-Laval Co. Ltd. together with experience of installation costs at the trial installation at King's Lynn factory.

Schenk system costs are based on installation costs of equipment already in the Company.

Table XI

Scheme	Capital costs of alternative schemes, £ x 1000						
	Major Plant Items	Pipework and Lagging	Civil Work	Install -ation	Electrical & control	Design	Total
Alfa-Laval Centrifuges	380	24	30	17	41	8	500
Schenk	318	59	74	33	106	10	600
Auto Plate & Frame	276	14	15	18	39	8	370

Automatic plate and frame system prices are based on quotations from filter manufacturers with estimated installation costs.

(b) Running costs

Existing plate and frame running costs were arrived at from factory figures throughout the Company.

Centrifuge system costs are based on those experienced with the single machine at King's Lynn factory.

Schenk system costs are estimated from running costs at current British Sugar installations.

Automatic plate and frame system have been determined by discussions with suppliers and comparison with current manually-operated systems.

Table XII

Scheme	Running costs of alternative schemes, £/campaign						
	Labour	Filter aid	Filter cloths	Extra power	Dilution	Maint-enance	Total
Existing Plate & Frame Presses	26,000	12,450	7,630	-	-	2,350	48,430
Auto Plate and Frame Presses	6,500	12,450	3,900	750	5,620	1,900	31,120
Schenk Filters	13,000	14,050	-	3,760	24,700	4,400	59,910
Schenk Filters Water Precoat	13,000	14,500	-	3,760	50,780	4,400	85,990
Alfa-Laval Centrifuges	-	-	-	5,475	-	1,500	6,975

Table XIII. Running costs in £ per campaign

Scheme	Labour	Operating Materials	Power	Dilution	Maint-enance
Existing plate & frame filters	-13,000	-6,030	3,760	50,780	2,050
Automatic plate & frame filters	6,500	-2,300	3,010	45,160	2,500
Schenk filters	-	-	-	26,080	-
Schenk filters with water precoat	-	-	-	-	-
Alfa-Laval centrifuges	13,000	14,050	-1,715	50,780	2,900

It is assumed that an equally satisfactory product would be achieved with an automatic press station as is currently achieved with a manually operated plate and frame press station.

The automatic filter system used for this assessment precoats the filters with a water/precoat mix and so dilution has been accounted for in the running costs.

Although the Schenk filters are in theory automatic, in practice a man is needed at the station so a labour allowance has been made.

Two costs of dilution have been determined with and without the use of water as a precoat medium.

(c) Economic analysis

The basic assumptions of our analysis were that the life of all equipment was 10 years, that the discount rate of future benefits is 15.5%, and we have compared all running costs with those of the current installed system i.e. a Schenk system using water as precoating medium, thus carrying out a marginal benefit analysis. Benefits have been inflated over the next ten years in line with predictions of the Company Purchasing Department.

Table XIII demonstrates savings relative to the Schenk scheme with water precoat.

The table below demonstrates results of the economic analysis:

Table XIV

Scheme	Capital cost, £	Net present value, £	Profitability ratio
Existing plate & frame filters	-	400,000	-
Automatic plate & frame filters	370,000	150,000	1.4
Schenk filters	600,000	-340,000	0.4
Schenk filters with water precoat	600,000	-600,000	0
Alfa-Laval centrifuges	500,000	210,000	1.4

Retaining the present system gives the best case but, of the replacement options, the installation of centrifuges gives the best economic return. However, the inclusion of the existing plate and frame system in this analysis is likely to be a false case as the equipment may well not function for a further 10 years.

Effect of antiscaling agent on filtration

Antiscaling agents have been used for several campaigns at many European beet sugar factories to prevent scaling of the evaporators, pans and centrifugal screens and also by refiners to eliminate pan scale. A trial using KEBO DS was undertaken at Kidderminster factory during the 1980-81 campaign[9] and was very successful.

Following this trial, four different antiscaling agents were tried at a total of six factories. The only factory to have difficulties was Cantley, where slower filtration of the standard liquor prevented the trials from continuing. A change of antiscaling agent did not ease the filtration difficulties, so it was concluded that this was an equipment problem rather than a condemnation of antiscaling agents.

Results at factories completing the trials are given in Table XV.

In general, filtration at the above factories was little different from normal as was the insoluble matter in the sugar produced.

Table XV

Factory	Turbidity			Insoluble Matter mg/kg		
	79/80	80/81	81/82	79/80	80/81	81/82
Allscott	3.4	3.2	10	2.2	4.0	2.1
Bardney	6.8	8.2	18	4.2	5.4	2.5
Brigg	12.0	9.0	20	6.9	-	3.9
Kidderminster	8.2	20.1[X]	16	2.7	5.8	2.2
King's Lynn	4.8	4.3	12	3.5	4.1	4.6
Mean other factories	6.4	5.7	7	4.5	5.7	3.0

As has been reported in other countries, turbidities were somewhat higher than in factories not using the additive. It was found that an increased addition of the agent reduced turbidity[10] to normal levels.

Alternatives to treating standard liquor

If an examination is made of the components of standard liquor, the particular requirement for filtration of each can be evaluated.

- Thick juice from the evaporators requires the solids from beet and plant scale rust particles, some precipitation from SO_2 addition and some calcium carbonate from leaks on the second filtration to be removed. Additionally, some calcium salts such as oxalates and sulphates will be precipitated as the solution is concentrated above their solubilities.
- Raw and A.P. Sugar have already been crystallized and washed and as such should not contain many insolubles but some calcium oxalate will be present as fine crystals in the surface syrup.
- White centrifugal wash should not contain many insolubles.
- White remelt sugar, obtained from our own factory operations, or from customers, can and does contain a variety of substances and has to be filtered. However, this could be dissolved in thin juice and returned to the beet end for filtering in the second carbonatation system.
- If the filtration were carried out only on evaporator thick juice, then use of the lower Brix solution should result in much longer filter cycles with reduced filter aid usage. Only screening of standard liquor would then be necessary before the white pans.

Conclusions

(1) The solids removal equipment used should be matched to the market requirement for the type of sugar to be produced.
(2) No significant differences in sugar quality were detected with any of the solid removal systems tried at King's Lynn factory.
(3) Filtration and centrifuging allowed a similar but small amount of solids to pass through to the pans.
(4) The use of antiscaling agents only affected filtration rate at one factory but did result in an increase in white sugar turbidity values.
(5) The use of hydrocyclones gave results very comparable to those of filtration and centrifuging except at times of increased loading of solids such as when antiscaling agents were used.

9 Piercy: *British Sugar Internal Report*, 1981.
10 Shore *et al.: Paper presented to 45th Works Managers Conf. British Sugar Corp.*, 1981.

(6) There appears to be little between the economics of a modern automatic plate and frame filter station and a battery of centrifuges, but the latter have been subjected to more development work and hence would be a safer choice for a new installation.
(7) Further trials are needed on micro-filtration systems in the 20-50 μm size range to check the effectiveness of available filter media to deal with standard liquor.

Summary

The performances of plate-and-frame presses and Schenk filters within British Sugar is compared with that of other possible methods of removing insoluble particles, and results of tests carried out at King's Lynn factory over the last three campaigns are summarized. The capital and operating costs of the different systems are compared by taking actual costs from existing systems and projected costs of alternative installations at King's Lynn factory. It is concluded that use of screening and hydrocyclones may be sufficient for granulated sugar manufacture while the use of centrifuges or presses to remove additional suspended solids from standard liquor will be needed for making liquid sugar or white crystal sugar of very high quality. The influence of antiscaling agents on standard liquor filtration is discussed and the small increase in turbidity of the sugar at certain factories that carried out trials last campaign is shown.

L'enlèvement de matières insolubles de la liqueur standard

On compare la performance des filtres presses et des filtres Schenk installés à la British Sugar avec celle d'autres méthodes possibles pour enlever les particules insolubles. On résume les résultats d'essais effectués à la sucrerie de King's Lynn au cours des dernières trois campagnes. On compare les coûts d'investissement et d'opération des différents systèmes en se basant sur les coûts réels des systèmes existants et sur des coûts projetés pour des installations alternatives à la sucrerie de King's Lynn. On conclut que l'utilisation de tamis et d'hydrocyclones peut être suffisante pour la production de sucre granulé, tandis que la mise en oeuvre de centrifuges ou de presses pour enlever l'excédent de matières solides en suspension sera nécessaire pour produire du sucre liquide ou du sucre cristal de très bonne qualité. On discute de l'influence d'agents antitartrants sur la filtration de la liqueur standard et on montre la faible augmentation en turbidité du sucre dans certaines sucreries que ont fait des essais au cours de la campagne passée.

Entfernen von unlöslichen Stoffen aus der Standard-Kläre

Die Leistung von Plattenrahmenfilterpressen und Schenkfiltern wurde bei der British Sugar mit anderen möglichen Methoden der Entfernung von unlöslichen Teilchen verglichen, und die Ergebnisse von Versuchen in der Zuckerfabrik King's Lynn während der drei letzten Kampagnen zusammengefaßt. Die Kapital- und Betriebskosten der verschiedenen Systeme werden an Hand der augenblicklichen Kosten der vorhandenen Systeme und die projektierten Kosten der alternativen Systeme in der Fabrik King's Lynn verglichen. Festgestellt wird, daß die Verwendung von Sieben und Hydrozyklonen ausreichend ist für die Herstellung von Kristallzucker, während die Verwendung von Zentrifugen oder Pressen erforderlich ist, um weitere suspendierte Feststoffe aus der Standardkläre zu entfernen, um Flüssigzucker oder Kristallweißzucker von sehr hoher Qualität zu gewinnen. Der Einfluß von Belagverhinderern auf die Standardklärefiltration wird diskutiert und die geringe Zunahme der Trübe des Zuckers in bestimmten Fabriken gezeigt, die in der letzten Kampagne Versuche durchführten.

Separación de materia insoluble de licor para alimentación de tachos de azúcar blanco

El cumplimiento de filtro-prensas y filtros Schenk en las azucareras de British Sugar plc se compara con ello de otros métodos posibles para separación de partículas insolubles, y los resultados de ensayos hecho en la azucarera de King's Lynn durante las tres campañas pasadas se resumen. Los costos de capital y de operación de los varios sistemas se comparan por uso de costos actuales de sistemas existantes y costos proyectados de instalaciones alternativas en la azucarera de King's Lynn. Los autores concluyen que el uso de cribado y de hidrociclones puede ser adecuado para fabricación de azúcar blanco granulado, mientras que el uso de centrífugas o filtro-prensas para separar sólidos suspendidos adicionales del licor de alimentación de los tachos sería necesario para fabricación de azúcar líquido o azúcar blanco en cristales de muy alta calidad. La influencia de agentes contra incrustación sobre filtración de licor de alimentación de los tachos se discute y el pequeño aumento en turbidez del azúcar en varias azucareras que han experimentado con los agentes in la campaña pasada se demuestra.

Holland sugar imports and exports, 1982[1]

	1982	1981
	tonnes, tel quel	
Imports		
Austria	532	522
Belgium	41,897	23,144
Finland	1,070	0
France	161	438
Germany, West	3,133	169
Mauritius	0	1,004
UK	2,848	3,179
Other countries	354	350
	49,995	28,806
Exports		
Algeria	1,000	0
Bangladesh	0	6,500
Belgium/Luxembourg	3,644	4,837
Congo	450	0
Djibouti	4,000	0
Egypt	14,761	12,557
Gambia	601	0
Germany, West	12,195	8,448
Ghana	0	1,800
Iran	10,023	40,418
Iraq	27,000	12,500
Israel	46,729	20,010
Jordan	20,800	0
Kuwait	5,009	4
Lebanon	4,462	4,000
Libya	2	4,209
Nigeria	34,064	40,581
Saudi Arabia	8,704	6,083
Sudan	3,765	10,000
Syria	26,400	16
Tunisia	35,660	7,534
Turkey	0	3,984
UK	39,129	26,640
United Arab Emirates	1,601	3,200
USSR	26,628	60,308
Yemen, North	5,000	0
Yemen, South	1	6,000
Yugoslavia	0	13,000
Other countries	1,345	2,089
	332,973	294,718

[1] C. Czarnikow Ltd., *Sugar Review*, 1983, (1641), 56.

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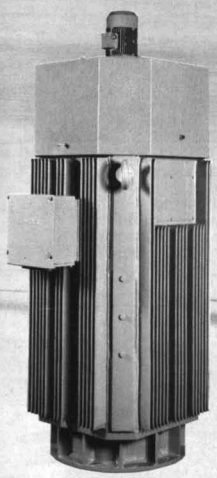

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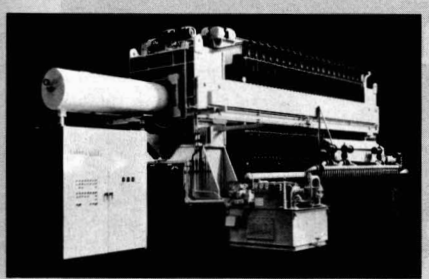

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Conglomerate formation in sugar crystallization Part I: Effect of process conditions

By L. J. KUIJVENHOVEN*, E. J. DE JONG and L. M. DE PREE†
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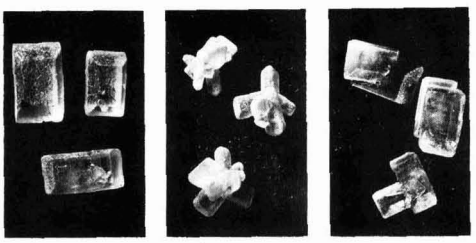
Introduction

The formation of conglomerated crystals is hard to avoid in industrial sugar crystallization. Conglomerates are small clumps of crystals joined together (see Fig.1) and this type of sugar influences considerably the purity of the sugar produced[1, 2], because mother syrup is easily retained between the component crystals. Hibbert *et al.*[3] found that the ash content in a thin film at the crystal surface is much higher than in the rest of the crystal and that this aspect is more pronounced with conglomerated crystals. Conglomerates also hinder the crystal handling[4], as the centrifugalling time must be increased to remove as much mother syrup as possible, as must the drying time. Furthermore, the bulk density is decreased and the free-flowing properties of the crystals are also affected, so that storage and packaging costs rise[3]. It is clear that formation of conglomerated crystals should be minimized and, to achieve this, knowledge about such formation is necessary.

Types of crystals

Several forms of sugar crystals may be distinguished as is shown in Figure 1, i.e. single, starlike and twins. The twin crystals are of two classes: the "real twins", which are composed of two individual crystals, one of them rotated 180° around the axis of twinning, and "pseudo twins", a special form of the starlike crystals. The formation of real twins is favoured by the presence of impurities as has recently been shown by Vaccari *et al.*[5] and earlier by Powers[6]. Many possible forms of twin crystals have been illustrated by Vavrinecz[7]. As most of the twin crystals found in the experiments were not real twins (see figure 1c) this type of crystal is not treated separately in this paper.

Starlike or conglomerated crystals, known for convenience as conglomerates, are, according to the literature, formed in crystallizer regions with a high supersaturation where many small crystals are present, i.e. just after seeding[3, 8, 9], in the boiling zone and near the feed inlet when a supersaturated feed is used. Conglomerates may also be formed during the crystal handling outside the crystallizer if the moisture content of the crystals is too high. This latter type of conglomerate formation will not be treated in this paper.



(a) (b) (c)

Fig. 1. Type of crystals, (a) single, (b) starlike, (c) twin

Conglomerates might be formed from two or more individual crystals, which are "sealed" together. Powers[10] states that this sealing is caused by the fact that a growing crystal has partially bonded molecules, which are moving freely over the crystal surface, until they are built into the crystal lattice. If two crystals approach, it is possible that a freely moving molecule may be built into both crystals, and in this way a conglomerate may be formed.

Another mechanism is described by Moller[9], who states that conglomerates can be formed via collisions of single crystals and he postulates the existence of a

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1 Madsen: *Zuckerind.*, 1980, **105**, 234.
2 van der Poel: *ibid.*, 237.
3 *Sucr. Belge*, 1977, **96**, 459.
4 Powers: Sugar, in "Food microscopy," Ed. Vaughan. (Academic Press, London) 1979, p. 551.
5 *Sugar J.* 1982, **44**, (4), 12.
6 "Principles of sugar technology. Vol. 2" Ed. Honig. (Elsevier, Amsterdam) 1959, p.1.
7 "Atlas of sugar crystals" (Verlag Albert Bartens, Berlin) 1965.
8 Moller: *I.S.J.*, 1947, **49**, 182.
9 Idem: *Sugar*, 1954, **49**, (11), 49.
10 *Socker Handlingar* II, 1964, **19**, (5), 51.

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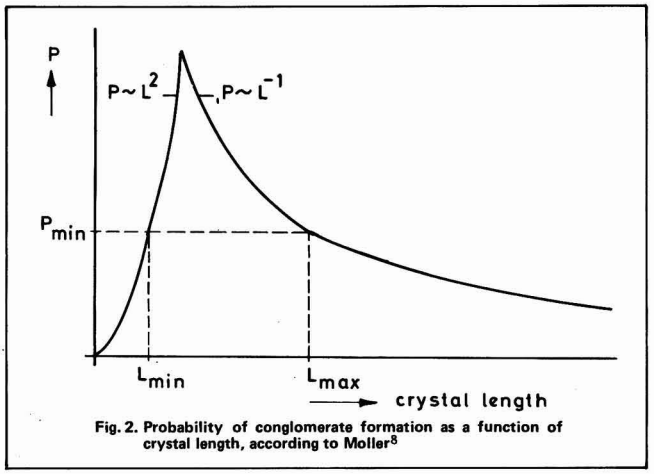


Fig. 2. Probability of conglomerate formation as a function of crystal length, according to Moller[8]

critical size range in which conglomerates are preferentially formed as a result of two opposing effects: the increasing probability of a collision between growing crystals ($\sim L^2$) and the increasing kinetic energy ($\sim L^3$) of these crystals; the latter effect, which has to be taken into consideration above a certain crystal size, favours the tendency of the crystals to separate after a collision has taken place. The probability of conglomerate formation is visualized in Figure 2. According to Moller the maximum critical length is about 0.15 mm. De Leer[11] states that in the case of potash alum crystallization the phenomenon of conglomeration also occurs preferentially in the lower size range, whereas the amount of conglomerates increases as agitation speed decreases. The latter effect has also been found by Janse[12] in potassium dichromate crystallization and by Madsen[1], van der Poel[2] and Austmeyer[13] in sucrose crystallization.

In addition to the two "sealing mechanisms", conglomerates might also be formed spontaneously or by surface nucleation, mechanisms which are not yet to be found in the literature, but which might be favoured by a local variation in nuclei formation resulting from a local variation in aggregates of sugar molecules. Aggregates of sugar molecules are very likely to occur in concentrated sugar solutions because of the many hydrogen bonds possible between various sugar molecules. This occurrence of aggregates has been reported by Schliephake[14] and Pidoux[15] and was recently demonstrated by Mathlouthi[16] by X-ray diffraction. These aggregates might form nuclei and, if several nuclei were formed close to each other, the "turbulence" of the solution might not be great enough to separate them and a conglomerate could result.

In the case of surface nucleation this turbulence also plays an important role. If the new crystal is not removed from the crystal surface by fluid shear, and it is not overgrown by the parent crystal, a conglomerate again might be obtained.

Apparatus

The experiments have been performed in a 1.4 m^3 stainless steel crystallizer under conditions of draft tube agitation. The driving force for crystallization is brought about by evaporating water by means of indirect steam heating (partial heat input) or by cooling of the feed. In the latter case the feed is saturated at a (much) higher temperature than the crystallization temperature. On entering the crystallizer the feed will cool down, while the liberated heat is used for the evaporation of water; this is called adiabatic crystallization. Heat may be supplied to the crystallizer either through the steam jacket or through the hollow draft tube. The crystallizer works in a closed loop. The product and the condensed vapours are collected in the dissolution tank, where most of the crystals are dissolved. Thereafter the solution is passed to the conditioning tank to dissolve even the smallest crystals, thus providing a crystal-free feed.

The sugar concentration in both tanks is kept below saturation concentration to prevent undesired crystallization. The feed loop features a saturator since the feed of the crystallizer should be near the saturation point, in order to reduce the energy demand of the crystallizer[17, 18]. On heating, sucrose forms coloured products (caramel, etc.) and invert sugars. These by-products may influence the crystallization behaviour and should therefore be kept at a constant level. For this purpose an ion-exchanger has been provided, on which the invert sugars and coloured products are exchanged for OH^- ions. In this way the purity of the solution is kept at 98-98.5.

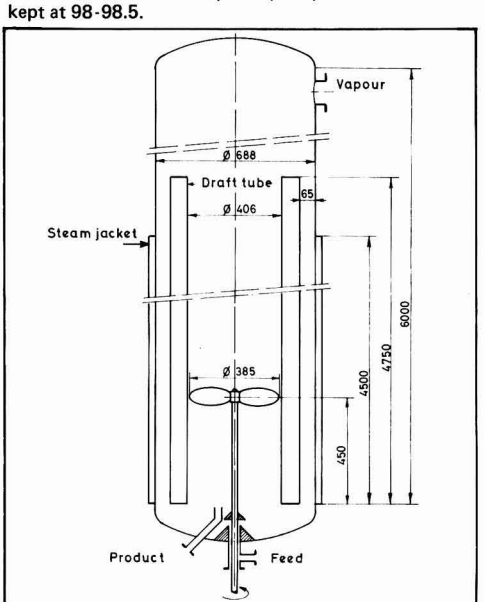


Fig. 3. 1.4 m^3 pilot plant crystallizer, dimensions in mm

11 "Draft tube baffle crystallizers" (Ph.D. Thesis, Delft University of Technology), 1981.
12 "Nucleation and crystal growth in batch crystallizers" (Ph.D. Thesis, Delft University of Technology), 1977.
13 *Zuckerind.*, 1980, **105**, 227.
14 *Zucker*, 1965, **18**, 138.
15 *Sucr.Franç.*, 1971, **112**, 431.
16 *Carbohyd. Res.*, 1981, **91**, 113.

