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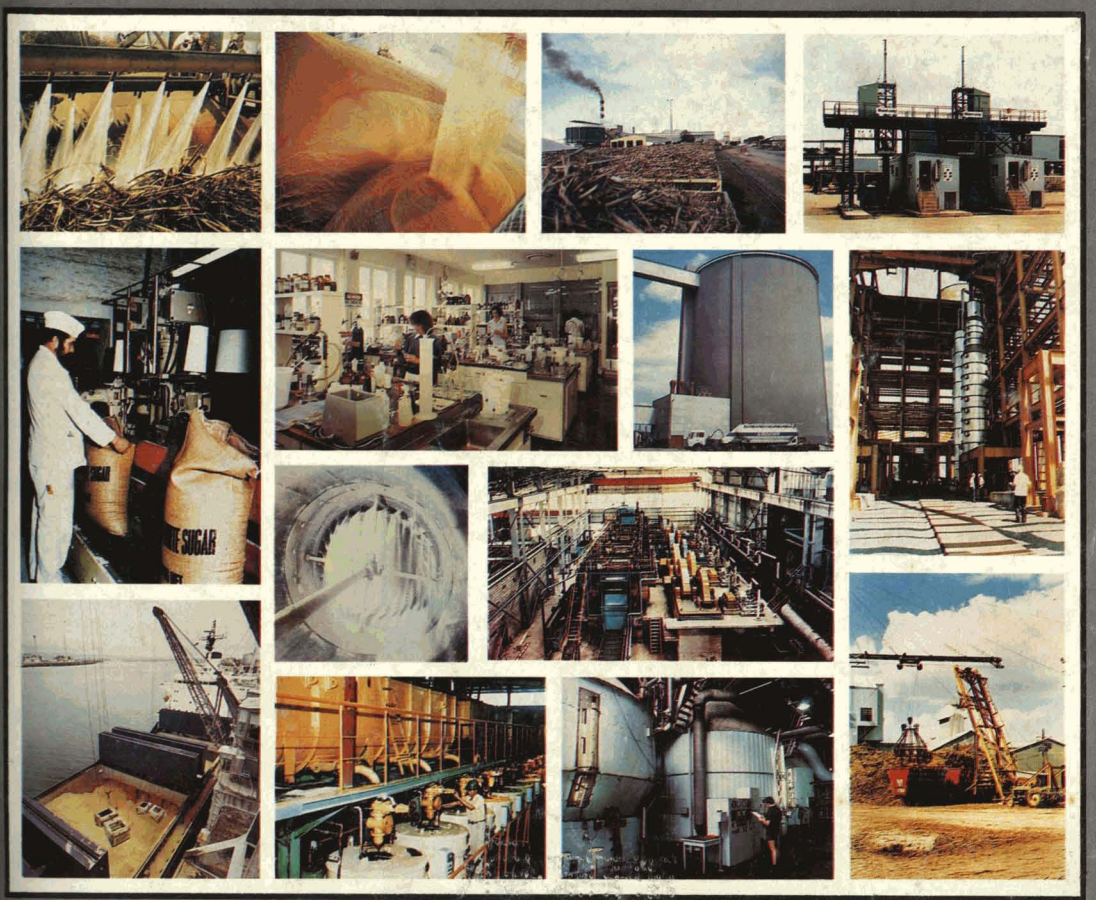

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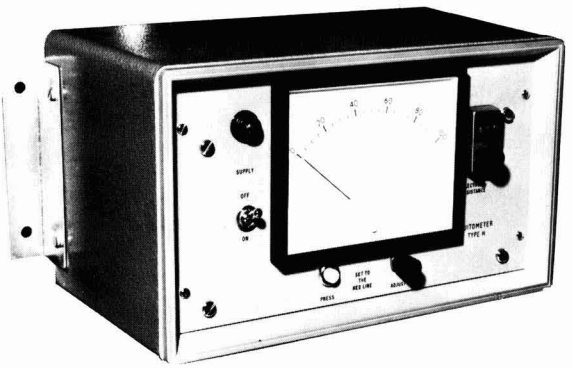

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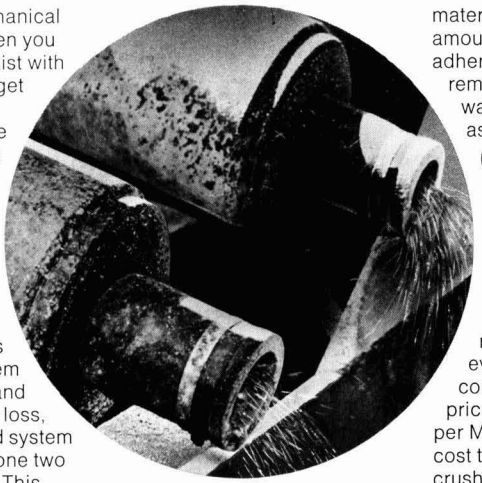

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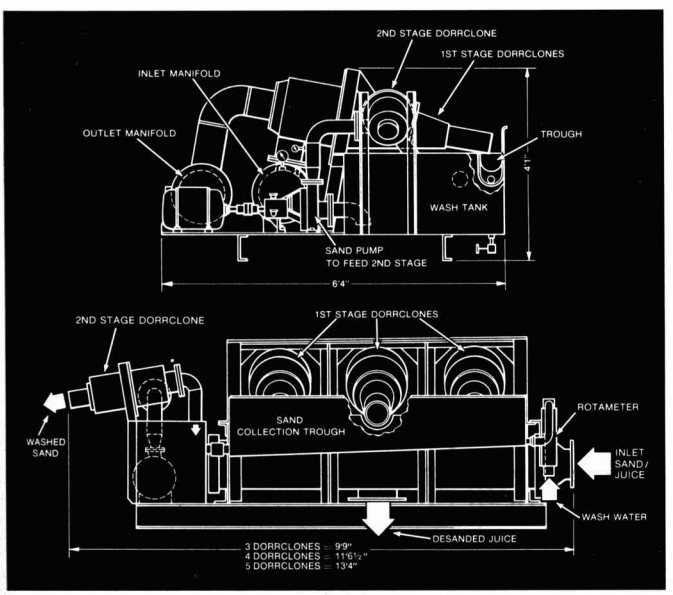

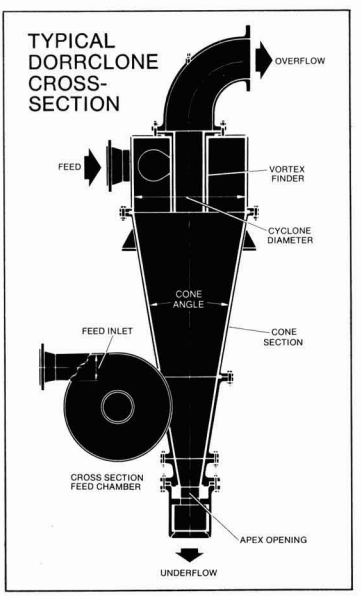

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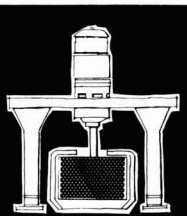

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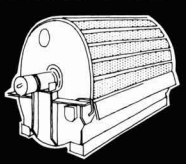

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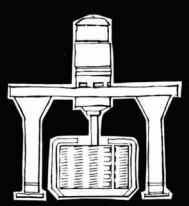

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NOTES AND COMMENTS

International Sugar Agreement

On January 16 representatives of the 12 largest sugar exporting countries met in London for informal talks under the chairmanship of Sr. Jorge Zorreguieta in order to progress towards a new Agreement. The meetings were scheduled for two weeks but finished on January 25 although the "Big 4" exporters were continuing talks among themselves afterwards. It became clear that political considerations among this small group were the main hindrance to agreement since all have entrenched positions seeking the greatest advantage for themselves. Australia and the EEC want the Reference Export Availabilities (quotas under a different name) to be based on recent export performance, while the EEC is adamant that it must have the right to export as much as it has done in recent years (5.4 million tonnes, raw value) irrespective of reductions in entitlements for other exporters. The other exporters are opposed to this since this amount – higher than that of any other exporter – has been achieved by expanding subsidized exports while those of ISA members have been voluntarily restricted. Cuba insists that her supplies to the USSR and other Eastern Bloc countries and China should be outside the scrope of the Agreement, while the other exporters think they should be included or at least limited to a fixed amount.