The crystallizer and a plant-flow sheet are shown in Figures 3 and 4, respectively; an overall view of the pilot plant crystallizer is shown in Figure 5.

Experimental

The crystallizer is fed continuously with saturated feed from the saturator. The crystallizing experiment was started either by spontaneous nucleation or by seeding. During the test, when steady operation was achieved, samples were withdrawn from the crystallizer and centrifuged to separate mother liquor and crystals. The crystals were washed with ethanol, dried and sieved.

The crystals from the sieve fractions are examined by eye, and divided into two classes: single crystals or conglomerated crystals. In this way a "Conglomerate Content" (CC) is obtained via:

$$CC = \frac{\text{number of conglomerates}}{\text{total number of crystals}} \times 100\% \qquad (1)$$

In this work the "crystal regularity index" (CRI), as introduced by Hill[19] and outlined by Hibbert *et al.*[3], was not used, as its determination is too laborious, while only a difference in the CRI of 8 to 10% is significant, and this can be achieved by our method. In our experiments the CC was determined as a function of crystal length, the experimental time after starting the test and the process conditions such as temperature difference between the feed and the crystallizer contents and the evaporation or production rate.

The sieve fraction 1.4-1.7 mm is used to determine the CC (except in the length dependency experiments, of course) by examining at least 100 crystals by hand. This sieve fraction was chosen because these crystals are large enough to be examined by eye without any magnification. The length dependency of the CC was investigated by taking photographs of each fraction by means of a microscope and counting the conglomerates and the single crystals by magnifying the picture to a suitable size. At least 100 crystals were examined in this way also. Figure 6 shows a typical picture of the crystals

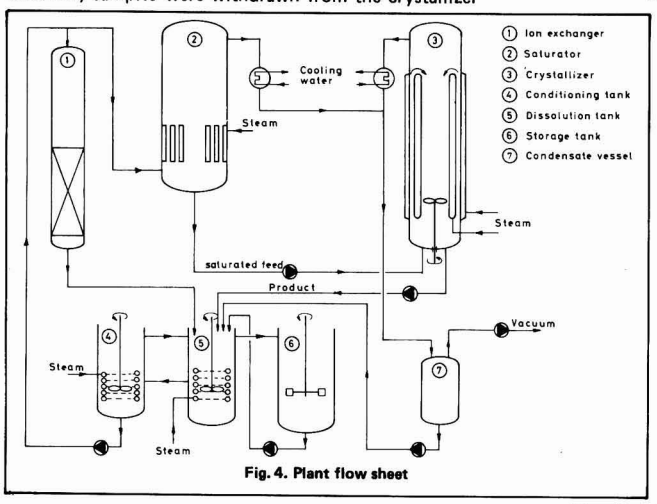


Fig. 4. Plant flow sheet

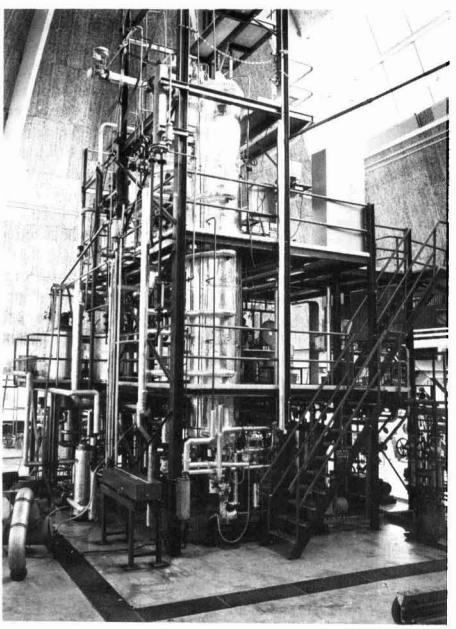
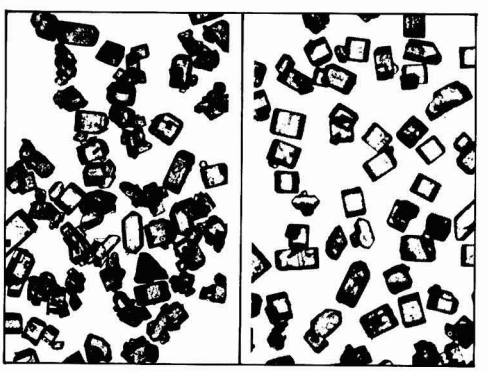


Fig. 5. Overall view of the pilot plant, showing the crystallizer in front. The plant dimension are: a working height of about 10 m and a ground surface of 50 m^2



(a) (b)

Fig. 6. Effect of production rate on appearance of product crystals (200-250 μm) obtained from the pilot plant crystallizer. (a) run 63-2, production rate: 430 kg sugar per m^3 per hr. (b) run 65, production rate: 200 kg sugar per m^3 per hr.

17 *Pot et al.: Proc. 16th Meeting CITS,* 1979, 799.
18 Hoks: *Zeitsch. Zuckerind.,* 1975, **100**, 23.
19 *I.S.J.,* 1965, **67**, 201.

in the 200-250 μm sieve fraction at two different production rates: 200 and 430 kg of sugar per m^3 crystallizer content per hour.

Results and discussion

Length and time dependency. – The CC in the 1.4-1.7 mm sieve fraction, as determined easily by visual observation, might not be representative for the whole range of crystal lengths and could also be a function of time. For this reason the length and time dependency of the CC was derived for some experimental runs. The process conditions for these runs are assembled in Table I.

Table I. Process conditions of the experiments used for the length and time dependency of the conglomerate content

Run†	τ (hr)	ϕ_s (kg sugar per m^3 per hr	ϕ_v (kg vapour per m^2 per hr	ΔT (°C)	ΔC (kg/kg)
60	0.77	290	220	7	0.05
61	1.00	300	220	19	0.29
62-I	1.04	240	210	13	−0.02
62-II	1.03	270	205	12	0.26
63-2	0.54	430	490	5	−0.23
63-3	0.54	430	490	5	−0.23
65	0.78	200	290	−1	−0.26
67-I	0.95	180	110	21	0.34
67-II	0.95	252	110	15	0.59

† I or II means first or second part of run 62/67; 2 or 3 means second or third sample of run 63.

Figure 7 shows the CC as a function of crystal length for the runs 63 and 65. The large difference in the CC is caused by the difference in production/evaporation rate as follows from the experiments discussed in the next paragraph.

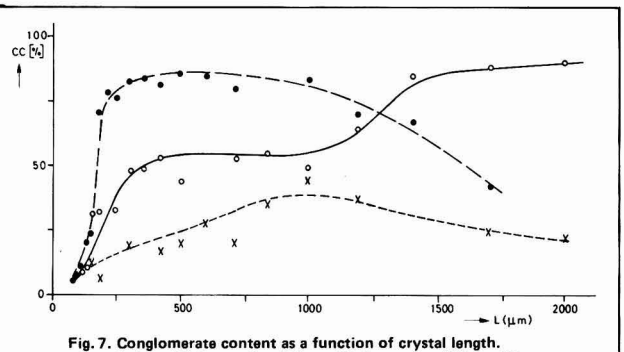


Fig. 7. Conglomerate content as a function of crystal length. (●) run 63-2, $\tau_s = 6\tau$; (O) run 63-3, $\tau_s = 9\tau$; (X) run 65.

In Figure 6 the CC is visualized for both experimental runs in the 200-250 μm range. Figure 6a shows that almost all crystals are conglomerated, while in figure 6b hardly any conglomerates are to be found. As run 63 continues, it may be seen that the CC is not only a function of crystal length but also of time. Sample 63-2 is taken at $\tau_s = 6\tau$ (which means a sampling time equal to six residence times after starting the crystallization experiment) and sample 63-3 after $\tau_s = 9\tau$, so the difference is equal to three residence times or about 1.6 hours. The time dependency of the CC is clear, and one can easily understand that crystals and conglomerates which are formed at the non-stationary start of the experiment need time to grow to the maximum crystal length before they are all removed from the crystallizer and a steady crystal product is formed.

The length dependency is also mentioned by van der Poel[2] and by Hibbert *et al.*[3]. They reported that in batch crystallization the CRI increases with increasing crystal length, which means that just after seeding many conglomerated crystals must be formed, or that the seed crystals are potentially conglomerates. Bennett & Fentiman[20] reported experiments with washed and unwashed seed crystals where the latter caused many conglomerated crystals because of adhering dust on the seed crystals while the washed seed crystals produced mostly single crystals. If the pan is equipped with a stirrer the CRI in the larger sieve fractions decreases[2] which may be attributed to (i) smoothing-out of the local high supersaturation and (ii) separation from each other of the tiny seed crystals[3] at higher shear rates so that they do not form conglomerates. The effect of seeding will be discussed later.

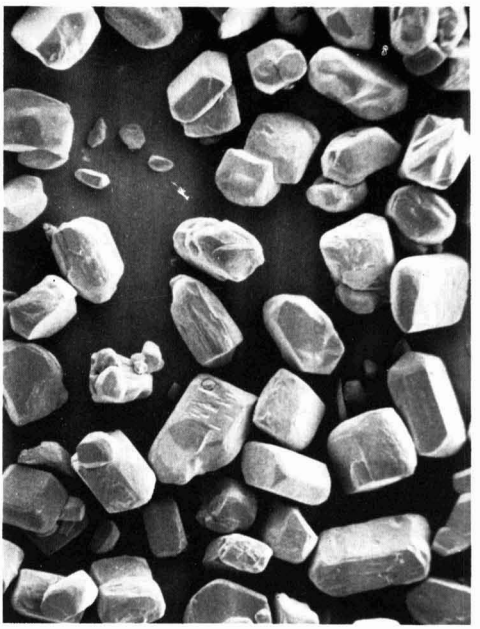


Fig. 8. Scanning electron microscope picture of sugar crystals in the 90-105 μm size range

From Figure 7 it may also be concluded that hardly any conglomerated crystal can be distinguished below a crystal length of 0.1 mm, so that this might be the minimum crystal length as shown in Figure 2. But on the other hand, crystals in this region are hardly to be distinguished as well-formed crystals, because they mostly are "potato shaped", as can be seen in Figure 8, a scanning electron microscope picture of the 90-105 μm

[20] *ibid.*, 1971, **73**, 198.

sieve fraction. As a consequence, it is very difficult to categorize the crystals as single or conglomerate in this size range, and the difficulty is even greater for smaller sizes. For this reason the values of the CC for a crystal length smaller than about 0.15 mm have no significance.

In Figure 9 the CC in the 1.4-1.7 mm sieve fraction is shown as a function of the number of residence times after the start of a run (point of seeding, $\tau_S = 0$) for four different runs. Run 67 shows a steep increase in the CC after $\tau_S = 12\tau$, because at this time the feed concentration was increased considerably (see Table I, run 67-I *vs.* run 67-II). This was also the case in run 62 (62-I *vs.* 62-II), but in 62-II the concentration difference between the feed and the mother liquor remained below the value of 0.3 kg sugar per kg water, almost the same as in run 67-I, whereas in run 67-II this value of ΔC is about 0.6 kg sugar per kg water. An explanation for this effect of ΔC on the CC will be given in the next section. If the process conditions are not changed during a run (i.e. run 60/61) then the variation in the CC in the 1.4-1.7 mm sieve fraction for $\tau_S > 7.5$ is within the experimental accuracy, while for shorter times changes of the CC are caused by non-stationary behaviour of the crystallizer.

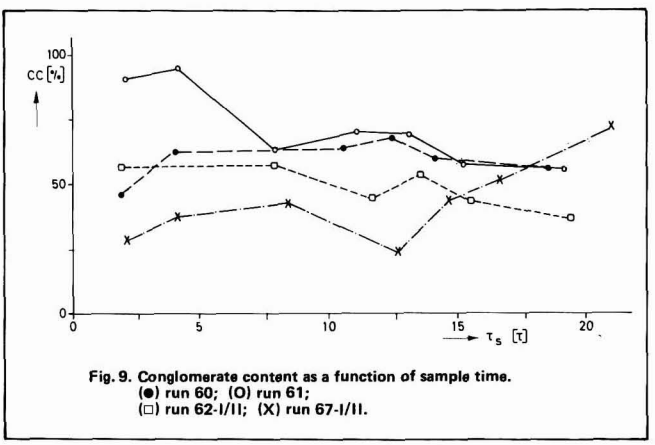


Fig. 9. Conglomerate content as a function of sample time. (●) run 60; (O) run 61; (□) run 62-I/II; (X) run 67-I/II.

Process conditions. — The CC in the 1.4-1.7 mm sieve fraction has been determined as a function of the process conditions. For this purpose the experiments were carried along for at least ten residence times of steady operation, before a sample was withdrawn from the crystallizer. Table II shows the CC, the sugar production rate (ϕ_S), the evaporation rate (ϕ_V), the temperature difference between the feed and the crystallizer (ΔT) and the concentration difference between the feed and the mother liquor (ΔC) under different circumstances. It is obvious that a high production rate corresponds to a high CC, in the case of operating with partial heat input as well as under adiabatic conditions. By decreasing the production rate the CC is also decreased. It will be demonstrated that the formation of conglomerates is affected by regions of high supersaturation as was also reported recently by Austmeyer[21]. In case I a high production rate is achieved by evaporating much water. As it seemed from visual observation that vapour bubbles are mainly formed in a belt of about 20-30 cm below the vapour-liquid interface, it is clear that in the boiling zone a high supersaturation exists so that formation of nuclei and conglomerates can result.

On the other hand, cases II and IV show almost the same evaporation rate (about half of case I) but there is a large discrepancy in the CC. This is caused by the fact that in case II the feed concentration is below the mother-liquor concentration, whereas in case IV it is the other way round. As the mixing of the feed with the crystallizer contents is very difficult, as has recently been indicated by Kuijvenhoven & de Pree[22], temperature adjustment will be much faster than the smoothing-out of the concentration. It is also possible that the superheated feed, not being mixed thoroughly with the crystallizer contents, will flash vapour, owing to the lowering of the hydrostatic pressure and in this case the local supersaturation will be increased by evaporation as well as by cooling.

Figure 10 shows a typical picture of the behaviour of the feed (coloured with a tracer) with the crystallizer contents. In this figure, the feed inlet is on the left hand side, while the flow direction is upward. A description of the apparatus used has been published elsewhere[22]. It is obvious from this picture that the dark coloured feed hardly mixes with the crystallizer content. This means that the feed might become supersaturated to a value of about S = 1.4 or more, which is in the nucleation region, as was apparent from non-seeded experiments where spontaneous nucleation occurred at a supersaturation ratio $S > 1.22$. Table III shows this nucleation behaviour for some experiments performed in the 1.4 m^3 pilot plant crystallizer as well as in a 45-litre batch cooling crystallizer. This result is in accordance with the work of Bretschneider & Svobodova[23] who report a value of $S > 1.2$ for homogeneous nucleation, while, if crystals are present, nucleation can start at a supersaturation level of S = 1.1. It also is in accordance with a report by Maurandi[24], who refers to an intermediate zone ($1.2 < S < 1.3$) in which spontaneous nucleation can be expected. Many small crystals will thus be formed in a highly supersaturated surrounding and conglomerate formation can result. The same effect is observed by comparing the cases II and III (Table II). Here the sugar production is the same, the evaporation rate in case III is lower than in case II, but the CC is somewhat higher.

The reason is that in case III the feed temperature and concentration are higher than the mother liquor temperature and concentration. So the feed becomes supersaturated, to a maximum value of about S = 1.25, if the temperature is smoothed-out before mixing occurs, with the same effect on conglomerate formation as mentioned before, but to a lower level because of a lower supersaturation. This effect of concentration difference is also the reason why, as can be seen in Figure 9, run 67 shows a steep increase in the CC, whereas in run 62 the CC stays unchanged if the concentration difference between the feed and the mother liquor is increased after $\tau_S = 12\tau$ (see also the preceding section).

[21] *Zuckerind.*, 1981, **106**, 421.
[22] *ibid.*, 1983, **108**, 35-38.
[23] *Zucker*, 1977, **30**, 11, 65.
[24] *Zuckerind.*, 1981, **106**, 993.

Fig. 10. Mixing of feed and crystallizer content, according to (22). See text for explanation

From batch experiments with a separate evaporating crystallizer with a crystallization volume of 10 litres it is also concluded that the production/evaporation rate has a large effect on the formation of conglomerates, which is almost the same as is found by the continuous crystallization experiments in the 1.4 m^3 crystallizer. The batch results are also shown in Table II, as cases V and VI.

sugar crystals with a mean size of about 0.6 mm. The washed crystals were suspended in 96% ethanol in which sugar is scarcely soluble so that adhering dust is dissolved but the actual crystal stays unchanged.

Homogeneous nucleation occurred when the supersaturation rose above the level of S = 1.22 (see Table III). Table IV shows the process conditions of the seeding experiments as well as the CC as a function of the sample time.

Table III. Supersaturation level at which homogeneous nucleation occurs (purity: 98%)

Run	S (-)	T (°C)	Remarks
47	1.25	72	Continuous, τ = 0.6 hr
48	1.24	72	Continuous, τ = 0.6 hr
56	1.22	72	Continuous, τ = 0.5 hr
M 1	1.22	57	Batch, ΔT = 6.3°C/hr
M 2	1.23	65	Batch, ΔT = 6.0°C/hr
M 3	1.23	65	Batch, ΔT = 5.6°C/hr

The "unwashed seed experiments" (which are also presented in Figure 9) show the same behaviour as was already recorded in Table II: a moderate evaporation and production rate and a CC below 60%, except for run 61. In this run seeding took place at a high supersaturation and on introducing the seed crystals many nuclei were formed and conglomeration could take place. After nine residence times, when the initial effect has been extinguished, the CC also approaches the level of 60%. The "washed seed experiments" however show a high production rate, but a low CC in the first sample, whereas in the second sample this value has risen to above 90%, which may also be predicted from the results in Table II. This means that at the seeding time mostly regular crystals are formed whereas later, when more crystal nuclei are formed in a highly supersaturated solution, conglomerated crystals result.

Table II. Conglomerate content in the 1.4-1.7 mm sieve fraction as a function of the process conditions

	Run	CC (%)	ϕ_s (kg.m^{-3} hr^{-1})	ϕ_v (kg.m^{-2}.hr^{-1})	T_f (°C)	ΔT (°C)	ΔC (kg/kg)	Remarks
I	16-21	90-100	350-700	280-540	79	7-9	0	Partial heat input
II	24-29	40-60	150-300	140-280	79	2-4	−0.14	Partial heat input
III	30-39	50-80	150-300	100-180	84	10-15	0.14	Adiabatic
IV	43/46	90-100	350-400	200-280	91	20-24	0.30	Adiabatic
V	A 8	40	108	-	-	-	-	Batch
VI	A 19	90-100	430	-	-	-	-	Batch

Effect of seeding. – As already mentioned, seeding can have a major effect on the formation of conglomerates, especially in batch crystallization, but also in continuous crystallization if full seeding is applied. For this reason experiments were performed to investigate the influence of various types of seed crystals: (i) unwashed crystals, (ii) crystals washed with ethanol and (iii) crystal produced by spontaneous nucleation. When the solution became supersaturated about 1-2 kg of seed crystals were introduced to the crystallizer, in the cases (i) and (ii), and the CC in the 1.4-1.7 mm range was followed during the run. The seed crystals used were commercial

The "homogeneous nucleation experiments" were performed with a high production and evaporation rate. A high CC should be expected according to Table II but now also the first and second sample show a moderate CC, which increases with sample time.

From these experiments it can be concluded that the method of seeding can influence the CC considerably, whereas production rate has only a minor effect, in the very first part of the runs. This means that in batch crystallization, seeding should take place very carefully, whereas in continuous crystallization the production rate should also be kept below a maximum value.

Table IV. Effect of seed crystals on the conglomerate content in the 1.4-1.7 mm range at various time intervals

Run	Seed	ϕ_s (kg.m^{-3}.hr^{-1})	ϕ_v (kg.m^{-2}.hr^{-1})	ΔC (kg/kg)	CC (%)		
					2τ	4τ	9τ
60	Unwashed	290	220	0.05	47	63	–
61	Unwashed	300	220	0.30	92	95	63
67-I	Unwashed	180	110	0.34	30	38	43
66	Washed	580	290	0.11	49	92	–
68	Washed	470	340	0.14	17	91	–
63	Spontaneous	430	490	−0.23	–	50	80
64	Spontaneous	540	500	−0.07	44	62	79

Future work

From the macroscopic results presented in this paper it appeared that the formation of conglomerated crystals can be related to regions where high supersaturations are to be expected. As to the way of formation, viz. collisions between crystals, spontaneous formation or via surface nucleation, no answer can be given at this stage, although it will be clear that the formation of conglomerates is strongly related to nucleation phenomena. Research will now be focused on the fundamentals of conglomerate formation and its relation to nucleation. The results will be published at a later date.

Conclusions

(1) Conglomerate formation mainly occurs in regions with a high supersaturation (i.e. the boiling zone and the place of feeding).
(2) As the overall supersaturation in the crystallizer is a function of the production rate, conglomerate formation is affected by this parameter; by decreasing the production rate the CC is also decreased.
(3) When the production rate is more than about 300 – 350 kg sugar per m^3 per hr, nearly all the crystals produced are conglomerates.
(4) The influence of the non-ideal mixed feed to the crystallizer on the CC can be gigantic. If the concentration difference between the feed and the mother liquor is more than about 0.3 kg sugar/kg water the CC increases considerably.
(5) When full seeding is not applied in continuous crystallization, the type of seeding has an effect on the CC only during the start-up of the crystallizer, but this factor plays an important role in batch crystallization and in fully seeded continuous crystallizers.

Notation

C	Concentration	kg sugar/kg water
C*	Saturation concentration	kg sugar/kg water
CC	Conglomerate content	%
CRI	Crystal regularity index	%
ΔC	Concentration difference between feed and mother liquor	kg sugar/kg water
L	Characteristic length	m
S	Supersaturation ratio (C/C*)	–
T	Temperature	°C
T_f	Feed temperature	°C
ΔT	Temperaturature difference between feed and crystallizer	°C
ΔT	Cooling rate	°C.hr^{-1}
τ	Residence time	hr
τ_s	Sample time	τ
ϕ_s	Production rate	kg sugar per m^3 per hr
ϕ_v	Evaporation rate	kg vapour per m^2 per hr

Acknowledgment

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Summary

The formation of conglomerated crystals has been studied in a 1.4 m^3 pilot plant continuous crystallizer under different process conditions. It appeared that the amount of conglomerated product crystals is strongly affected by the occurrence of regions of high supersaturation, as in the boiling zone and near the feed entrance in the case of a superheated feed. If full seeding is not applied, the type of seed crystal used has only a minor effect on conglomerate formation in continuous crystallization.

Formation de conglomérats au cours de la cristallisation du saccharose. Partie I. L'effet des conditions du processus

On a étudié la formation de cristaux conglomérés de saccharose en réalisant différentes conditions dans un cristalliseur continu pilote d'un volume de 1,4 m^3. Il s'est montré que le nombre de conglomérats était fortement affecté par l'existence de régions de haute sursaturation, comme c'est le cas dans la zône en ébullition et celle près de l'entrée de l'alimentation (lorsque ce lui-ci est surchauffé). Si on n'applique pas le grainage total, le type de cristal utilisé comme germe n'a qu'un effet mineur sur la formation de conglomérats au cours de la cristallisation continue.

Bildung von Konglomerat in der Zuckerkristallisation. Teil I. Einfluß der Prozeßbedingungen

Die Bildung von Konglomeratkristallen wurde in einem kontinuierlichen 1,4-m^3-Kristallisationsapparat anhand unterschiedlicher Prozeßbedingungen untersucht. Es zeigte sich, daß die Menge konglomerierter Kristalle stark vom Vorhandensein sehr übersättigter Regionen beeinflußt wird, so in der Kochzone und nahe der Einzugsöffnung bei überhitztem Zuzugssirup. Sofern kein Saatimpfen erfolgt, hat das Impfgut nur einen geringen Einfluß auf die Bildung von Konglomerat bei der kontinuierlichen Kristallisation.

Formación de conglomerados en cristalización de azúcar. Parte I. Efecto de condiciones de elaboración

La formación de cristales conglomerados se ha estudiado en un tacho continuo de escala pilota de volumen 1.4 m^3 sobre varias condiciones de elaboración. Parece que la cantidad de cristales conglomerados producidos es afectado profundamente por la ocurrencia de regiones de supersaturación alta, como en la zona de ebullición y cerca de la entrada alimentadora en el caso de un alimento supercalentado. Si no se aplica semillamiento completo, el tipo de semilla no tiene que un efecto menor sobre formación de conglomerados en cristalización continua.

CANE SUGAR MANUFACTURE

Cane preparation drives. B. K. Chaturvedi. *Maharashtra Sugar,* 1982, **7,** (9), 41-42. — It is shown that the replacement of standard slip-ring motors with motors of high slip on cane preparation equipment will improve motor performance with increased torque, and will take advantage of the inertia of the system, to which the flywheel is a major contributor, and thus reduce current peaks. Two sample calculations are given.

Whole reduced mill extraction. P. K. More. *Maharashtra Sugar,* 1982, **7,** (9), 67, 69, 71-73. — See *I.S.J.,* 1983, **85,** 178.

Mechanically harvested cane and its influence on the manufacturing process. B. Guzmán. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 155-172 *(Spanish).* The quality of mechanically harvested cane is subject to several influences in addition to the nature of the cane, viz. the amount of trash present, the contents of immature cane, leaves, dirt and sand, and, especially, the delay involved between harvesting and crushing. Washing of cane is a means of removing extraneous matter, while centrifuging may be used for separation of dirt and sand from juice. Clarification can be difficult in the presence of impurities, and delayed processing is important; if the factory crushes fresh cane, the difficulties will be small or absent. The presence of polysaccharides causes problems not only in clarification but also in evaporation and crystallization.

Milling and diffusion. J. L. Carbonell. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 173-180 *(Spanish).* — A review is presented of the application of diffusers to cane and bagasse sugar extraction in many countries, with notes on the relative advantages and disadvantages compared with milling and between cane and bagasse. A description is given of the DDS bagasse diffuser installed at Ingenio Cruz Alta, of 110 tch capacity, preceded by a crusher and first mill, and followed by two dewatering mills. The system has operated for six years and achieves 95.7% reduced extraction with 197% imbibition on fibre, against 90.4% reduced extraction at 75 tch from the mill alone, using 110% imbibition on fibre. No ill effects have been found in the process, and similar results have been observed in a second installation at Ingenio San Isidro since 1977.

Milling and diffusion. J. R. Valdez. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 181-190 *(Spanish).* — Where insertion of a diffuser in a milling train increases extraction efficiency by only a small amount, the pay-back time is so long that it is not economical; consequently, such an investment is more appropriate to a factory where milling efficiency is low, i.e. with an extraction of 92% or less. Milling efficiency has been raised to very high levels in Australia, e.g. to 96%, but the capital cost of doing so is high; in Florida, the philosophy is not to seek such high efficiency but to crush much greater amounts of cane. High extraction of sugar by means of a diffuser without the need for rigorous preparation and mill maintenance is an argument in its favour. Further, its low demand does not create disequilibrium in power generation in contrast to the installation of additional mills to raise throughput and extraction. The cost of a cane diffuser is lower than that of a bagasse diffuser plus mills, but it produces bagasse of 80-85% moisture, and expense is incurred in providing equipment to reduce this. Liming can take place within the diffuser and reduces corrosion; at Ingenio Montelimar, such limed juice from a BMA tower diffuser is then sulphited, heated and settled, and yields a direct white sugar of good quality. Although mill juice is generally of lower purity than the corresponding diffusion juice, this is the result of insoluble solids present; if the mill juice is centrifuged, the supernatant juice is of the same purity as the diffusion juice which has been filtered in its separation.

Simulation study of a raw sugar vacuum pan under automatic control. O. Mayo A., C. Alvarez P. and I. Cardoso C. *Centro Azúcar,* 1981, **8,** (2), 3-15 *(Spanish).* An account is given of the mathematical modelling of a raw sugar pan under the control system adopted at Central Espartaco in Cuba. Only the control loop is analysed by conductivity of the flow of feed to the pan. The system of differential equations which make up the model is integrated and solved by means of a computer, and the final results obtained are within a range achieved in practice, so that they can be used for analysis of the effects of different variations.

Exergetic analysis of the process of raw sugar manufacture. A. Calvo. G., H. Pérez A. and L. Toledo G. *Centro Azúcar,* 1981, **8,** (2), 17-25 *(Spanish).* — An analysis is presented of the thermal scheme of a sugar factory with the typical production process for raw sugar, using as basis for calculation experimental data obtained from the literature. The places where the greatest exergy losses occur are identified and the losses determined. Possible means of reducing losses are suggested.

Behaviour of operation indicators in the pan section of a sugar factory during the 1980 season. N. Rodríguez R. and T. Díaz B. *Centro Azúcar,* 1981, **8,** (2), 27-35 *(Spanish).* — The results are tabulated and discussed of statistical analysis of a number of data from the boiling house of a sugar factory, including volumes, Brix and purities of massecuites and molasses, as well as boiling times; these are compared with the previous season. Analysis of data at 10-day intervals permits the identification of trends, observation of the effects of process modifications, raw material changes, etc.

Study on the optimization of the raw sugar manufacturing process. I and II. P. García G. *Centro Azúcar,* 1981, **8,** (2), 37-52, 53-63 *(Spanish).*
I. A summary is presented of the methodology employed in the derivation of model equations for use in the optimization of sugar crystallization in a vacuum pan, together with the list of equations developed.
II. A description is given of the method of applying the above system to pan operations.

Automatic control in the new process of cane juice purification. M. Léon S., F. Oyárzabal G. and E. Rodríguez A. *Centro Azúcar,* 1981, **8,** (2), 65-71 *(Spanish).* — The "new process", attributed to Guerra, is that in which the juice phosphate level is also con-

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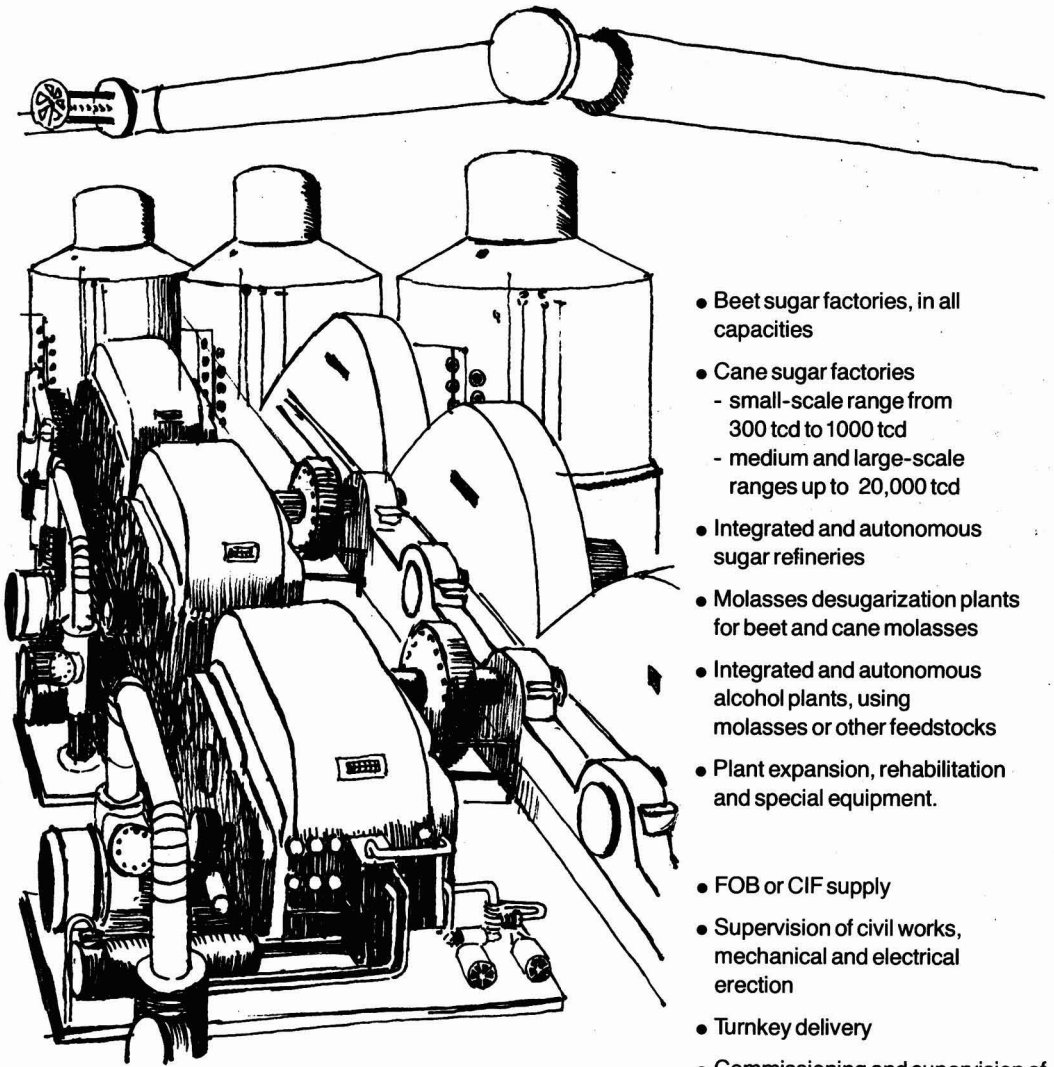

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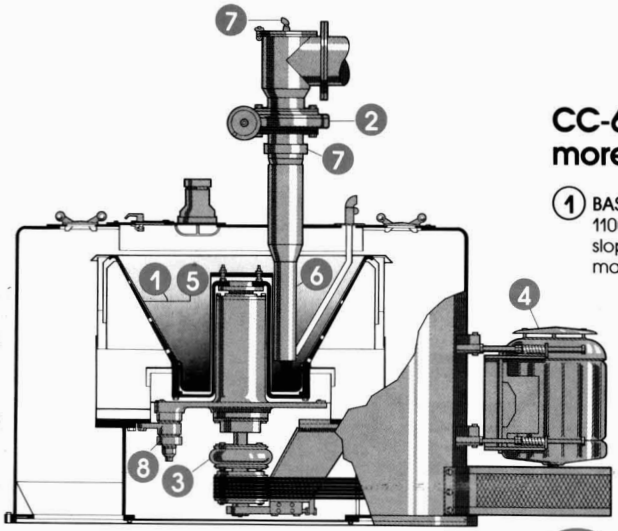

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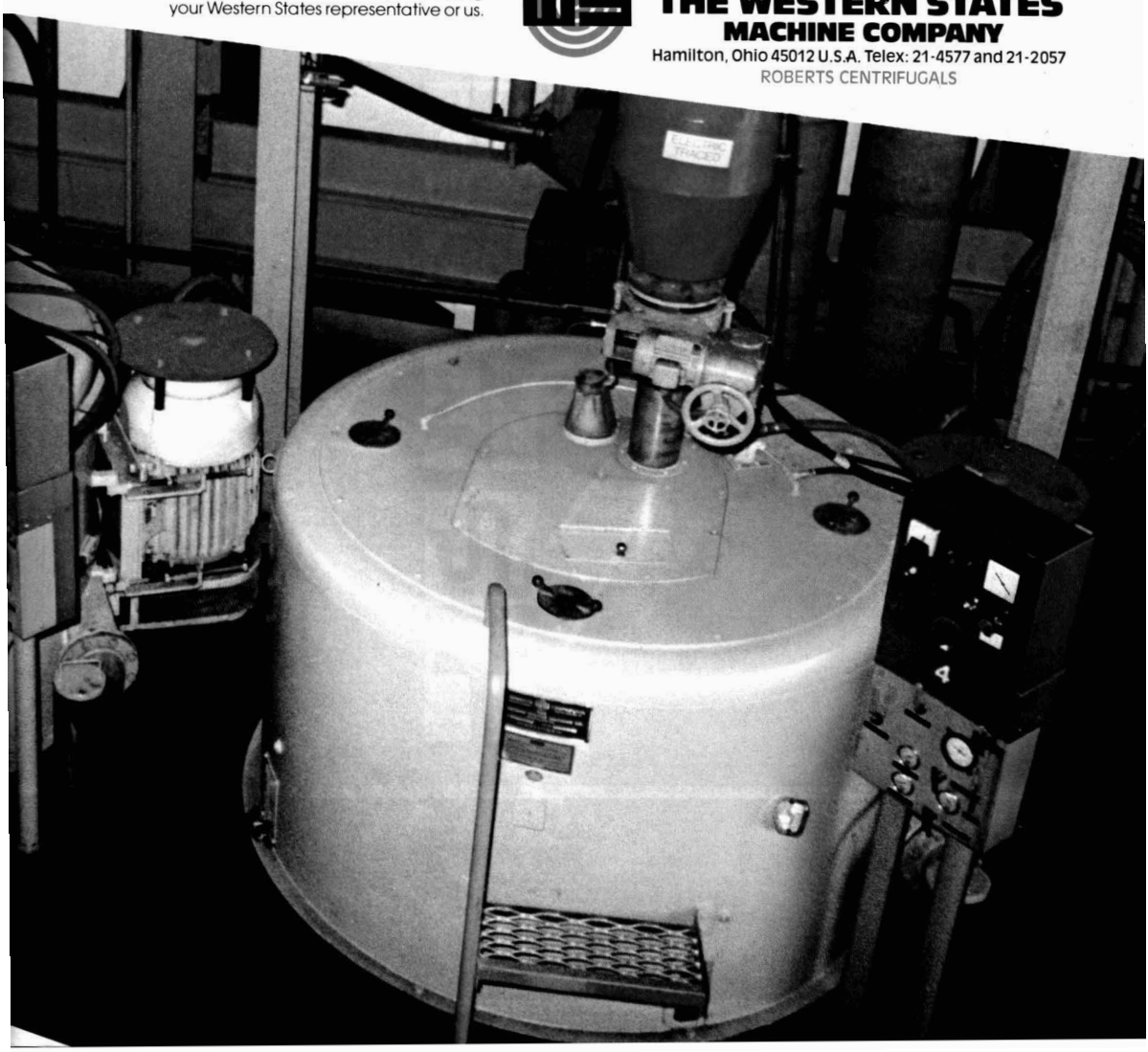

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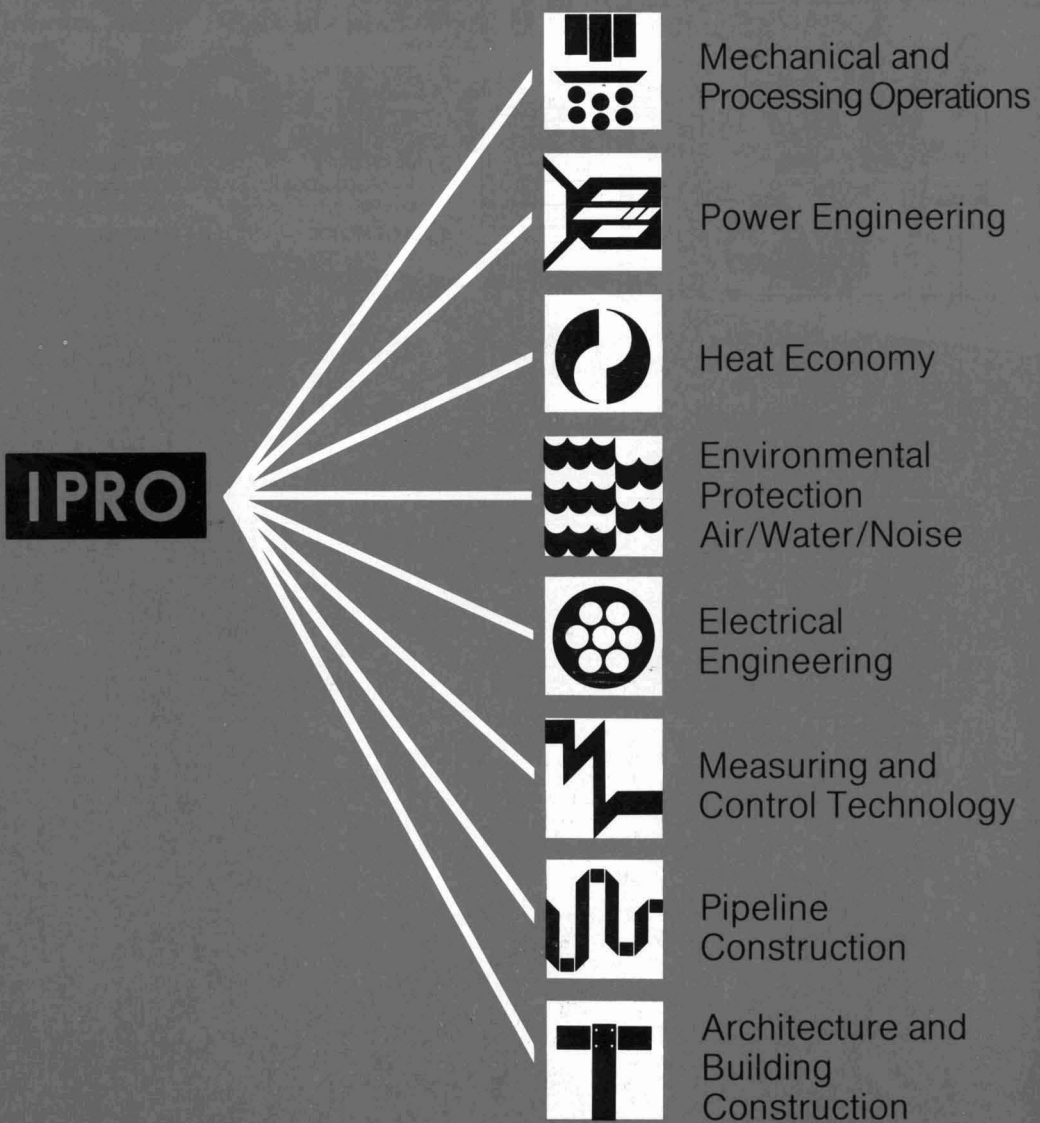

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trolled as well as the lime addition. A control loop is characterized which employs the results of chemical analysis for automatic control of the process.