The meeting did not solve the problem of over-supply. The total of REA's proposed is 23.4 million tonnes, against outlets calculated at no more than 17 or 18 million tonnes. The REA's are fixed and proposals are for the difference to be held off the market as stocks, but the financing of such huge amounts is still not agreed. A further meeting of the consultative group is scheduled for the end of March/beginning of April and a third session of the full conference is arranged for June 12.

F. O. Licht GmbH comment[1]: "In view of the existing huge surplus exporters would have to make significant sacrifices in order to bring supply and demand on the world free market into balance. However, for most members this would be politically unacceptable. The two alternatives left are not very encouraging. Either the talks break down or the conference agrees on an ineffective agreement because exporters are not prepared to make the necessary sacrifices. On the other hand, it could be argued that the major exporters have little choice but to agree in order to avoid a further drop in world prices. The Executive Director of the International Sugar Organization already warned that 'if we do not have a new agreement ready to fall into place, negotiations could drift on for quite a while. Lots of people in the sugar business would be more or less ruined'.

"The chances for an effective agreement are not particularly good. It is obvious that the current surplus would threaten any ISA. Certainly the objective observer would find it difficult to draw up a balance sheet of supply and demand, apply to that reference export availabilities likely to be acceptable to the exporters, reduce them by a percentage that would also be acceptable and would at the same time make noticeable inroads into the accumulated stocks, and at the end of the day retain an audience of any size interested in taking the study further. The statistical considerations must therefore be gloomy".

World sugar prices

The London Daily Price for raw sugar started the new year at a level of £122 per tonne and stayed not far from this level during the first half of January. An improvement began which brought the LDP to £137 on January 23 but concern at the lack of progress at the talks in London about a new International Sugar Agreement led to a fall to £124 on January 30. A slight rise to £126.50 occurred on the last day of the month, perhaps due to news that a US consumer group is seeking to have the use of the artificial sweetener Aspartame stopped which, if the attempt is successful, could improve sugar offtake, if only to a small extent.

White sugar quotations followed the general pattern of raw sugar prices and showed little reaction to news of sales by India and Pakistan and reports of high output in Poland and Spain.

EEC Commission farm price proposals

The EEC Commission's proposals for the agriculture sector[2] aim at only marginal adjustments for 1984/85 and, if adopted, would increase common prices overall by only 0.8%. For sugar beet and white sugar it proposes increases of 1%. This would bring the basic price for beet to 41.3 e.c.u. per tonne and for white sugar to 540.1 e.c.u. per tonne. The guaranteed prices are to continue to apply to 9.5 million tonnes of A-quota and 2.2 million tonnes of B-quota sugar. The Commission has also proposed a series of monetary reforms and has stated that the whole program has to be seen as a package.

The monetary reforms involve reduction of Monetary Compensatory Amounts by revaluation of the "green" national currencies in terms of the e.c.u. The effect of this and the rise in the e.c.u. prices would bring about a new reduction in farm prices, in terms of national currencies, for West Germany (3.5%), Holland and the UK (1.9%) and Denmark (0.4%), while prices would increase for Greece (3.4%), France (3.1%), Belgium (2.3%), Ireland (2.1%), Luxembourg (1.9%) and Italy (0.8%).

The proposals met considerable opposition from farmers' organizations and the West German Agricultural Minister said they were unacceptable. Nevertheless, they reflect the current financial difficulties of the Community and, while their eventual acceptance is not a foregone conclusion, it seems that 1984/85 may see an end to the seemingly inexorable rise in payments to EEC beet growers and sugar producers irrespective of internal demand and external prices.