Thermo-energetic balance in sugar factories. R. Espinosa P. *Centro Azúcar,* 1981, **8,** (2), 73-85 *(Spanish).* — Equations have been developed concerning heat and steam usage in a sugar factory intended for use in raising thermal efficiency and reducing oil consumption.

Method for determining the validity of results for energy balances obtained by different methodologies. L. Toledo G. and H. P. de Alejo V. *Centro Azúcar,* 1981, **8,** (2), 117-124 *(Spanish).* — Vapour flow was measured in practice and compared with values calculated by two methods. The size of the differences show that it is necessary to know the error involved if the calculation methods are to be used in real circumstances.

Optimum design for cane juice heat exchangers. R. Espinosa P. and P. García G. *Centro Azúcar,* 1981, **8,** (2), 143-155 *(Spanish).* — The dynamic programming method has been applied to a design of juice heater using deformed tubes connected in series, and the heater shown to cost less than a heat exchanger of conventional design.

Industrial evaluation of the SEDINAZ-I sedimenter and the modified SEDINAZ-I PREDCO. S. Morales M. *Centro Azúcar,* 1981, **8,** (2), 165-173 *(Spanish).* — With the advent of mechanical harvesting and increasing fineness of cane preparation, the quantity of non-sugars in juice is increasing, and increase is also observed in the amount of insoluble material in rotary vacuum filtrate. It would be of advantage if this could be sent direct to the evaporator instead of being recycled to mixed juice, and tests were conducted on sedimentation of filtrate in a SEDINAZ-I settler and also with one of these and a PREDCO settler in series, with and without prior addition of milk-of-lime and of an anionic flocculant. With the SEDINAZ-I alone, in the absence of pre-treatment, 7% insolubles separation occurred; with flocculant it reached 13%, with lime 25% and with lime plus flocculant 24%. In the subsequent PREDCO unit, untreated filtrate yielded a further 5%; the combined units gave separation of 6.5% and 6.5% with filtrate treated with lime, 15% and 11% with flocculant-treated filtrate, and 14% and 22% with filtrate treated with both. Separations of 7% or less were within the limits of error.

Automation in the sugar and alcohol industry. F. F. Zanni. *Brasil Açuc.,* 1982, **99,** 336-338 *(Portuguese).* — A brief account is given of the locations and features within a sugar factory and distillery where automatic controls may be applied to advantage; these include the cane level in the Donnelly chute of a cane mill, the top roller level, turbine power consumption, milling mass balance, juice Brix, juice level, fermentation tank temperature and level, steam pressure, column temperature, etc.

Input, disposition and effect of dirt in Queensland sugar mills. R. L. Muller, M. R. Player and M. B. Wise. *Sugar J.,* 1982, **45,** (2), 9-13. — See *I.S.J.,* 1983, **85,** 115.

Cane sampling and its effect on cane yard design and operation. M. R. Kedian. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.,* 1982, 7-10. — Cane sampling by the hatch method as used in South Africa is compared with core sampling at the weighbridge, and the possible benefits of the latter method and of reduced-frequency sampling are discussed, particularly in regard to the problems concerning cane that is to be held in storage instead of being crushed immediately on arrival at the factory. While the present sampling system places restrictions on yard operations, the costs of modifying an existing yard to take advantage of core sampling are so high that it is considered unlikely that hatch sampling will be replaced except in the case of new factories and factories having to carry out major yard modifications such as with expansion. Reduced-frequency sampling could be used as an intermediate step to provide some freedom of yard operation.

Fifty-seventh annual review of the milling season in Southern Africa (1981-1982). J. P. Lamusse. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.,* 1982, 11-33. — A detailed survey is presented of cane quality and factory performances in Malawi, South Africa, Swaziland and Zimbabwe. In South Africa, rain had an adverse effect on pol % cane, and the cane:sugar ratio was the highest since 1934.

Control of centrifugals with the use of a programmable controller. P. Glaum. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.,* 1982, 34-36. — At Ubombo Ranches Ltd., the sequence controllers on a battery of five automatic batch centrifugals for *A*-massecuite had been a constant source of downtime, while logic relays required considerable maintenance, so that it was decided to replace the control equipment with an electronic system; a Gould Modicon 484 programmable controller was chosen in preference to a sophisticated computerized system. Details are given of the controller, which has replaced, on each centrifugal, 19 relays, four timers, one process timer and one rotary sequence controller. The economics and advantages of the controller are discussed; the system has proved so successful in operation that the company is considering installation of programmable controllers on other automatic centrifugals and on semi-automatic machines for conversion to complete automation.

The operation and performance of continuous *C*-centrifugals. L. M. S. A. Jullienne. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.,* 1982, 37-40. — Investigations of the performances of low-grade continuous centrifugals at a number of factories are reported. Significant correlation was found between *C*-molasses purity and *C*-sugar purity. Wide variation in purity rise from day to day at the same factory was apparently caused by the presence of a large and varying number of small sugar crystals in the molasses that were not always visible under normal operation conditions because they dissolved in hot dilute molasses and were only seen by a microscopic examination of undiluted molasses obtained by omitting steam and water washing. Further factorial-design experiments confirmed a rise of about 0.1° in molasses purity per unit rise in *C*-sugar purity. There was an approximate 0.4° drop in molasses purity when the temperature of the wash water was reduced from 81.5° and 83.4°C to 55.0° and 53.3°C, respectively, at two factories, while massecuite throughput also fell (by 14% and 7%, respectively); increase in the rate of water addition from 90 to 123 $kg.hr^{-1}$ and from 77 to 129 $kg.hr^{-1}$ at normal operating wash water temperature and steam addition caused a 20% and 14% increase in throughput but also a 0.3° rise in final molasses purity. Increasing the amount of steam at normal wash water quantity and temperature increased throughput and molasses purity, while combining a high steam consump-

tion with a high water temperature also increased throughput and molasses purity. Replacement of steam by 38% extra water did not cause any change in molasses purity.

Assessment of a plate heat exchanger on process juice heating. S. S. Munsamy. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 41-43. – The performance of an Alfa-Laval plate heat exchanger, consisting of 44 plates of herringbone design for clear juice and a further six plates for mixed juice heating, was assessed at Dalton sugar factory. Results showed that the average heat transfer coefficients of 3400 $W.m^{-2}.°C^{-1}$ for clear juice and 3000 $W.m^{-2}.°C^{-1}$ for mixed juice were higher than reported for conventional shell-and-tube heaters. After 5 weeks' operation on clear juice, the only fouling material found was sludge (mainly clear juice carry-over particles) and a black film on the plates; the sludge was easily removed by hosing-down with water. The unit was cleaned every week when used for mixed juice heating; the fouling material was mainly sand and bagacillo plus a thin surface scale similar to that found in tubular heaters. Backwashing once per shift removed accumulated sludge, while the plates were removed, hosed-down with water and scrubbed with wire brushes to remove the scale. All parts of the heater are completely accessible for inspection, cleaning and replacement; the unit is well suited to chemical cleaning. Apart from its superior performance, the heater is less costly than a shell-and-tube heater.

Friction losses in massecuite pipelines. A. Rouillard. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 44-45. – A study was undertaken to see if viscosity measurements using a rotating cylinder viscometer would, in conjunction with available equations, predict friction losses in straight massecuite pipelines reasonably accurately and permit an estimation of the magnitude of losses in pipe bends. Although there was considerable scatter in the results (giving a correlation coefficient of only 0.59) for various suggested reasons, the values obtained with a Brookfield HBT viscometer generally followed the line $16/N_{Re}$ in a plot of Fanning friction factor f *vs.* Reynolds' number N_{Re}. Friction loss in a straight pipe can thus be estimated using the Hagan-Poiseuille equation $\Delta H = \frac{32\ LV^2}{gDN_{Re}}$, where ΔH is head loss (m), L is length (m), V is velocity ($m.sec^{-1}$), g is acceleration due to gravity ($m.sec^{-2}$) and D is diameter (m). Friction losses in bends seemed to increase with falling Reynolds' numbers and could be calculated from $\Delta H = \frac{kV^2}{2g}$, where k is the velocity head given by $800/N_{Re}$.

Design features of steam turbines for use in the sugar industry. K. Körner. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 58-63. – A representative of AEG-Kanis Turbinenfabrik GmbH describes the G25 back-pressure steam turbine manufactured and supplied by his company as a power generation unit of 8 MW rated output to three South African sugar factories.

Conveyor chain experience at Malelane mill. A. A. Landman. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 64-67. – At Malelane, slat conveyors used to carry shredded cane and bagasse suffered from 85.8 hours of stoppage in the 1978/79 season as a result of chain failures, representing 10.7% of the total mechanical stoppages at the factory. A number of conclusions were drawn from examination of the problems associated with the roller chains, and these and desirable properties of a good chain are listed. It was decided to experiment with the use of rollerless chains as used in the cement industry, and alloy steel (Apex 6) was compared with SG70 cast iron as material for the chain links. Results showed that the cast iron links had greater resistance to abrasion and suffered no fractures, unlike the alloy steel links. An entire chain cast in SG 70 gave trouble-free service in carrying 750,000 tonnes of cane, after which hydrogen embrittlement fractures of the pins occurred; however, after a few hours' downtime and replacement of the pins with unhardened, forged pins, no further problems were encountered. The total downtime caused by slat conveyor failure in 1981/82 was 38% of that in 1978/79.

The dewatering of smuts using a multi-roller filter. A. E. Goring. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 71-74. – Details are given of the system used at Tongaat to treat waste water from the wet scrubbers handling boiler flue gas. The water, together with any factory wash-down water, flows to a primary settling tank, the outflow from which is gravity fed to a sump and thence transferred to a clarifier. The overflow from this passes via a sump to the scrubbers, with any surplus overflowing into the irrigation system. The underflow is pumped to a multi-roller filter, flocculant being added between the pump and the filter. The filtered mud is in the form of a dry, manageable cake which is mixed with filter cake for disposal; the filtrate is returned to the primary settling tank. Full details are given of the multi-roller filter; despite a number of teething problems, it is considered to have proved a success – the cake produced from the fly ash was easily handled and suitable for transportation, while the water returned to the scrubbers was much cleaner than previously, power consumption and running costs were low, although installation costs were high.

Preliminary tests on the use of smuts as filter aid for mud filtration. N. Kalidass and S. S. Munsamy. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 75-77. – Trials on the use of boiler fly ash mixed with bagacillo as filter aid in clarifier mud treatment at Sezela are reported. Pol % cake was always lower when the fly ash-bagacillo mixture was used than when bagacillo was used on its own, as was filter cake moisture content, although filtrate purity was also slightly lower, while the filtrate K content was higher than with bagacillo alone as filter aid. There was no apparent adverse effect on filtration of reduction in the amount of the filter aid mixture from 8.0 to 5.8 $tonnes.hr^{-1}$ with a drop in the amount of fly ash to 4.8 $tonnes.hr^{-1}$, while the amount of bagacillo used on its own in separate tests was 3.5-3.8 $tonnes.hr^{-1}$. Although the results indicated that the use of fly ash would give an appreciable saving in bagacillo and in the transport costs of filter cake and fly ash for disposal, plus the cost benefits of the other advantages mentioned above, one major disadvantage was the accumulation of sand (associated with the fly ash) in the filters and piping.

Controllable factors affecting exhaustion of molasses in a crystallizer. N. I. Tumonong. *Crystallizer*, 1982, **5**, (3), 13-15. – Experiments conducted by various authors on massecuite exhaustion in vacuum pans and crystallizers are reported and their findings summarized. Application of the results to possible improvement in exhaustion is indicated.

BEET SUGAR MANUFACTURE

Minimization of the amount of water to be evaporated as a means of minimizing the energy consumption in sugar manufacture. J. Burianek. *Listy Cukr.*, 1982, **98**, 160-163 *(Czech)*. — A water balance for Hrusovany sugar factory shows that, at a daily slice of 4000 tonnes of beet, 3904.2 tonnes of water enter the factory in the thin juice. Of this and 659.3 tonnes of process water used in the boiling house, 4520.3 tonnes is evaporated (the remainder is in the molasses). Since it is desirable to reduce steam consumption in evaporation and hence fuel consumption, there is need to reduce the amount of water: by increasing the sugar:water ratio in the beet, by optimizing diffusion juice draft and by reducing the amount of water used for juice decalcification. However, of much greater effect is reduction in the water used in the boiling house, including the use of thin juice to melt affined sugar for mingling with medium- and low-grade massecuite. This and other measures are discussed.

Thermal problems associated with post-campaign processing of thick juice. F. Buja. *Ind. Sacc. Ital.*, 1982, **75**, 73-82 *(Italian)*. — Doubts expressed by Italian sugar companies on the merits of storing thick juice for post-campaign processing are discussed; they generally include the increased costs involved in the extra energy and processing as well as plant use. Various aspects of steam and condensate usage are examined, starting with an explanation of the significance of the so-called "deferred quota", i.e. that fraction of recoverable sugar in the beets entering the factory which remains in the stored thick juice, and then considering steam, condensate and feedwater treatment and utilization, including the operation of a quadruple-effect evaporator on exhaust steam (the system commonly used by those factories that do store thick juice). A number of recommendations are then made on optimum energy consumption which will permit the benefits of thick juice storage and processing to be enjoyed without considerable increase in costs. The schemes described are considered equally applicable to refining. Where factories use ion exchange processes other than the Quentin process, some modifications to the schemes are required.

Rationalization of the molasses exhaustion process. Preliminary considerations. K. Wagnerowski. *Gaz. Cukr.*, 1982, **90**, 1-5 *(Polish)*. — After a brief indication of the low-grade massecuite cooling times in US and Danish sugar factories, the author discusses the effect of cooling rate on crystallization, mentioning tests conducted some 20 years ago[1] in which the cooling rate had the greatest effect on the final crystallization phase, when the massecuite, of 80°C initial temperature, had reached a point below 65°C. A model of the crystallization process based on the results of these experiments is described, which shows that, with non-linear programming, a cooling rate of 0.5°C/hr from 80° to 40°C will give a molasses standard purity of 58.7; on the other hand, a linear program based on a cooling rate of 1°C/hr, i.e. halving the cooling time, gives a molasses standard purity which is only 0.8 units higher, equivalent to a loss of 0.06% on beet.

Drying of air on a bed of calcium oxide. R. Glaser, Z. Pelech and Z. Kalata. *Gaz. Cukr.*, 1982, **90**, 5-8 *(Polish)*. — Details are given of experiments conducted in a vertical vessel at Strzelin sugar factory, in which air intended for manufacture of SO_2 was dried by being passed over beds of CaO.

Optimization of the extraction process in continuous trough-type diffusers. A. Butwilowicz and A. Tomaszewska. *Gaz. Cukr.*, 1982, **90**, 16 *(Polish)*. — Observations of diffusion at three Polish sugar factories are discussed as part of preliminary work aimed at optimizing the process in a DDS-type diffuser so as to obtain maximum raw juice purity and minimum losses. It is shown how the three factories differed in raw juice purity, the Silin number of the cossettes and (less so) pH of diffusion water for each of the three months October, November and December.

Decalcification of thin juice by the Gryllus-Zsigmond ion exchange method. J. Haszczynska and S. Zarzycki. *Gaz. Cukr.*, 1982, **90**, 17 *(Polish)*. — Preliminary tests at Lublin sugar factory on the Gryllus-Zsigmond ion exchange process for thin juice deliming are reported. These showed that replacement of Ca^{++} ions with Na^{+} and K^{+} had little effect on pH, Brix and purity, while deliming efficiency averaged 85% and there was marked increase in the quantity of clarifier mud (0.43-1.4 g/100 cm^3).

The use of ion exchange resins in purification of sugar factory juices and syrups. S. Zarzycki. *Gaz. Cukr.*, 1982, **90**, 17-18 *(Polish)*. — Advantages and disadvantages of ion exchange processes (juice deliming with NaCl used as resin regenerant, decolorization, the Quentin process and demineralization) are indicated, and the merit of the Gryllus deliming process in having no effluent for disposal emphasized.

Polymer adsorption on the surface of calcium carbonate. I. G. Bazhal, E. N. Shirokikh, I. A. Oleinik, R. M. Polishchuk and E. P. Dzyubenko. *Ukr. Khim. Zhurn.*, 1982, **48**, 709-711 *(Russian)*. — Trials are reported in which adsorption of flocculants K-4 and K-9 (cation active agents) and POE (non-ionic polymer) on $CaCO_3$ was investigated in a model beet juice. Results, given in the form of isotherms, were obtained under conditions in which the polymer concentrations were optimum for maximum mud flocculation, so that the tests are considered a good model for flocculant investigations.

Development of an automatic control system in a closed-circuit diffusion process using a micro-processor. H. Dabrowski. *Gaz. Cukr.*, 1982, **90**, 19-20 *(Polish)*. Reference is made to mathematical modelling of the static process in a DDS diffuser as a contribution to automatic control. Simulation was intended to establish an optimum rate of sugar extraction from the cossettes, and results were to be applied to a dynamic model used as basis for a micro-processor system.

Means of disinfecting heat exchangers, particularly barometric water coolers, in the sugar industry. B. Amerski and H. Gawronski. *Gaz. Cukr.*, 1982, **90**, 20 *(Polish)*. — A scheme is described for disinfection of a

[1] Wagnerowski *et al.*: *I.S.J.*, 1963, **65**, 23.

condenser water cooler and for removal of a gelatinous deposit formed bacterially from albumin and sugars. The deposit is removed by dehydration and hydrolysis using a 1% aqueous solution of NaOH sprayed at 80°C from the top of the cooler, after which 0.02% aqueous Sterinol is sprayed, also at 80°C.

Contribution to removal of the toxicity of an anti-foam agent for the sugar industry. M. Potokar, H. Tesmann and A. Asbeck. *Zuckerind.*, 1982, **107**, 744-748, 750 *(German)*. — The legal aspect of using chemical aids in the West German food industry is explained, and the particular case of anti-foam agents, of which 3000-3500 tonnes is estimated to have been used in the 1980/81 beet campaign, discussed. While it is important for the user to establish the toxic properties of an anti-foam agent, there are a number of problems: (1) there is no fixed method of determining toxicity, (2) there may be considerable scatter of experimental results where the test product is a complex mixture rather than a chemically pure model substance, (3) it is difficult to establish the quantity of anti-foam agent that can be taken up by the sugar over a given period of time under the most unfavourable conditions, and (4) determination by non-clinical tests of the effects of such a contaminant in sugar on the health of the consumer is not easy. Criteria used in toxicology are described, and tests, in which an anti-foam agent of stated properties was incorporated in rat diets over a 28-day period, are reported.

Historical development of white sugar silo construction. G. Fuchs. *Zuckerind.*, 1982, **107**, 753-760 *(German)*. A survey is presented of white sugar silos, from the first to be built (at the Wheatland factory of Great Western Sugar Co. in the USA in 1930) to the latest designs and arrangements in pairs or in a four-leaf clover pattern. A storage capacity of 35,000 tonnes has been found to be optimum for silos of circular cross-section standing on their own. This corresponds to an effective storage compartment 35 m in diameter and 40 m high; with a greater height of sugar there would be excessive pressure on the wall, which is not as strong as in a battery arrangement.

The thixotropic properties of the colloidal precipitates in predefecation juice. J. Grabka. *Zuckerind.*, 1982, **107**, 765-769 *(German)*. — Investigations of the rheological properties of the precipitated colloids after preliming with a suspension of calcium saccharate with or without $CaCO_3$ showed that the muds had a marked non-Newtonian character and a high viscosity when no $CaCO_3$ was incorporated in the suspension, whereas its presence led to muds of much lower viscosity and a lower thixotropic surface index, so that their structure was more orderly and less liable to deformation, compressibility was lower and their filtration and settling properties good. The calcium saccharate suspension was made up of 150 g sucrose, 50 g CaO and 800 g water, while the other suspension was obtained by gassing the above suspension with CO_2 to a final alkalinity of 2.2-2.4 g CaO/100 cm^3.

Inhibition of *Clostridium thermosaccharolyticum, Clostridium thermohydrosulphuricum* and *Bacillus stearothermophilus* by antiseptic substances. D. Matteuzzi, P. Brigidi and G. Vaccari. *Zuckerind.*, 1982, **107**, 769-771. — Tests were conducted on inhibition of the activity of four strains each of *C. thermosaccharolyticum* and *C. thermohydrosulphuricum*. Results showed that, of the eight antiseptics tested, by far the most effective was Deosteril; only a maximum of 30 ppm was required for inhibition, compared with (typically) 150 ppm of Anios BX5 and Micro-Quat, 250 ppm of Anios DIF, 500 ppm of 35% formalin, 600 ppm of RH 886 and more than 1000 ppm of Busan 881 and Nalco 247. In tests involving two strains of *B. stearothermophilus*, Deosteril was again the best (only 5 ppm being required), followed by Anios DIF, Busan 881, Nalco 247, RH 886 and 35% formalin in that order. *B. stearothermophilus* was clearly more sensitive to treatment than were the other two bacteria. All three micro-organisms are to be found in diffusion juice.

Some problems in the development of sugar industry apparatus and equipment. K. Urbaniec. *Gaz. Cukr.*, 1982, **90**, 25-30 *(Polish)*. — A survey is presented, with 50 references to the literature, on developments in sugar factory equipment during the 1970's, mostly of Polish and West European origin, and covering beet yard equipment, beet washers, diffusers, juice purification, filters, evaporators, juice heaters, vacuum pans, crystallizers, centrifugals, granulators and pulp presses and dryers. The two major constraints on machinery designers are the energy consumption involved in operation and processing, and environmental protection.

Fuel consumption in sugar factories and possibilities of reducing it. S. Nikiel. *Gaz. Cukr.*, 1982, **90**, 30-34 *(Polish)*. — In an examination of fuel and steam consumption in a sugar factory, it is shown that it is possible to make reductions, although at high capital cost. Suggested means include replacing existing boilers with high-performance boilers operating at pressures of 4-6 MPa (40-60 atm), replacing steam turbines with ones operating at 0.3-0.4 MPa pressure and consuming 7 kg steam per kWh, converting to a quintuple-effect evaporator with juice heated to 133°C in the 1st effect, installing high-performance white sugar granulators heated with 2nd effect vapour, and stopping the campaign on about December 20 through the erection of new factories and expansion of existing ones, with modernization of energy schemes. Prolonging the campaign in the winter months is inadvisable in view of the increased difficulties in processing and higher fuel consumption but lower sugar recovery.

The effect of beet wilting on the juice purification process and sugar production. I. Oglaza, S. Zarzycki, E. Walerianczyk and E. Smolinska. *Gaz. Cukr.*, 1982, **90**, 52 *(Polish)*. — Investigations have demonstrated the adverse effect of beet wilting, viz. increase in enzyme activity and in the reducing sugars content in factory products, reduction in juice purity and associated crystallization problems, and an overall 0.9% extra loss of sugar (on beet) by comparison with processing of fresh beet.

Tests on raising the purification efficiency of juice extracted from raw material of low processing quality. I. Oglaza, E. Walerianczyk, J. Haszczynska and S. Zarzycki. *Gaz. Cukr.*, 1982, **90**, 53-54 *(Polish)*. Investigations on the adverse effect of low-quality beet on juice purification are reported, and recommendations based on the findings are listed: rapid separation of predefecation mud, addition of lime at the lowest practical juice temperature and at a point where the maximum amount of CaO will be dissolved, and maintenance of lowest practical temperatures during liming and 1st carbonatation so as to minimize the reducing sugars content.

Preliminary evaluation of anti-foam agents for the sugar industry. B. Siutowicz, E. Wojtczak and A. Tomaszewska. *Gaz. Cukr.*, 1982, **90**, 54 *(Polish)*. — After tests on a number of anti-foam agents conducted on a factory scale had failed to confirm laboratory results, a number of modifications were made to the method used for evaluation. Preliminary findings of the modified tests are briefly reported; as before, the best agent for prevention and removal of foam was Spumol C, a product that is already in use in the Polish sugar industry.

Open tanks are still unsafe. B. Karas. *Gaz. Cukr.*, 1982, **90**, 62-63 *(Polish)*. — Open tanks, particularly those holding hot juice or mud, can be dangerous; the most frequent cause of accidents is blockage of overflow pipes and/or breakdown in automatic control systems, so that the contents may overflow. A fatal accident is described in which hot mud from a holding tank serving a battery of filter-thickeners overflowed just as the victim was passing the tank; an enquiry was held, and recommendations were made on the basis of the findings.

Microbial sucrose loss in the diffusion process. S. Oikawa, K. Sayama, K. Hashizume and T. Kawamoto. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **31**, 19-28 *(Japanese)*. — Quantitative studies were conducted on microbial sugar losses in beet diffusion, and equations derived from the results for calculation of the loss in terms of the lactic acid content in (i) raw juice and (ii) thick juice; very close agreement was obtained between the values given by the two equations. Results for the previous three years showed losses in the range 0.02-0.14% on beet for Japanese factories. A very small loss at Shibetsu factory was associated with a low nitrate-N content in the beet, a relationship that was confirmed experimentally. The lactic acid coefficient was higher in an open-type diffuser than in a closed type. The fermentation characteristics of thermophiles isolated from raw juice were investigated and the results tabulated.

A model for vacuum pan crystallizers. H. Gros. *Papers presented at 12th Symp. Computer Applications in Chem. Eng.*, 1979, (2), 1010-1020; through *S.I.A.*, 1982, **44**, Abs. 82-1029. — A mathematical model was constructed to represent the boiling process in batch vacuum pans. It simulates all four phases of the process and is applicable to factory massecuites. The equations were solved by digital computer; for *A*-massecuite boiling, results agreed well with beet sugar factory data, but for low-grade boiling there was considerable deviation. The model permits rapid evaluation of possible boiling strategies. Its use has confirmed that successful boiling is possible only within a limited range of operating variables.

Microprocessors in process control. Anon. *Mf. Chemist*, 1982, **53**, (6), 44-45, 47; through *S.I.A.*, 1982, **44**, Abs. 82-1031. — The concept of distributed control based on microprocessors is outlined, with descriptions of systems supplied by various manufacturers. A Diogenes VDS system has been supplied by Rosemount to the Carlow factory of the Irish Sugar Co. Ltd.; at present it controls two of the twelve vacuum pans. Crystal quality has improved and steam consumption decreased.

Determination of the cooling rate in ventilated sugar beet piles. P. V. Schmidt and S. Wölfel. *Lebensmittelind.*, 1982, **29**, 364-370 *(German)*. — The mathematics of calculating the rate of temperature fall in a ventilated beet pile as a function of ambient temperature, beet temperature, ventilation intensity and duration, efficiency of the ventilator and dirt tare are explained and a nomogram presented for calculation of the temperature in a pile after one day's storage.

Purification of 2nd carbonatation juice by electrodialysis. L. D. Bobrovnik, N. S. Fedorova, P. P. Zagorodnii and K. P. Zakharov. *Pishch. Prom.*, 1981, **27**, 19-22 *(Russian)*. — Pilot-scale trials were conducted at Yagotinskii experimental sugar factory on electrodialysis of 2nd carbonatation juice pre-cooled to 45°C. No information is given on the juice composition, while the only process parameters given are juice flow velocity (0.0265 $m.sec^{-1}$) and current intensity (40 $A.m^{-2}$). Equations are presented for calculation of important factors, and a possible 0.55% increase in sugar yield (on weight of beet) indicated.

Effect of sodium sulphite on non-sugars removal from viscous beet sugar products. N. I. Odorod'ko, A. P. Kozyavkin and L. D. Bobrovnik. *Pishch. Prom.*, 1981, **27**, 22-24 *(Russian)*. — Tests on treatment of low-grade sugar solutions of 65°Bx with sodium sulphite are reported. The sulphite was added at 0.1% by weight to one solution and at 0.02% to two other solutions, all of which were then heated at a constant 80°C for 6 hours. Results showed that treatment reduced the colloids content, colour content and viscosity, minimum values of which were obtained at a pH_{80} in the range 7.40-7.85. By contrast, there was no change in the three parameters with untreated controls. Calcium sulphite that was formed was found to have adsorptive properties with regard to colour and lime salts.

Change in the temperature coefficients of pH of concentrated sugar solutions with sodium sulphite. A. P. Kozyavkin and N. I. Odorod'ko. *Pishch. Prom.*, 1981, **27**, 24-25 *(Russian)*. — It has been found that addition of 0.02-0.03% sodium sulphite (by weight) to sugar solutions causes a sharp rise in pH, although the effect diminishes with increase in the quantity added. Since there is a linear relationship between pH and temperature, the ratio Δ pH: Δ temperature was determined for solutions of 64.5, 69.4, 96.6 and 99 purity which were heated at a constant 80°C and to which sodium sulphite was then added in the range 0.01-0.50% by weight. While pH fell with temperature rise, the degree of fall was lower when sulphite was added than without sulphite. At constant sulphite addition, increase in pH_{20} and pH_{80} of high-purity solutions was greater than for lower-purity solutions.

The effect of rapid heat treatment of beet cossettes on raw juice quality. N. N. Pushanko and A. S. Dmitrash. *Pishch. Prom.*, 1981, **27**, 25-28 *(Russian)*. — Three methods of pre-scalding cossettes were tested: 4-8 seconds' contact with saturated steam at 115°C on a rake conveyor housed in a closed trough mounted at an inclined angle above the feed port of an experimental horizontal ring diffuser; application of recirculation juice, pre-heated to 80°C, in the feed chamber of the diffuser, and a combination of these two methods. Results showed that rapid steam treatment was better than pre-scalding with juice as regards juice pectin content, while the combined method gave best results. In all cases, the pectin contents were lower than those of juice in a DDS diffuser and were within permissible limits of 0.07-0.18%.

Selection of optimum control parameters in automatic control of a sugar factory evaporator. L. I. Kornienko. *Pishch. Prom.,* 1981, **27,** 83-85 *(Russian).* — Mathematical expressions are given for use in calculation of control parameters for optimum evaporator operation, i.e. at which a target thick juice Brix is achieved and steam usage minimized under varying conditions of juice feed rate and concentration and steam consumption in other factory stations.

Comparison of raw juice purification schemes. V. A. Golybin, V. M. Fursov and A. R. Sapronov. *Sakhar. Prom.,* 1982, (8), 28-29 *(Russian).* — Pilot-scale tests were conducted at Ramonskii experimental sugar factory on preliming and precarbonatation of juice from low-quality beet (having a juice purity of 82.6, a reducing sugars content of 0.2% on weight of beet and a pH of 4.7). Preliming was conducted at 50, 60, 70 or 80°C, 0.5% CaO (on weight of beet) being added in all cases, while precarbonatation was carried out with 1% CaO at these temperatures and a pH of 11.1 or 9.2. The rate of settling was determined, as was the colour (immediately after treatment and after 30 minutes' settling) at 560 nm. In terms of settling velocity, best was precarbonatation at pH 9.2 and 70-80°C, while lowest colour (immediately after settling) was achieved by precarbonatation at 60°C and pH 1.1. In further tests, three purification schemes were compared: (1) the conventional method, including hot pre- and main liming at 80°C and a total lime addition of 2.3% CaO on weight of beet; (2) with removal of precarbonatation mud and fractional warm and hot liming (at 50° and 80°C, respectively), a total of 1% CaO added and other steps as in (1); and (3) using progressive preliming at 50°C with 0.3% CaO added, warm and hot fractional main liming with 1.7% CaO and 2nd liming with 0.3% CaO before 2nd carbonatation. For non-sugars removal, scheme (2) was best, (3) was slightly inferior, while (1) was unsatisfactory; in terms of colour, (3) gave best results, (2) was less effective, while (1) gave very poor results; reducing sugars retention was lowest with scheme (3), while scheme (1) gave the lowest lime salts content, although generally it was considered unsatisfactory, while scheme (2) was the most efficient of the three.

A rotary device for filter cake washing on rotary vacuum filters. N. G. Lila, B. I. Eibozhenko, Yu. V. Anikeev and G. S. Stepanov. *Sakhar. Prom.,* 1982, (8), 30-31 *(Russian).* The sweetening-off device described comprises a cylinder carrying longitudinal blades which is located parallel to the axis of the filter drum below the wash water distributor. The cylinder breaks the falling curtain of water into a fan-shaped spray of fine droplets, the extent of dispersion and wetting of the filter cake being governed by the speed at which the cylinder rotates. Cake losses were found, during a two-shift period (measurements being made at half-hourly intervals), to be 0.02% less (on weight of beet) than for filters equipped with spray nozzles, at the same water consumption; gravity feed of the water ensured that the filter cake remained unbroken.

Methodology for determining optimum doses of chemical anti-foam agents. B. I. Goncharenko and A. L. Chegoryan. *Sakhar. Prom.,* 1982, (8), 32-34 *(Russian).* — A series of equations is presented for calculation of the minimum amount of anti-foam agent to add to flume-wash water to achieve the desired result. A nomogram is presented for calculation of the dosage as a function of pH and saponin and suspended matter concentration.

New evaporators. A. A. Dudnik, O. D. Kosenko and D. A. Stolyar. *Sakhar. Prom.,* 1982, (8), 43-45 *(Russian).* Details are given of a new series of Soviet evaporator, the A2-PVV, which is provided with a louvre-type entrainment separator.

The level and trends in development of sugar factory automation. S. Ginal. *Gaz. Cukr.,* 1982, **90,** 81-84 *(Polish).* — A survey is presented of automatic measurement and control of flow, pH and Brix and of problems confronting Polish sugar factories with regard to shortage of requisite equipment such as induction flowmeters and electrodes for pH meters. It is considered unjustifiable to use expensive isotope density meters for measurement of juice Brix if other, cheaper, means can be used, while there is also need to modernize automatic equipment (that is, say, older than 15 years) and to make better use of computers. Mention is made of computers installed at two factories for central data banking and processing which, but for the absence of suitable software, could be used for direct process control.

Rationalization of the molasses exhaustion process and the problem of optimum supersaturation. K. Wagnerowski. *Gaz. Cukr.,* 1982, **90,** 84-87 *(Polish).* — The relationship between supersaturation W_p and viscosity η and the effects of both parameters on crystallization rate are discussed on the basis of the findings of various authors and experiments conducted by the author of the article. The characteristics of the diffusion layer are described, particularly the distribution of supersaturation and viscosity within the layer, the layer thickness, diffusion coefficient, crystallization rate and the driving force responsible for crystallization (the thermodynamic potential of the solution measured as the difference between the concentration of a saturated and supersaturated solution) and optimum supersaturation at which the crystallization rate V is maximum. An equation is derived in which V is given by $\frac{r.W_n(W_p - 1).T}{\frac{1}{2}(\eta_p + \eta_n)} k$, where r = sucrose solubility in water, W_n = saturation coefficient, T = temperature (°C), η_p and η_n are, respectively, the viscosity of the supersaturated mother liquor and of the saturated syrup, and k is a temperature-dependent constant.

Major problems in the sugar campaign. E. Walerianczyk. *Gaz. Cukr.,* 1982, **90,** 88-89 *(Polish).* — The problems created in processing by poor beet quality are briefly discussed, particularly diffusion difficulties and losses as well as juice purification problems. Data for 1974-80 indicate the general fall in quality of Polish beet.

Some trends in improvement of ion exchange column operation. S. Wysocki, E. Wojtczak and J. Marczynski. *Gaz. Cukr.,* 1982, **90,** 100-101 *(Polish).* — In operation of ion exchange columns in Polish sugar factories, cases have occurred of considerable quantities of effluent, not only resulting from regeneration but also from rinsing, while excessive dilution of syrup has taken place as well as fouling of the resin. Since it was thought that direction of flow was a major factor responsible for these problems, laboratory investigations were carried out in which identical columns of resin were sweetened-on with 59.5° Bx liquor, but in two opposite directions of flow at a rate of 180 $cm^3.hr^{-1}$. As soon as flow started, 20-cm^3 fractions of eluate were taken. Tabulated data showed that, in the case of downward flow, only the first fraction contained no sugar, while the sub-

sequent fractions were of increasing concentration; a total of 500 cm^3 of eluate was required for recovery of all the sugar. With upward flow, the first five fractions contained no sugar, and complete recovery required only 300 cm^3 of eluate. When regeneration was carried out with 10% NaCl + 2% NaOH, only three fractions of water were obtained when flow was downward, by contrast with six fractions when upward flow was used. Downward flow also caused marked stratification and fouling of the resin. However, while upward flow is recommended for both sweetening-on and the first phase of regeneration (using spent brine), the second phase of regeneration with fresh brine should be carried out with downward flow so as to obtain a colourless eluate more rapidly.

The effect of a magnetic field on reducing the scaling of the heating surface in an evaporator. T. Bogumil, W. Fornalek and W. Kosieradzki. *Gaz. Cukr.*, 1982, **90**, 101 *(Polish)*. — An outline is given of pilot-scale trials on treatment of thin juice in a magnetic field with the aim of reducing scale formation in evaporator tubes. A 35-40% reduction in the weight of tube samples (by comparison with tubes in which the juice had not been pretreated) was considered sufficient proof of the effectiveness of the method, and a unit was to be installed in a sugar factory for the 1982 campaign. No details are given of optimum field intensity.

Comparative tests on diffusers with and without a "cold point" during the 1981-82 campaign. J. P. Ducatillon and R. Gontier. *Sucr. Franç.*, 1982, **64**, 325-336 *(French)*. The article is concerned with the effect of partial prescalding of cossettes, i.e. with recirculated raw juice which is not reheated until it passes to purification, the aim being to reduce steam consumption. Comparative tests were conducted at two factories (Eppeville and Connantre) equipped with RT diffusers, one of which at each factory was provided with a Fives-Cail Babcock pre-scalder, while at Guignicourt comparison was made between a De Smet diffuser in which the juice was partly cooled and a Buckau-Wolf diffuser with modern prescalder. The experiments were designed to establish the effect of operating with cool juice on bacterial development in diffusion as well as on purity and alkalinity of the juice. Full details are given of the test procedures and results obtained, which indicated that, despite a general increase in bacterial counts, particularly mesophiles, in the cooled juice there was little difference in quality of hot and cold juice at discharge from the diffuser. It is calculated that under normal diffuser operation, heating of cossettes and juice consumes about 100 kg of steam per tonne of beets.

A centrifugal beet slicer at Hajdusag sugar factory. F. Gal and K. Berki. *Cukoripar*, 1982, **35**, 117-119 *(Hungarian)*. — An illustrated description is given of a Polish KO24T-1700 B beet slicer of 3000 tonnes daily capacity that has been installed at Hajdusag. Some performance data are included.

Rationalization of the molasses exhaustion process — detailed considerations. K. Wagnerowski. *Gaz. Cukr.*, 1982, **90**, 105-108 *(Polish)*. — The theory of optimum supersaturation of pure sucrose solution and low-grade massecuite (at which the crystallization rate is maximum) is examined, and the effects of other parameters (temperature, non-sugars concentration, saturation function m and b, and viscosity) on crystallization rate discussed, as is the relationship between viscosity and purity. Results of experiments are discussed, and an expression developed for the optimum supersaturation of low-grade massecuite based on a value of 1.17 established at 40°C and one of 1.20 at 80°C: $0.001t + 1.13$, where t = temperature. The maximum change in optimum supersaturation as an effect of alteration in the other above-mentioned factors (apart from temperature) was ± 0.01 unit.

Juice purification with preliminary removal of mud. M. Wachowicz. *Gaz. Cukr.*, 1980, **90**, 109-110 *(Polish)*. Comparative tests were conducted on juice purification by the conventional method (1) based on addition of 1.4-2.4% CaO on juice (with 0.25% CaO added in preliming) and by a method (2) including preliming (with 0.25% CaO), removal of the mud, sulphitation to pH 6.0-6.2, clarification to separate any residual mud, and liming of the clear juice with 0.7% CaO on juice; 1st and 2nd carbonatation were as in the conventional method. While the invert, albumin-N and total N contents in the juices from both processes were similar, the juice from method (2) contained some 25% less colloids but about 10% more lime salts, while it settled quicker and the mud volume was smaller than with method (1).

Invert degradation by K11G complex. J. Grabka. *Gaz. Cukr.*, 1982, **90**, 111-113 *(Polish)*. — Tests are reported in which K11G sucro-carbonate complex (made by liming an aqueous sugar solution) was added before liming of juice at 80°C. Results showed that, for juice containing 1.58-1.63 g invert per 100°Bx, treatment gave 73.5-74.0% degradation of the invert. In the case of lower-purity juice containing 2.06 g invert per 100°Bx, the efficiency of the complex was reduced to an average of 34.7%. At least 15% complex on juice (w/w) was required to give the desirable results.

Thoughts on the operation of lime kilns and lime stations. A. Krol, W. Maniecki, J. Osmanski and Z. Pauch. *Gaz. Cukr.*, 1982, **90**, 113-117 *(Polish)*. — The general situation as regards lime kiln and lime station efficiency in Polish sugar factories is discussed, and the need to improve their performances indicated. Details are given of equipment and systems used at specific factories as examples of how to achieve improved results, including a carbonatation gas CO_2 content of more than 30%, at lower fuel consumption.

Anaerobic processes in the sugar industry. A. Hasenböhler. *Zuckerind.*, 1982, **107**, 835-838, 848-849 *(German)*. Details are given of the Sulzer Anodek two-stage process for anaerobic treatment of waste water. In the first (conditioning) stage, hydrolysis to fatty acids, lactic acid and ethanol is carried out in a single, stirred reaction vessel provided with a mud separator. Hydrogen is formed by acetogenic bacteria and is then directly metabolized (by interspecies hydrogen transfer) by methanogenic bacteria, thus providing the thermodynamic conditions requisite for the action of the acetogens. H_2S and nitrate, nitrite and ammonium ions are eliminated. The conditioned mud is fed into a UASB (upflow anaerobic sludge blanket) reaction vessel serving as second stage. As an alternative to the use of a mud containing the acetogenic and methanogenic bacteria, the bacteria may be fixed on inert material in stationary or fluidized bed form. Increase in the pH in the second stage causes precipitation of up to 80% of the lime salts, so that provision must be made for removal of large quantitities of these salts.

LABORATORY STUDIES

Development of an optical saturation temperature measuring instrument. S. Oikawa and R. Takeda. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **31**, 40-46 *(Japanese)*. — In tests on boiling control using an automatic optical saturation temperature meter, difficulties were encountered in pretreatment because of outside influences, so that insufficient results were obtained with the conventional measuring method. A number of modified methods were investigated, and an improved meter developed which was highly accurate and simple to handle. No special pretreatment is required, and a newly developed special slide glass is used, so that the two major sources of error are removed. Details are given of the two-pen recorder system.

Juice concentration by reverse osmosis. S. Imafuku, S. Watano, H. Sekino and K. Tsukamoto. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **31**, 85-97 *(Japanese)*. — In view of increasing energy costs in a beet sugar factory, and since the energy consumption in solution concentration by reverse osmosis (RO) is characteristically very low, studies were made of possible application of RO to thin juice pre-concentration. Experiments with tubular membrane modules showed that the optimum flow rate in a module for maintenance of high flux and rejection of sugar was in the Reynolds' number range of 20-30,000, depending on feed juice concentration, and that there is a very close relationship between feed juice concentration and flux, the latter decreasing almost linearly with increase in concentration. At 11.6-22.0°Bx, rejection of sugar was virtually constant at 97.5-98% using a membrane capable of rejecting about 90% NaCl. Continuous operation was tested over 80 days in a pilot plant having a capacity of 4 m^3/day demineralized thin juice. The RO system incorporated an automatic cleaning system using sponge balls. The flux decline rate, expressed as *m* value, was −0.02, and sugar rejection was 99.6-99.8%. Filtration efficiency of the pre-filter used to protect the membrane module was reduced by dextran (formed by *Leuconostoc mesenteroides)*, but this had substantially no effect on module performance. The results showed that it is technically possible to concentrate demineralized thin juice to 20-25°Bx by RO and that a combination of RO with evaporation could be economically beneficial by comparison with conventional evaporation.

Demineralization of molasses by electrodialysis. I. Takahashi and M. Aoi. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **31**, 98-103 *(Japanese)*. Tests were conducted on demineralization of refinery molasses by electrodialysis after dilution to 30°Bx, centrifuging and addition of HCl. It was found that the lower the molasses pH, the higher was the ratio of limiting current density to conductivity, so that a higher electric current could be used with molasses of lower pH. During 75 cycles over 30 days, the capacity of the anion exchange membrane was slightly changed, while the cation exchange membrane remained unaltered. After the 75 cycles, there was hardly any reduction observed in the demineralization ratio and current efficiency. The demineralized molasses had a good flavour, with a delicate sweetness but no bitter taste.

Isolation and identification of phenolic glucosides in liquid sugars from cane molasses. G. Palla. *J. Agric. Food Chem.*, 1982, **30**, 764-766. — Liquid sugar samples obtained from cane molasses by clarification, demineralization and decolorization contained 70% dry solids, 69.3% total sugars and 0.05% ash, on average, and had an absorbance (measured at 420 nm) of 2-3. After 1:1 w/w dilution with distilled water, 200 g samples were passed through ES-861 resin in a glass column at a flow rate of 1.5 bed volumes/hr. Sugars were then displaced with distilled water, and adsorbed colouring matter was recovered by elution with aqueous methanol, and then subjected to gel filtration on Sephadex G-10. Three major coloured fractions were recovered: a brown fraction, a pale yellow fraction, and an orange-yellow fraction; the components of the last fraction, representing 40% of the colour recovered, were fractionated by column chromatography with silica gel. A low-molecular weight coloured fraction was obtained which represented more than 10% by weight of the starting material. It showed no reducing power with Fehling's reagents, contained no nitrogen but gave a strong positive reaction with specific reagents for phenolics, while its aqueous solution gave a U.V. spectrum agreeing with the phenolic nature of the components. After enzymatic hydrolysis, the brown hydrolysate was purified by column chromatography, the Kieselgel 60 used then being eluted with ethyl acetate; the dried residue from the main coloured fraction was subjected to gas chromatography-mass spectrometry, from which a number of phenolic glucosides were identified. These probably originated from microbial and chemical degradation of lignins during processing. The colour of the liquid sugar obtained from the molasses was found to increase with time as a result of autoxidation of the glucosides, and it is concluded that the phenolic glucosides and their oxidation products greatly contributed to the colouring of the liquid sugars examined.

The surface reaction in the growth of crystals in supersaturated solutions. V. Maurandi. *Sucr. Belge*, 1982, **101**, 207-221 *(French)*. — See *I.S.J.*, 1983, **85**, 59.

Investigations in sugar technology. B. Guzmán. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 139-153 *(Spanish)*. — It has been appreciated that more basic information is required in respect of sugar cane in Tucumán as a consequence of changes which have occurred with time, and that observations made in Australia, South Africa, etc., are not necessarily valid in Argentina. A program of research has thus been instituted, including polarimetric analysis and analytical techniques that do not require expensive equipment such as for HPLC analysis. Other projects include the chemical composition of different cane varieties, the effect on cane composition of different methods of harvesting and storage, starch determination in cane juice, etc.

Preliminary design study of a reactor-clarifier for cane juice. C. Díaz R., R. Santana M., M. García A. and O. Soto O. *Centro Azúcar*, 1981, **8**, (2), 125-142 *(Spanish)*. — The theoretical basis is explained for a new design of reactor-clarifier, as well as the results of experiments carried out on a small laboratory unit, using water and additions of methylene blue to examine flow

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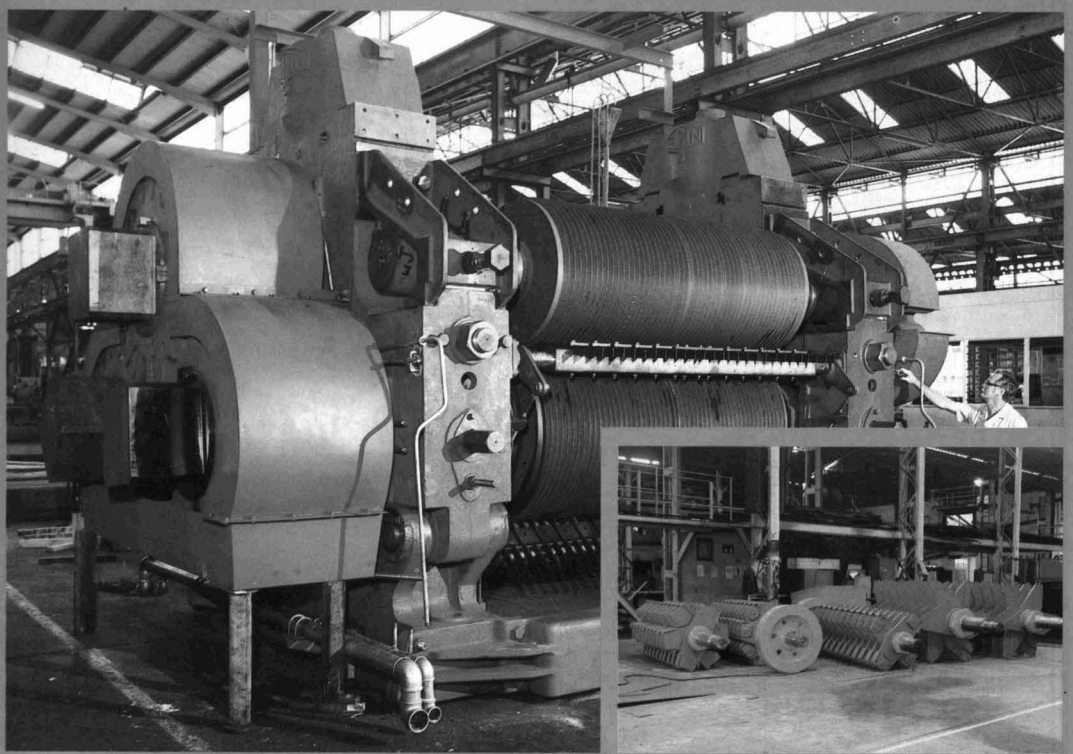

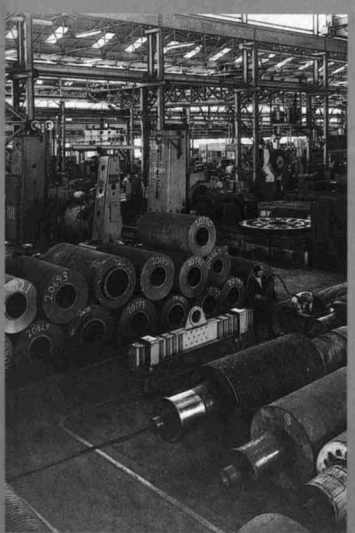

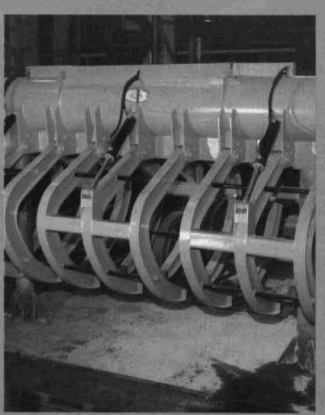

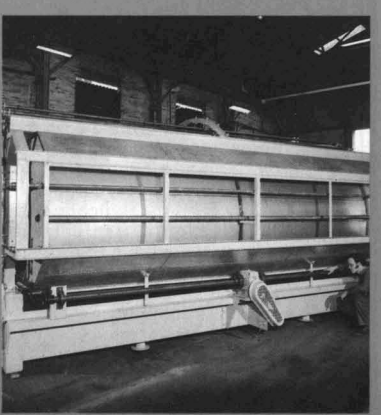

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patterns, and a synthetic limed juice. The results showed that the unit performed acceptably as a reactor, with slightly less than half of the Ca being precipitated. However, sedimentation characteristics were poor and further studies will be needed.

Characterization of a seeding medium by electronic microscopy. L. Carrazana R. and L. M. Mejías G. *Centro Azúcar,* 1981, **8,** (2), 157-163 *(Spanish).* — A method has been developed in the Sugar Research Laboratory at the Central University of Las Villas in which microcrystals of sucrose are obtained in a quaternary system (sucrose-water-ethanol-glycerol) and are so fine that they are not visible in an optical microscope. The method is not described. The suspension has been used satisfactorily as a seeding medium on the industrial scale but, in order to study its state of aggregation, etc., it has been necessary to use electron microscopy. Various techniques were tried and carbon replication found to be suitable; it was confirmed that solid particles were present and that they were of sucrose. The seeding medium was found to be stable for up to 12 days.

Microbiology of crystal sugar distributed in the trade. J. S. Goldoni, L. G. Souza, S. M. da Costa and A. A. da Silva. *Brasil Açuc.,* 1982, **99,** 331-335 *(Portuguese).* Samples of white sugar of four different origins within Brazil were taken from stores at different times and examined for micro-organisms present. Sampling was repeated at weekly intervals, to give four sets of analysis, and the counts are tabulated. They were lower than the standards of the US National Canners Association for sulphide-producing and non-sulphide-producing anaerobes, for *Bacillus stearothermophilus* and for yeasts and moulds, the last being the most numerous and showing the greatest variation between samples and origins.

Determination of white sugar moisture. L. I. Trebin. *Pishch. Prom.,* 1981, **27,** 15-17 *(Russian).* — When the conventional Soviet method of moisture determination is used, errors (up to a total of 20%) may occur as a result of (1) infiltration of atmospheric moisture into the weighing bottle carrying the dried sample (this can occur right up to sealing of the bottle), (2) inadequate sealing, and (3) reduction of the density of hot air in the bottle when hermetic sealing is used. To eliminate the sources of error, a procedure is described in which 10 g of the sample is placed in a pre-weighed, long-necked, round-bottomed glass flask connected by a rubber sleeve to a funnel; the funnel and sleeve are then removed, the flask re-weighed and connected, with other such flasks, to a connector linked to a vacuum pump. The flasks are placed in a constant-temperature chamber from which the air is carefully withdrawn, so as to avoid sugar entrainment, and the temperature raised to 105°C during 30 min. The sample is dried at 1-2 mm Hg pressure during 2 hr, after which the neck of the flask near the upper end is heated by gas burner to fuse the glass, thus providing hermetic sealing (the vacuum pump operating all the time). The flask and contents are then weighed and the moisture content of the sugar calculated.

The effect of solution viscosity on sucrose crystallization rate. Yu. D. Kot, A. V. Vlasenko, A. N. Savich and A. F. Kravchuk. *Sakhar. Prom.,* 1982, (8), 31-32 *(Russian).* It is stated that the equation based on Fick's law (involving diffusion kinetics) is not valid for quantitative evaluation of sucrose crystallization because of the absence of data on the thickness of the film of solution adjacent to the crystal and unavailability of a method for determining it. By analogy with heat transfer processes, the film can be calculated as the ratio between viscosity η (centipoises) of a saturated solution in contact with the crystal and the velocity at which the crystal moves in a viscous fluid. Using Stokes' and Einstein's laws, the crystallization rate was calculated in terms of the diffusion coefficient K, temperature T (°K), concentration of the supersaturated solution C_{sup} and concentration of the solution on the crystal faces C_{sat} (often assumed equal to that of a saturated solution), given values of K. For values found to be in close agreement with experimental results,

$$S = \frac{2318T\,(C_{sup} - C_{sat})}{\eta^2}$$

is the recommended equation, where S is the crystallization rate given in mg.$(m^{-2}\,min^{-1})$, and $C_{sup} - C_{sat}$ is in g %.

Treatment of cane raw sugar with coagulants and manufacture of liquid sugar from it. G. A. Ermolaeva and A. I. Krygina. *Sakhar. Prom.,* 1982, (8), 34-36 *(Russian).* Tests are reported on decolorization of 45% raw sugar solution (to which some white sugar had been added) with MgO and one of five metal sulphates to yield a liquid sugar of 99 purity which would be suitable, it is suggested, for various food industry applications. Best results were achieved by adding 1.5% MgO (on weight of sugar) and 0.04-0.05 mole.litre^{-1} aluminium sulphate, and clarifying at 40-45°C and pH 9.2-9.5.

New physico-chemical methods of analysis. S. Rydel. *Gaz. Cukr.,* 1982, **90,** 103-105 *(Polish).* — The benefits of the ion-selective electrode are discussed, and accounts given of the construction and types of electrode, the procedure for carrying out measurements using them, and potential applications of the electrodes.

Exhaustion performance yardsticks in the South African sugar industry. A. B. Ravnö and G. R. E. Lionnet. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.,* 1982, 46-50. — A review is presented of formulae developed for calculation of molasses target purities as yardsticks of molasses exhaustion performance. Comparison was made between the actual exhaustions at all sugar factories in South Africa during the 1981/82 season; weekly composite samples of final molasses were analysed, and two formulae (an old and a new one) used as criteria: (1) LEP = 39.94 − 19.6 log (RS/A) (r = −0.51), where LEP is the target purity based on sucrose and reducing sugars analysis by the Lane & Eynon method, RS = reducing sugars % molasses and A = sulphated ash % molasses, and (2) GCP = 33.9 − 13.4 log (F+G)/A (r = −0.84), where GCP is the target purity based on sucrose, glucose and fructose analysis by gas-liquid chromatography and (F+G) = (fructose + glucose) % molasses. Values of the target purity difference (that between measured purity and the calculated target purity) based on the two different approaches followed similar trends at all factories, whereas differences between them were not constant but showed a distinct seasonal trend; these variations were found to be largely a result of analytical error where the Lane & Eynon method was used with the earlier SMRI formula. The newer formula was found to be clearly superior because of the greater accuracy of the GLC method for sugars determination, because it is based on a much larger and possibly more evenly time-distributed data base and because it did not display any marked seasonal trend during the 1981/82 crop.

The direct determination of lactic acid in cane molasses by gas-liquid chromatography. T. A. Chorn. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 51-54. — A method for the direct determination of lactic acid in cane molasses by GLC using a Hewlett Packard 5840 gas chromatograph with flame ionization detector is described. A capillary column was used in preference to a packed column because of the high resolution required. Heptanoic acid was used as internal standard; rapid quantitative derivatization with bis (trimethylsilyl) trifluoroacetamide was ensured by using acetonitrile as solvent, which also improved integration of peaks with no serious tailing. The GLC method proved superior to a currently used ion exchange method (which is time-consuming and has consistently overestimated the lactic acid); each sample was analysed by GLC twice, and excellent agreement was obtained between the results. Accurate results were obtained for samples containing down to 0.1% lactic acid, although a lower limit is possible by derivatizing larger aliquots of sample.

Standards for the analytical precision of sugar and molasses analyses. P. Mellet, G. R. E. Lionnet, Z. J. Kimmerling and P. J. Bennett. *Proc. 56th Ann. Congr. South African Sugar Tech. Assoc.*, 1982, 55-57. — A program of analyses was carried out by three major laboratories in order to establish analytical standards for raw sugar and final molasses quality control within and between laboratories. While the Sugar Milling Research Institute was involved in analyses of both raw sugar and molasses, Huletts Research & Development paired with the SMRI for molasses analyses, and the South African Sugar Terminal laboratory was the partner for sugar analyses. Details are given of the chemical analyses and statistical analyses, and data are tabulated for six molasses parameters and sixteen sugar parameters, showing the degree of difference within and between the laboratories for each factor.

The dynamic viscosity of a fluidized bed of white sugar. G. V. Zubova. *Izv. Vuzov, Pishch. Tekh.*, 1982, (3), 142 *(Russian)*. — Investigations of the dynamic viscosity η of four white sugar fractions of identical moisture content but varying crystal size (0.5, 0.75, 1.00 mm and a mixture of all three sizes to give an average of 0.75 mm) were carried out, with a viscometer designed particularly for free-flowing materials, at an air flow velocity through the bed of sugar increasing to 1.5 $m.sec^{-1}$; under these conditions, the bed passed through all stages of fluidization, ending with its destruction when the fine crystals were entrained. Measurement of the bed parameters permitted calculation of the sugar bulk concentration σ. From the results, it was concluded that the dynamic viscosity of a fluidized bed under normal conditions is practically independent of crystal size but is governed by σ; at σ = 0.2-0.5, which corresponds to drying and pneumatic conveying by high volumes of air, $\eta = 25.2 \times 10^{-3} \sigma^{0.55}$.

Automatic analysis of sugar factory products. P. Devillers, R. Detavernier and M. Leroux. *Ind. Alim. Agric.*, 1982, **99**, 497-504 *(French)*. — While the Institut de Recherches de l'Industrie Sucrière (IRIS) has used auto-analysers for some years to determine the sugar, glucose, lactic acid and ammonia contents in various sugar factory products, examination of the recorded data is an arduous task which delays obtaining the results, so that automatic processing of the data would be desirable. A simple system has been developed which can simultaneously process data from eight automatic analysers and provide a print-out. Details are given of the system and programs used.

Preliminary studies on microbial degradation of some of the hygroscopic substances present in distillery waste. D. Matteuzzi, P. Brigidi, F. Crociani and P. Sina. *Ind. Sacc. Ital.*, 1982, **75**, 111-113 *(Italian)*. — Laboratory experiments were conducted on degradation of some of the hygroscopic organic substances contained in a substrate composed of tripticase, yeast extract, sodium lactate, glycerol and various mineral salts. Three strains of propionic bacteria were tested, and M 43 found to have the best degrading action. Complete degradation of lactic acid and glycerol was achieved, while 2,3-butylene glycol and betaine remained unaffected. Subsequent culturing of *Candida utilis* gave a final product which was enriched in microbial protein (38.2% dry solids in culture N.20) and had good desiccation properties.

Automation of the system of cane payment. F. Nolting. *Brasil Açuc.*, 1982, **99**, 362-368 *(Portuguese)*. — The author, representing the Schmidt + Haensch company, describes a system for obtaining data in an automated laboratory especially intended for payment for cane on a basis of the analytical characteristics.

The morphology of sucrose crystals. F. H. C. Kelly. *Sugar Tech. Rev.*, 1982, **9**, 271-323. — In a review of studies on sucrose crystal shapes and factors influencing their development, 99 references are given to the literature. The external shape of the crystal is of considerable economic importance for industrial sugar manufacture; optimization has been best defined in terms of sphericity, for which values above 0.8 are both desirable and obtainable — for raw cane sugar the typical crystal has a value of 0.88, compared with 0.83 for beet sugar. An infinity of shapes is possible, but a useful shape classification is given, with nine groups allotted to single crystals, three to true twins, and a general group to agglomerates. Vavrinecz has defined a "development number" and provided initial numerical data in terms of combined frequency and size of faces for 21 of the possible 30 faces of a sucrose crystal. Variation in shape is related to variation in relative growth rates of specific faces, and reference is made to the evaluation of these and differences in sucrose molecule orientation relative to the important faces. Physical factors, e.g. viscosity or convection, or chemical factors, e.g. non-sucrose solutes and non-aqueous solvents, may cause inhibition of growth in the macro- or micro-environment in which the crystals grow. Best known values for axial ratios and β-angle have been identified and corresponding interfacial angles for all possible face pairs calculated and recorded in matrix relationships. The orthopinacoid faces have a dominant influence on the shape, followed by the orthodome pairs; the former pair is inhibited in crystals elongated along the *c*-axis (more common in raw cane sugar), and the latter pair or the basal pinacoids are inhibited when elongation occurs along the *b*-axis (more common in beet sugar). The clinodomes and the pyramid faces develop rounding of left end corners for favourable sphericity when moderately developed, or produce exotic wedge shapes when strongly inhibited. Pictorial representation using orthographic projections (as in engineering drawing) enhances morphological analysis, for which scanning electron microscopy is a valuable aid. The relationship between the more common illustrations in clinographic perspective and orthographic projections has been given. Relative rates of dissolution

of faces have been recorded as a useful analysis of crystal washing criteria and prediction of final crystal shape.

Adsorption of organic non-nitrogenous acids by calcium carbonate mud. L. V. Khorunzhaya and L. D. Bobrovnik. *Sakhar. Prom.,* 1982, (9), 34-35 *(Russian).* — Studies were made of adsorption by $CaCO_3$ of the salts of arabonic (a), glycolic (b), glyceric (c) and lactic acids (d) formed as a result of monosaccharide degradation during liming in the presence of atmospheric oxygen. The investigations were carried out at pH 9.5 and 11 and at 40° and 80°C. Results showed that the order in which the four salts were arranged according to their descending order of adsorption differed with conditions: at pH 9.5 the order was c > d > b > a (40°C) and c > b > a > d (80°C), while at pH 11 it was d > c > a > b (40°C) and d > c > b > a (80°C). Since glycolic and glyceric acids particularly are formed during hot liming and 2nd liming before 2nd carbonatation, aeration of the juice in both processes is recommended.

The behaviour of indicators in sugar solutions at elevated temperatures. V. S. Shterman, I. Shakhovtseva, A. R. Sapronov and E. V. Glushchenko. *Sakhar. Prom.,* 1982, (9), 39-40 *(Russian).* — Thymolphthalein and phenolphthalein, used as indicators for pH measurement of 1st and 2nd carbonatation juice, respectively, have been found with temperature rise to undergo a colour change indicative of a lower pH than the true value. Investigations were carried out to determine the quantitative effects of temperature on colour change, as expressed by optical density, and on pH measurement. Results showed that the indicated pH of 1st carbonatation juice was 1.4-1.5 units lower with temperature rise from 20° to 80°C, while that of 2nd carbonatation juice was 1.2-1.3 units lower with temperature rise from 20° to 98°C. It is therefore recommended to cool juice samples to room temperature before analysis.

Method of determining the sugar content in pulp, products of sugar manufacture and wastes. A. Ya. Zagorul'ko and A. A. Lyashenko. *Sakhar. Prom.,* 1982, (9), 40-42 *(Russian).* — While polarimetry would be an attractive means of determining the sugar content in factory products, intermediate products and wastes, there is need to have a means of clarifying the various solutions and reducing the colour intensity. Basic lead acetate is not suitable for use with pulp because of its toxicity, while other reagents require considerable time for their preparation and use. Investigations were therefore conducted on the possiblity of using ultrafiltration as a pretreatment stage. Seven different membranes of Soviet origin were tested, and results tabulated. These showed that ultrafiltration was promising as a clarification method, and recommendations are made regarding the suitability of the different membranes for individual products.

Measurement of volatile material in waste waters by chemical oxygen demand. J. Conde, J. Barto, M. Loón and A. Reyes. *Rev. ICIDCA,* 1981, **15,** (2/3), 3-13 *(Spanish).* — A 1-ml sample of waste water is placed in an Erlenmeyer flask, acidified with 1% phosphoric acid (normally 0.1 ml is sufficient), 5 ml of distilled water added and evaporated almost to dryness, after which 1 ml of distilled water is added and the sample examined to measure its COD (by adding 1 ml of 0.25N $K_2Cr_2O_7$, 0.04 g of $HgSO_4$, a few pieces of pumice previously heated at 600°C for 1 hr, 3 ml of a 10 g/litre solution of $AgSO_4$ in concentrated H_2SO_4, heating under reflux for 12 minutes, diluting with distilled water to 10 ml and analysing the excess dichromate with 0.05N ferrous ammonium sulphate using 1-2 drops of ferroin as indicator). A similar COD measurement on a sample without the initial acidification and evaporation is carried out, and the difference between the two values is the COD due to volatile material in the waste water, designated COD_V.

Bagasse equilibrium at different relative humidities. M. Blanco C. and E. Ramírez. *Rev. ICIDCA,* 1981, 15, (2/3), 14-22 *(Spanish).* — Adsorption isotherms of bagasse possess a sigmoidal form similar to those of wood. Milling of bagasse increases its adsorption properties, but these are reduced when the bagasse is dried to below ambient humidity, and this desorption is not completely reversible. The moisture content of bagasse in equilibrium with air varies between 22 and 24%.

Processes and equipment for examination of sugar beet. II. Determination of sugar yield in extracts clarified with aluminium chloride. W. Wöhlert. *Lebensmittelind.,* 1982, **29,** 417-420 *(German).* — Because of the desirability of replacing toxic basic lead acetate with a non-toxic clarifying agent, investigations were conducted on the use of aluminium chloride in the determination of sugar, (K + Na) and noxious N (blue number). Comparison of the results obtained with both agents showed that $AlCl_3$ gave a lower measurement of sugar than did lead acetate, 95% of the differences between the two falling in the range 0.06-0.27 units, although other authors have obtained practically identical results using the two agents. A lower filtration rate for beet extract clarified with $AlCl_3$ was considered of little importance, since enough filtrate was obtained within a given time to meet analytical requirements. While the blue number was always higher after clarification with $AlCl_3$ than after lead clarification, the curves for both extracts followed very similar patterns, and in any case the blue number is considered only an approximate indication of noxious N, representing only 65% of it. While it would be of advantage to remove colour that is formed by $AlCl_3$ clarification without interfering with the other measurements, the use of aluminium hydroxide is not practical for a number of reasons.

Determination of the effective attenuation coefficient of infra-red irradiation of food products. A. V. Kryanev, Yu. M. Plaksin and V. G. Shcherbakov. *Izv. Vuzov, Pishch. Tekh.,* 1982, (4), 66-70 *(Russian).* — A method for calculating the attenuation coefficient applicable to infra-red heating of foodstuffs is described, as are investigations conducted on heating of Algerian white sugar divided into four different size fractions. Two possible values of the attenuation coefficient were found to correspond to the measured temperature at one fixed distance from the irradiated surface.

The action of gamma radiation on sugar cane as a new sterilization method. S. Acosta and J. Lodos. *Sugar y Azúcar,* 1982, **77,** (9), 55, 58-59. — Irradiation of chopped cane samples and of suspensions of *Leuconostoc mesenteroides* with gamma rays from ^{60}Co was investigated as a means of reducing bacterial degradation. Results showed that a 90% reduction in the *L. mesenteroides* count was achieved with a 27,000 rad dose applied to the suspensions and with a 30,000 rad dose applied to the chopped cane. The difference in the doses needed to achieve the same percentage reduction was attributed to cane components that have a radioprotective effect on micro-organisms.

BY-PRODUCTS

Using by-product recycling to boost sugar factory profits. J. A. Casey. *Sugar y Azúcar,* 1982, **77,** (6), 54-55, 58-62. Details are given of the Fabcon 3F modular system aimed at by-product utilization as a means of increasing sugar factory profitability. Module 1 is a milling and clarification system designed to increase the amount of surplus fibre while improving sugar quality. Module 2 is a bio-compost plant developed for conversion of filter cake-bagasse mixture into fertilizer, using a bacterial concentrate at 10% on mixture weight. Module 3 is a bagasse pelleting plant, and Module 4 is a distillation plant. Full details are given of each module, each of which can be added to existing sugar factory equipment. Cost balances are drawn up for each module as guidelines, while performance data are given for the juice/syrup purification process incorporated in Module 1 and for the bio-compost plant.

Disposal of beet soil and carbonatation lime as demonstrated by the example of Zuckerfabrik & Raffinerie Aarberg AG. W. Hoppe and W. G. von Matt. *Zuckerind.,* 1982, **107,** 741-744 *(German).* — An outline is presented of the scheme adopted by Aarberg sugar factory/refinery in Switzerland for dewatering filter cake and soil removed from the beet and disposal of the solids to Ricoter AG, a company in which Zuckerfabrik & Raffinerie Aarberg AG and Zuckerfabrik Frauenfeld AG have interests. All of the filter cake from Aarberg is used for agricultural purposes, while some 20-30% is processed for use as compost in flower growing and the rest (unprocessed) for agricultural and land filling purposes.

The risk of fire and explosion during pneumatic conveying of dried pulp. S. Kabat. *Gaz. Cukr.,* 1982, **90,** 34-38 *(Polish).* — The risk of fire and explosion resulting from electrical discharge from the dust and by spontaneous combustion of pulp itself during pneumatic conveying is discussed, and means of reducing it are examined. The thermo-kinetic properties of dried pulp, as taken from the literature, are tabulated.

The problem of utilizing saline solutions after regeneration of decolorizing columns. I. Januszewicz. *Gaz. Cukr.,* 1982, **90,** 52-53 *(Polish).* — While NaCl-containing effluent from regenerated decolorizing resin presents a major disposal problem (the quantity of NaCl is estimated at 220 g per dm^3 of resin), tests have shown that addition of 27 dm^3 regenerant effluent of 12% dry solids per tonne of pulp inhibited development of lactic and butyric bacteria during ensilage and gave a good quality silage after six months. Cattle feeding trials showed no difference in the effects of normal silage and salt-added silage.

Manufacture of a complex seasoning from concentrated Steffen filtrate. T. Kaga and T. Hiramoto. *Proc. Research Soc. Japan Sugar Refineries' Technol.,* 1982, **31,** 8-14 *(Japanese).* — Laboratory and pilot-plant experiments have shown that a food seasoning can be prepared from concentrated Steffen filtrate by electrodialysis, which removes unsavoury components such as potassium salts and reduces the glutamate content to a suitable level to give a good amino-acid balance.

Chromatographic separation of molasses constituents. VII. Pilot plant production of raffinose, betaine and adenosine. S. Oikawa, K. Sayama, Y. Senba, T. Kawamoto and T. Muratsubaki. *Proc. Research Soc. Japan Sugar Refineries' Technol.,* 1982, **31,** 55-63 *(Japanese).* The IRC method of chromatographic separation of the three title constituents from beet molasses was tested on a pilot plant scale. Results showed a raffinose recovery of 33.3% from 40 tonnes of molasses, a high-grade betaine recovery of 61.6% from 35 tonnes, a low-grade betaine recovery of 73% from 80 tonnes, and an adenosine recovery of 30% from 80 tonnes. Respective yields were 4.95%, 8.6%, 8.80% and 0.063%. Dowex 50W X 4 resin was used in Na^+ form for raffinose recovery, and in Ca^{++} form for betaine and adenosine recovery.

Potassium removal from concentrated Steffen filtrate. Y. Senba, T. Muratsubaki and S. Oikawa. *Proc. Research Soc. Japan Sugar Refineries' Technol.,* 1982, **31,** 71-75 *(Japanese).* — Steffen filtrate of 3% solids content was concentrated by carbonatation and filtration (to remove lime), addition of sulphuric acid, multiple evaporation and centrifuging to give a solids content of 55.1%. After crystal separation in the centrifuge, the filtrate had further sulphuric acid added, followed by addition of NaOH to neutralize the ammonia and centrifuging to yield a product that contained 21.8% crude protein and 12.1% total sugars (w/w) and 44.9% moisture, but only 3.7% potassium, and was therefore of value as animal fodder.

Growth regulator and enzyme production from molasses: a bright prospect. R. L. Samaniego, J. D. Layoso and A. T. Angeles. *Crystallizer,* 1982, **5,** (2), 12, 16. — It is stated that 56.4% of Philippine molasses is exported for conversion to growth regulators and enzymes, which could be manufactured in the Philippines for export and thus provide more hard currency and employment. A list is given of bacteria, yeast and fungi that are suitable for molasses fermentation, with details of the products obtained and an outline of the process.

Microbial production of L-lysine. A. K. Misra, J. Dasgupta and V. C. Vora. *J. Chem. Technol. Biotechnol.,* 1980, **30,** (8), 453-457; through *S.I.A.,* 1982, **44,** Abs. 82-815. L-lysine was produced on a laboratory scale by fermentation with a strain of *Corynebacterium glutamicus.* When the substrate was cane molasses, pretreatment with 1% (on sugar) super-phosphate increased the lysine yield after 196 hr by 55%. The yield was improved by increasing the initial sugar concentration to 18%, but not by adding molasses during fermentation.

Production of high-fructose syrup by a heat-fixed *Lactobacillus* sp. M. Bhatia and K. A. Prabhu. *Biotechnol. Bioeng.,* 1980, **22,** (9), 1957-1977; through *S.I.A.,* 1982, **44,** Abs. 82-817. — Bagasse was pretreated with NaOH and hydrolysed with H_2SO_4; the filtrate was neutralized and concentrated. The resulting solutions, in which glucose concentrations were 1, 2 or 3M, were incubated at 70°C with glucose isomerase isolated from *Lactobacillus* sp. The maximum conversion of glucose to fructose was only 27.5%, being slightly higher when the enzyme was immobilized than when it was in the free state.

Study of the alkaline pretreatment of pith and its effect on bacterial growth. R. Lopez Planes, L. Hernandez, R. Sanjurjo and M. Gonzalez. *Rev. CENIC, Ciencias Biologicas,* 1979, **10,** (2), 279-299; through *S.I.A.,* 1982, **44,** Abs. 82-820. — In the pretreatment of bagasse pith with NaOH before culture of cellulolytic bacteria, the effects of NaOH concentration (6 or 10%), temperature (90, 100, 140 or 160°C), air flow (200 or 400 litres. min^{-1}) and time (30, 60 or 120 min) were studied. Results show that the lower temperatures and lower air flow led to higher specific growth rates and higher solids consumption in the subsequent fermentation.

Study of batch fermentation with *Candida utilis* Y-900 in chemical prehydrolysates from pith. C. Ramos, R. Lopez and L. Llerena. *Rev. CENIC, Ciencias Biologicas,* 1979, **10,** (2), 301-311; through *S.I.A.,* 1982, **44,** Abs. 82-821. — *Candida utilis* Y-900 was grown in media obtained by acid hydrolysis of bagasse pith and containing 8% reducing sugars, mainly xylose and arabinose. Cell counts and optical densities of cultures with and without addition of yeast extract are shown. Maximum specific growth velocity was 0.38/hr, 75% of the sugars were consumed in 24 hr and the biomass contained 43% protein.

Direct fermentation with cellulolytic bacteria of bagasse pretreated with high concentrations of sodium hydroxide. G. Iglesias, R. Lopez Planes and L. M. Hernandez. *Rev. CENIC, Ciencias Biologicas,* 1979, **10,** (2), 313-320; through *S.I.A.,* 1982, **44,** Abs. 82-822. — Bagasse was pretreated at 180°C for 1 hr with NaOH solutions of concentrations ranging from 4.22% to 16.6%. It was used in media for culture of *Cellulomonas* strains (which could be used as fodder). Growth was monitored by measuring the optical density at 600 nm. Best results were obtained by using low NaOH concentrations (about 4%), after which 68% of the bagasse was consumed in 70 hr.

Rapid ethanol fermentation in immobilized yeast cell reactor. T. K. Ghose and K. K. Bandyopadhyay. *Biotechnol. Bioeng.,* 1980, **22,** (7), 1489-1496; through *S.I.A.,* 1982, **44,** Abs. 82-1054. — Cane molasses media were fermented by *Saccharomyces cerevisiae* immobilized on various supports. Maximum ethanol productivity, 24.9 $g.litre^{-1}.hr^{-1}$, was obtained with a medium containing 19.7% reducing sugars, with a residence time of 2.86 hr. Substrate conversion was 75%, and stable operation continued for more than 75 days.

Studies on immobilized *Saccharomyces cerevisiae.* I. Analysis of continuous rapid ethanol fermentation in immobilized cell reactor. R. D. Tyagi and T. K. Ghose. *Biotechnol. Bioeng.,* 1982, **24,** (4), 781-795. **II. Effect of temperature distribution on continuous rapid ethanol formation in molasses fermentation.** T. K. Ghose and K. K. Bandyopadhyay. *ibid.,* 797-804; through *S.I.A.,* 1982, **44,** Abs. 81-1055, 82-1056.

I. Cane molasses media were fermented by *S. cerevisiae* NRRL-Y-132 at 30°C and pH 5. Batch experiments were carried out in a free-cell system containing 100-180 g reducing sugars per litre; in continuous experiments, an immobilized-cell system and 150 g reducing sugars per litre were used. Productivity was much higher in the continuous system, reaching 28.6 $g.litre^{-1}.hr^{-1}$ at a dilution rate of about 0.5. The column was operated continuously in a steady state for 35 days. Rate equations were constructed and used to calculate the specific ethanol productivities and specific growth rates for immobilized cells.

II. A disadvantage of the system is CO_2 gas hold-up associated with non-uniform temperature distribution. From a substrate balance and an energy balance, a mathematical model to predict the steady-state temperature profile along the reactor was developed. Experimental data for an immobilized-yeast reactor column agreed well with those calculated from the model.

Production of ethanol from sugar cane molasses by *Zymomonas mobilis.* H. J. J. van Vuuren and L. Meyer. *Biotechnol. Letters,* 1982, **4,** (4), 253-256; through *S.I.A.,* 1982, **44,** Abs. 82-1057. — Five strains of *Z. mobilis* and one of *Saccharomyces cerevisiae* were compared for batch ethanol fermentation of cane molasses media containing 10% sugars. The effects of pH (4.2-6.6) and temperature (28-38°C) were also tested. At a low sugar concentration (5%) ethanol yields were similar with both organisms, but at higher concentrations *S. cerevisiae* gave higher yields.

Production of phenols and charcoal from bagasse by a rapid continuous pyrolysis process. F. Mobarak, Y. Fahmy and W. Schweers. *Wood Sci. and Technol.,* 1982, **16,** (1), 59-66; through *S.I.A.,* 1982, **44,** Abs. 82-1139. — Tar and charcoal could be produced in high yields from bagasse by a rapid continuous pyrolysis process at relatively low temperatures (420-720°C). The yield of tar and oil was maximum (9.4% on bagasse) at the lowest temperature. Phenols constituted 79% of this mixture. Of the identified simple phenols, 38% comprised guaiacol and its derivatives, with much smaller amounts of syringol. Depithing of the bagasse yielded a charcoal containing practically no S or N, and thus environmentally clean; it did not decrease the ash content of the charcoal, but this could be done by removing the fine fraction from the bagasse after grinding. The C content of the charcoal increased rapidly with pyrolysis temperature, reaching 96% at 720°C. The charcoal had a very high adsorption capacity in spite of not having been subjected to any activation treatment.

Sucrochemistry: sucrose fatty acid esters. L. Bartolucci. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 3-6 *(Spanish).* — At the National University of Tucumán, sucrose in the form of solid refined sugar has been reacted with tallow, in vessels of glass and stainless steel, up to 1500 cm^3 capacity, at temperatures below 130°C using different catalysts. With reaction times less than 4 hours, products have been obtained as solid, anhydrous mixtures of esters which have proved suitable for use as surface-active components of domestic and industrial detergents, cosmetics, etc. Further work involves use of vegetable oils and raw sugar as reaction components.

Production of paper from bagasse. H. L. Poviña, L. Millia and M. Menéndez. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 7-19 *(Spanish).* — An account is given of a plant to be used for production of bagasse paper, located at the centre of the Tucumán cane area. It will use 450,000 tonnes per year at a rate of 1300 tonnes/day and produce 333 tonnes of paper per day. The process to be used is described in detail; it was chosen for its economy and low power consumption. Of the 21,000 kW required, 60% will be produced in the plant and 40% taken from the grid. Considerable attention is given to recovery of chemicals employed and re-use of liquors where possible.

By-products

Production of single-cell protein using bagasse pith as carbohydrate source. O. Molina. *Mem. Semana Agro-Ind. Caña de Azúcar* (Argentina), 1982, 21-28 *(Spanish).* An account is given of protein production by cultivation of *Cellulomonas* sp. and *Bacillus subtilis* on bagasse pith. In the absence of pH control, urea may be used as N source; if the pH is controlled, ammonium salts and $NaNO_3$ may also be used. Pith treatment with NaOH to remove lignin is needed if yields are to be satisfactory. pH affects yields, and best results are obtained at 7.0-8.0. The temperature affects production, which is greater at 34°C than at 36°C and 38°C, although the rate of production is slower so that the conditions have to be chosen in accordance with requirements. The protein meets FAO standards except in respect of methionine content. It proved suitable for feeding to chickens.

Statistical determination of the relationships between pulp and paper in "Damuji". E. González S., M. García A. and V. González R. *Centro Azúcar,* 1981, **8,** (2), 87-100 *(Spanish).* — The characteristics of pulp and paper at the Damuji factory have been studied and used to prepare a matrix which characterizes the paper production system.

Comparative study on the sedimentation of diluted fibrous suspensions of bagasse and wood. A. García R. and I. Rodríguez R. *Centro Azúcar,* 1981, **8,** (2), 101-115 *(Spanish).* — Sedimentation curves were prepared from bleached and unbleached bagasse pulp and bleached wood pulp in suspensions of various concentrations and show that the bagasse pulps compressed more easily than the wood pulp; this is attributed to the shorter fibre length of the former.

Micro-distillery: technico-economic viability. A. C. Gemente, C. H. Lopes, D. G. G. Ruas, H. A. Germek and E. R. de Oliveira. *Brasil Açuc.,* 1982, **99,** 227-276 *(Portuguese).* — A bibliographic review is presented on the study of micro-distilleries — up to 5000 litres/day, and a description is given of the process, from reception of the cane and extraction of juice in a miniature mill, fermentation and distillation to storage of product. The costs involved are discussed and an economic analysis of the process presented, including taxation and socio-economic aspects whereby conditions in which such a unit is economically viable may be assessed.

Automatic control of the heat conditions in a pulp dryer. B. N. Azbekyan, S. G. Tarasov, Yu. E. Kichkar' and P. I. Neveselyi. *Sakhar. Prom.,* 1982, (8), 39-40 *(Russian).* — Details are given of a system for automatic control of beet pulp moisture content as a function of temperature of the discharge gases. At Pavlovskii sugar factory, the temperature is maintained constant to within ± 1.5°C, while the average moisture content of the pulp on discharge is 11.7% (compared with a target value of 12.0%) at an hourly throughput of 1.3-1.4 tonnes.

Studies on alcohol production from molasses by fed-batch fermentation — examination of the optimum conditions. H. C. Hsie. *Rpt. Taiwan Sugar Research Inst.,* 1982, (95), 33-40 *(Chinese).* — The orthogonal-array table method of experimental design was used to analyse the effect of a number of factors on ethanol yield from molasses by intermittent-feed fermentation and to determine the optimum level of each parameter. The factors examined included initial mash volume introduced, amount of inoculum, aeration rate and time, starting time of feeding, and time interval between additions of molasses. Fermentation was conducted at a sugar concentration of 21% w/v. Under optimum conditions, the ethanol yield could be as high as with batch fermentation of the same molasses at a sugar concentration of about 18% w/v, while it was higher than that of batch fermentation at 21% sugar. Comparison of ethanol yields from sterilized and non-sterilized molasses showed that they were always higher when sterilization was omitted, the degree of difference depending on type of molasses, total sugar concentration in the mash and the method of fermentation.

Recycling beet vinasse. O. Vassard. *Ind. Alim. Agric.,* 1982, **99,** 525-528 *(French).* — It is pointed out that, while vinasse recycling to fermentation must produced from beet juice or dilute molasses has become a general practice because of the resultant fall in the costs of vinasse concentration, the approach has been only empirical, so that there is risk of disappointing results. A study was carried out at a molasses distillery to determine the amount of vinasse that could be recycled without adversely affecting fermentation. The results are discussed with the aid of a flow diagram for a scheme embodying yeast recyling with double centrifuging, and recycling of 60% vinasse, assuming that the vinasse discharged from the distillation column or diluted vinasse replaces all or some of the molasses dilution water to give an alcohol of 9.5-10°.

Anaerobic treatment of beet distillery vinasse with vaporization of the biogas produced. Results obtained in the 1000 m^3 fermenter at the Distillerie Coopérative d'Auvernaux during the 1981 campaign. P. Oger and J. Chandesris. *Ind. Alim. Agric.,* 1982, **99,** 571-572 *(French).* — Results obtained during the 1981 campaign using the IRIS anaerobic process to treat some 10,000 m^3 of vinasse are discussed. The fermenter was designed to handle a mixture of vinasse and pulp press water of 13,700 mg.litre^{-1} BOD_5 and 18,900 mg.litre^{-1} COD; mean values of 13.0 g.litre^{-1} BOD_5 and 14.1 g.litre^{-1} COD were achieved (12.1 and 13.1 g.litre^{-1}, respectively, after centrifuging). Details are given of gas analyses at weekly intervals over a 2-month period; methane content of the 42,600 m^3 of total gas yield was 60%. Despite a H_2S content ranging from 0.5 to 7.09%, the gas had no adverse effect on boiler equipment and replaced about 25 tonnes of fuel oil.

Beet pulp. New solutions to energy problems. M. Demaux and M. Taccard. *Ind. Alim. Agric.,* 1982, **99,** 575-581 *(French).* — The energy problems associated with pressing and, particularly, drying of beet pulp are discussed, and the potential of the pulp itself as a fuel, either directly (for which the dry matter content must be raised to 50%) or indirectly as a source of methane produced by anaerobic treatment, considered.

Secondary fines from bagasse pith. I. Characterization and effect on drainage properties. R. Molina. *Rev. ICIDCA,* 1981, **15,** (2/3), 23-44 *(Spanish).* — From a pith-rich bleached chemical bagasse pulp, two kinds of secondary fines were prepared: whole fines from highly beaten pulp and crill obtained by isolation of the fraction passing the 200-mesh wire of the highly beaten pulp. Changes in the physico-chemical and drainage properties of a depithed bagasse pulp submitted to beating were compared with those arising from the addition of both kinds of fines to the unbeaten pith-free pulp.

Cuba sugar exports, 1982[1]

	1982	1981	1980
	tonnes, raw value		
Albania	15,946	12,143	17,069
Algeria	207,896	253,259	207,131
Angola	52,028	57,641	67,173
Bulgaria	277,678	249,851	234,112
Cambodia	0	1,626	5,423
Canada	160,299	375,985	263,508
China	915,311	573,246	512,095
Czechoslovakia	134,892	99,871	98,775
Dutch Antilles	2,346	977	2,183
Egypt	190,269	162,415	138,088
Finland	38,816	173,261	78,124
Germany, East	213,461	254,770	209,900
Guinea Bissau	2,096	2,131	0
Hungary	72,903	76,216	34,152
Indonesia	14,236	13,646	39,394
Iraq	133,783	178,184	277,840
Jamaica	1,626	8,872	1,081
Japan	294,986	354,593	267,082
Korea, North	17,079	27,559	10,897
Libya	45,055	54,729	75,723
Malaysia	26,269	107,749	25,206
Mexico	139,702	138,126	401,122
Mongolia	4,701	4,697	4,720
New Zealand	15,662	0	0
Nicaragua	0	0	10,830
Poland	0	70,154	63,128
Portugal	70,814	154,405	131,377
Rumania	89,663	138,820	46,754
Senegal	0	27,560	0
Singapore	0	0	12,611
Spain	21,588	22,746	0
Surinam	4,558	1,080	0
Sweden	0	24,647	0
Switzerland	3,089	3,072	3,640
Syria	109,274	108,714	133,999
Tanzania	0	0	11,383
Tunisia	0	14,354	32,904
Uganda	0	0	1,084
USSR	4,425,519	3,204,475	2,726,339
Vietnam	24,155	102,613	41,841
Yugoslavia	0	10,389	0
Other countries	8,583	6,869	4,386
	7,734,283	7,071,445	6,191,074

US elimination of blended sugar imports. — A loophole in US sugar import quota rules has been exploited this year by mainly Canadian suppliers. The rules have not applied to blended sugar, a mixture of high fructose corn syrup and less than 94% sugar. As a consequence such blended sugar has been coming into the US at a rate of 5000-6000 short tons a week, and the price of sugar has fallen in areas close to the Canadian border. A task force was set up, including officials from the USDA and the US Trade Representative, and this has now recommended that the flow be cut off by extension of the rules to cover the blended sugar and application of a zero quota for the product[2]. After a proclamation has been made to this effect, the International Trade Commission will look into the question of whether the imports threaten the US domestic sugar price support program and will recommend whether blended sugar should be allowed to enter the country and in what quantities, including a zero option.

Denmark sugar production, 1982/83[3]. — The six Danish sugar factories sliced a total of 3,925,278 tonnes of beet in the 1982/83 campaign to yield 537,622 tonnes of white sugar.

New Nicaragua sugar factory[4]. — A new sugar factory is to be built with Cuban aid 60 km east of Managua and will start operations in November 1984. It will be equipped with Cuban machinery valued at $50 million.

Record Irish sugar production[5]. — Beets from an area of 34,800 ha were sliced during the 1982/83 campaign to yield a record production of 223,000 tonnes of white sugar.

Panama sugar exports, 1982[6]. — While the USA was the only destination for Panama's sugar exports of 145,369 tonnes, raw value, in 1980 and 111,269 tonnes in 1981, it took only 97,889 tonnes of the 111,581 tonnes total in 1982, the remaining 13,692 tonnes going to Tunisia.

Norway sugar imports, 1982[7]

	1982	1981
	tonnes, white value	
Austria	16,343	10,370
Belgium/Luxembourg	2,170	3,379
Czechoslovakia	0	165
Denmark	56,907	87,209
Finland	11,996	12,606
France	0	1,143
Germany, West	20,240	32,333
Holland	19	9
Malawi	10	0
Sweden	104	72
Switzerland	2	26
UK	24,235	27,365
Total	132,026	174,677
Total (raw value)	143,507	189,866

Argentina sugar production, 1982[8]. — A total of 14,437,163 tonnes of cane were crushed in Argentina's 24 sugar factories to produce 1,059,080 tonnes of white sugar and 471,603 tonnes of raw sugar; these correspond to 14,884,198 tonnes of cane crushed to yield 1,027,158 tonnes of white sugar and 599,935 tonnes of raw sugar in 1981. Domestic consumption in 1981/82 was 908,861 tonnes, down from 982,565 tonnes in 1980/81. Exports in 1982 included 59,769 tonnes of white sugar and 197,763 tonnes of raws, totalling 257,532 tonnes, tel quel, which compares with a total of 721,173 tonnes in 1981 and 489,495 tonnes in 1980 which included 60,079 tonnes of whites and 661,094 tonnes of raws, and 89,950 tonnes of whites and 399,545 tonnes of raws, respectively. The cane area was almost the same, at 349,500 hectares against 351,300 ha. Alcohol production fell to 130,402,000 litres in 1982 from 153,894,000 litres in 1981 and 212,263,000 litres in 1980.

New Indian sugar factories[9]. — The Haryana government has sanctioned three new cooperative sugar factories to be built at Palwal, Shahbad-Markanda and Jind and to commence crushing in October 1984.

Guyana sugar exports, 1982[10]. — Sugar exports from Guyana totalled 265,051 tonnes, raw value, in 1983, down from the 281,622 tonnes of 1981 but slightly higher than the 1980 total of 263,412 tonnes. As in previous years, the EEC was the principal destination, taking 184,680 tonnes (201,270 tonnes in 1981), while the US took 54,497 tonnes (67,696) and Canada 25,741 tonnes (10,639). Other Central American countries received 133 tonnes (2017 tonnes in 1981).

Japanese continuous alcohol fermentation process[11]. — Kyowa Hakko Kogyo Co. Ltd. has developed a process to pilot plant stage in which cane molasses is diluted and passed through a double fermentation column of 200 m^3 capacity which is occupied to the extent of 50-60% by a calcium alginate gel on which are immobilized cells of *Saccharomyces cerevisiae*. The grains of gel are kept in suspension by jets of air and by the CO_2 produced. The unit produces 2000 litres/day of alcohol and the residence time of the feed is 3½ hours. Fermentation efficiency is 95% and the alcohol yielded is of 10% concentration, v/v. The short retention time, plus feed treatment with sulphuric acid, explains the lack of need to pasteurize; contaminating bacteria do not have time to colonize the culture. Work is continuing on improvement of yield and on automation of the process.

Honduras sugar exports, 1982[12]. — Honduras exported a total of 87,106 tonnes, raw value, in 1982, up from 75,541 tonnes in 1981. The principal destination was the US which took 66,983 tonnes.

1 *I.S.O. Stat. Bull.*, 1982, **42**, (4), 10.
2 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 193-194.
3 *Zuckerind.*, 1983, **108**, 273.
4 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 142.
5 *Zuckerind.*, 1983, **108**, 273.
6 *I.S.O. Stat. Bull.*, 1983, **42**, (2), 32.
7 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, S100.
8 "El Azúcar Argentino en Cifras"; Supp. to *La Ind. Azuc.*, 1983, (1017).
9 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 145.
10 *I.S.O. Stat. Bull.*, 1983, **42**, (2), 20.
11 *Biomasse Actualités*, 1983, (12), 3.
12 *I.S.O. Stat. Bull.*, 1983, **42**, (2), 21.

Belgium-Luxembourg sugar exports, 1982[1]

	1982	1981
	tonnes, tel quel	
Algeria	110	22,650
Bahrein	10,110	0
Bangladesh	2,500	946
Burundi	3,007	537
Chile	19,024	4,265
Congo	2,873	4,114
Cyprus	2,234	130
Djibouti	4,300	6,587
Egypt	23,050	22,581
France	1,048	3,188
Gambia	4,545	615
Germany, East	0	11,261
Germany, West	38,388	31,042
Ghana	350	5,767
Holland	34,356	23,345
Iran	4,000	29,624
Iraq	0	12,354
Israel	22,863	15,515
Ivory Coast	560	1,675
Jordan	6,926	10,250
Kuwait	6,987	7,454
Lebanon	28,743	33,942
Maldives	1,700	1,100
Mali	2,291	0
Mauritania	5,001	12,640
Mexico	9,300	0
Morocco	0	2,165
Nigeria	198,622	221,605
Norway	792	2,371
Pakistan	100	1,210
Portugal	4,527	11
Qatar	6,300	200
Saudi Arabia	106,946	74,580
Somalia	957	2,350
Spain	0	1,185
Sri Lanka	5,810	5,050
Sudan	23,522	12,640
Syria	16,160	0
Tunisia	2,010	0
Turkey	0	7,981
United Arab Emirates	17,968	6,555
USSR	64,107	24,222
Yemen, North	5,842	4,702
Yemen, South	0	4,500
Zaire	5,642	5,666
Other countries	14,155	14,882
	707,726	653,457

Central American Sugar Technologists Association. — The 5th Congress of the Asociación de Técnicos Azucareros de Centro America is to be held in San José, Costa Rica, during September 19-24 this year. The 4th Congress was held in San Pedro Sula, Honduras, in September 1981. Sugar technologists from all of Central America including Belize and Panama, as well as others from Brazil, Colombia, Mexico, the US, Venezuela and Europe are expected to participate. Information, registration forms, etc., may be obtained from the Organizing Committee, V Congreso ATACA, Apartado Postal 6860, San José, Costa Rica ZP.1000 (Telex 3340 SETEC).

Chile sugar imports fall. — Sugar imports by Chile in 1983 are expected to drop to 170,000 tonnes, compared with 255,492 tonnes in 1982[2]. Devaluation of the Chilean peso, coupled with a recent increase in import duties, have pushed prices up and a further drop in consumer demand, to 400,000 tonnes, is expected for 1983 against 404,500 tonnes in 1982.

Australia-Malaysia sugar supply agreement[3]. — Malaysia and Australia have successfully negotiated the sale of 190,000 tonnes a year of sugar from the latter during 1985, 1986 and 1987, with the option for Malaysia to buy an additional 50,000 tonnes when the world market price rises above the contract price, which was not disclosed. A contract is expected to be signed in the near future.

Flood damage to cane in South America. — Torrential rains and flooding have been reported from several South American countries, causing loss of life and damage to crops, including sugar cane, in Argentina, Bolivia, Brazil and Peru.

Canada sugar imports, 1982[4]

	1982	1981
	tonnes, tel quel	
Raw sugar		
Australia	413,622	281,777
Belize	19,301	0
Colombia	12,919	0
Commonwealth Africa	27,917	27,906
Cuba	188,797	303,928
Fiji	16,000	0
Guyana	24,658	10,119
Mauritius	13,564	4
South Africa	164,596	225,800
Other countries	20	18
	881,394	849,552
White sugar		
US	3,040	6,616
Other countries	258	165
	3,298	6,781
Total imports, raw value	884,979	856,923

Uganda sugar factory rehabilitation[5]. — The International Finance Corporation has agreed to lend $8 million for rehabilitation of the sugar estates and industrial complex at Lugazi, Uganda, belonging to the Sugar Corporation of Uganda. Rehabilitation is expected to be complete by 1985, when sugar output at Lugazi should reach the pre-1977 level of 55,000-60,000 tonnes a year.

Premature end to Panama cane harvest[6]. — Low world sugar prices and lack of export markets have forced an early end to this season's sugar cane harvest in Panama, according to *Latin America Commodities Report.* At mid-March — at least one month earlier than usual — the state sugar corporation stopped cane harvesting and closed its three sugar factories, one of them (Felipillo) permanently. The United States is partly blamed for the crisis in the sugar sector; Panama has been hit by the imposition of US import quotas which limit sugar purchases from Panama to 81,200 short tons during October 1982-September 1983, equivalent to about 70,650 tonnes and a reduction from more than 92,000 tons in the previous period, or nearly 90% of total sugar exports. There have so far been no official estimates of the impact on the size of the 1982/83 harvest as a result of the early cut-off; however, the two privately-owned mills were also shut down prematurely and local sources say that output will be well below the 200,000 tonnes maximum raw sugar production capacity. At least 200,000 tonnes of cane (roughly equivalent to 20,000 tonnes of raw sugar) remained uncut in the private sector. In spite of the lower production, a further build-up of stocks is possible as the total supply may still exceed the combined national consumption of about 70,000 tonnes and the 74,000 tonnes earmarked for the United States under quota.

Cane payment in Thailand[7]. — Most sugar factories in Thailand have paid for cane on the basis of weight alone, although in some places the sugar yield is calculated in addition. The Thai Sugar Institute is seeking to introduce an effective quality-based system into the industry, to provide an incentive to farmers to grow and deliver good cane, and to the factories to extract the maximum possible amount of sugar. Tate & Lyle Process Technology have demonstrated a computerized cane payment system, comprising a microcomputer, software and analytical equipment, adequate for up to 1000 loads per day from any of 1000 farmers and capable of recalling records up to 6 months old.

Paris white sugar market trading in dollars[8]. — The French government has agreed to allow non-resident operators on the Paris white sugar market to convert their franc-denominated operations into US dollars. It had been feared that operators wishing to eliminate exchange risks might use the new London white sugar dollar contract. Some operators will no doubt continue to use both the franc and dollar Paris contracts because of the prospect of profits on exchange rate movements.

[1] C. Czarnikow Ltd., *Sugar Review,* 1983, (1639), 45.
[2] F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 214.
[3] *World Sugar J.,* 1983, **6**, (9/10), 38.
[4] F. O. Licht, *International Sugar Rpt.,* 1983, **115**, S147.
[5] *Westway Newsletter,* 1983, (113), 19.
[6] F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 230.
[7] *Tate & Lyle News,* April 1983.
[8] F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 247.

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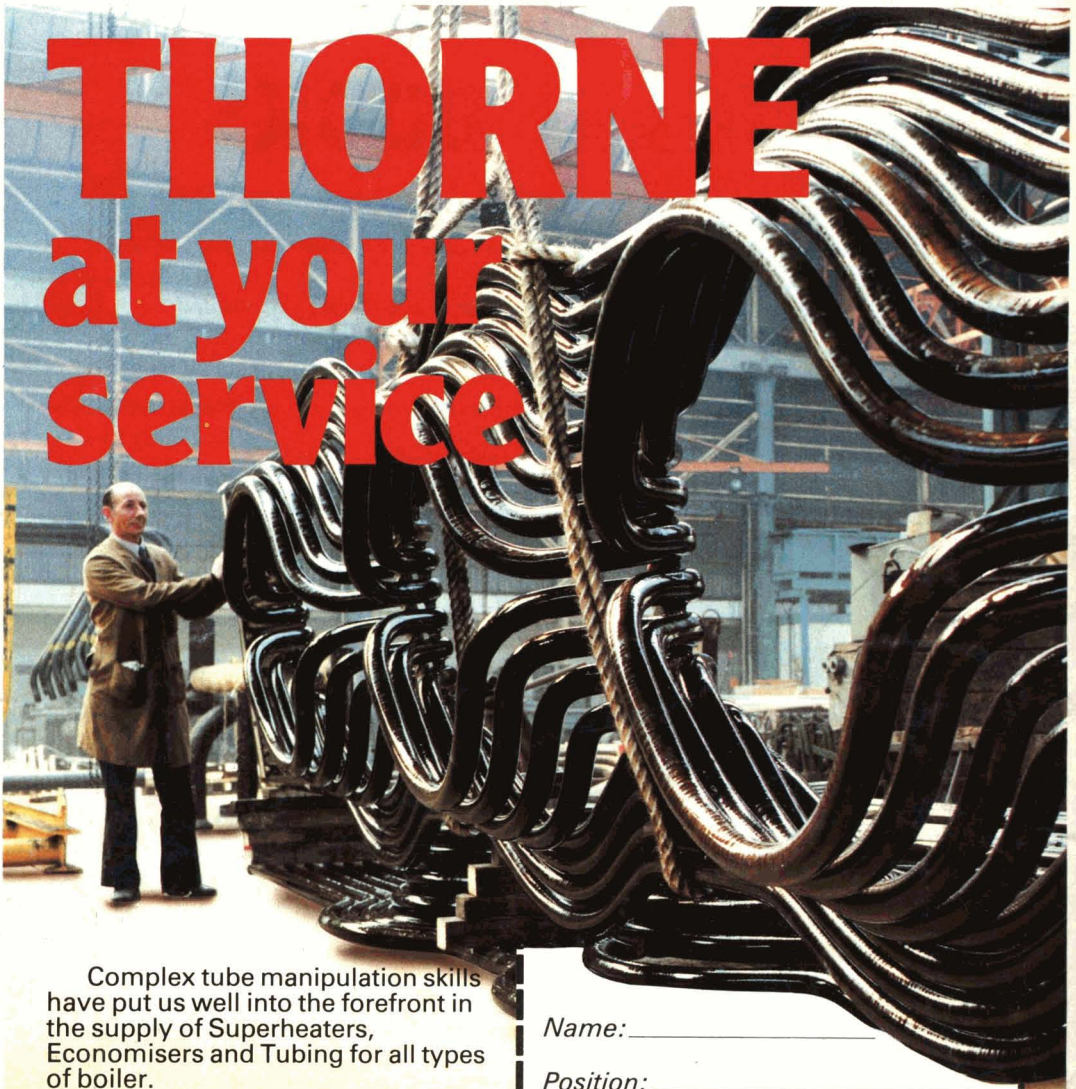

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