European sugar production estimates, 1983/84

F. O. Licht GmbH have recently published their second estimate of beet sugar production in Europe during the 1983/84 campaign[3]. In many countries the campaigns were almost at an end so that Licht's figures are more likely to be nearer the actual than his earlier estimate in August.

The figures demonstrate the remarkable way in which good conditions at the end of the growing season and during harvest can improve the crop, with the Belgian estimate raised by 10% to 860,000 tonnes, raw value,

[1] *International Sugar Rpt.*, 1984, **116**, 49-50.
[2] C. Czarnikow Ltd., *Sugar Review*, 1984, (1684), 12.
[3] *International Sugar Rpt.*, 1983, **115**, 635-637.

that of France from 3,260,000 to 3,860,000 tonnes, that of Holland from 755,000 to 815,000 tonnes and the UK figure from 1,050,000 to 1,195,000 tonnes. Other EEC estimates are almost the same or slightly reduced, to give a total of 11,717,000 tonnes against the August estimate of 10,990,000 tonnes and the 1982/83 outturn of 14,813,000 tonnes.

In other countries of Western Europe, the increases, especially in Spain, are more than counterbalanced by the decreases, especially in Turkey, so that the total for Western Europe, including the EEC, is set at 16,476,000 tonnes, against the 15,782,000 estimate of August and the 1982/83 figure of 19,848,000 tonnes.

It seems possible that estimates of East European sugar production in the 1982/83 and 1983/84 campaigns have been too low and information from Poland and the USSR now suggests that sugar outturn must be put higher. Licht has raised his estimates for these two countries by 270,000 and 500,000 tonnes, respectively, and for Europe as a whole, therefore, production is now set at 29,474,000 tonnes against 28,087,000 tonnes earlier and 32,482,000 tonnnes in the 1982/83 campaign.

	1983/84	1982/83	1981/82
		tonnes, raw value	
West Europe			
Belgium	860,000	1,200,000	1,120,000
Denmark	380,000	584,000	522,000
France	3,860,000	4,822,000	5,567,000
Germany, West	2,730,000	3,589,000	3,689,000
Greece	324,000	322,000	351,000
Holland	815,000	1,229,000	1,135,000
Ireland	203,000	242,000	183,000
Italy	1,350,000	1,282,000	2,226,000
United Kingdom	1,195,000	1,543,000	1,187,000
EEC Total	*11,717,000*	*14,813,000*	*15,980,000*
Austria	373,000	612,000	486,000
Finland	141,000	116,000	95,000
Spain	1,303,000	1,226,000	1,097,000
Sweden	310,000	389,000	374,000
Switzerland	122,000	120,000	135,000
Turkey	1,740,000	1,860,000	1,521,000
Yugoslavia	770,000	712,000	871,000
West Europe	*16,476,000*	*19,848,000*	*20,559,000*
East Europe			
Albania	40,000	42,000	40,000
Bulgaria	110,000	180,000	145,000
Czechoslovakia	730,000	876,000	749,000
Germany, East	790,000	885,000	747,000
Hungary	478,000	587,000	601,000
Poland	2,120,000	2,012,000	1,873,000
Rumania	630,000	652,000	663,000
USSR	8,100,000	7,400,000	6,200,000
East Europe	*12,998,000*	*12,634,000*	*11,018,000*
Europe Total	29,474,000	32,482,000	31,577,000

US sugar prospects for 1983/84

The US Department of Agriculture's *Sugar and Sweetener Outlook and Situation Report* of December 1983 forecasts that total beet and cane sugar output in that country will be 5.75 million short tons, raw value, marginally down from the 5.78 million tons of the 1982/83 season. The sugar beet crop is expected to total around 21.1 million tons, only slightly less than in 1982/83 but sucrose content is likely to be lower and sugar output in 1983/84 could fall by 50-100,000 tons from the 2.72 million tons, raw value, of the previous campaign. Drilling was late in most areas because of the cold winter and late spring, and the crop has faced late rains and early frosts in certain areas.

The 1983/84 sugar cane crop is estimated at 30.7 million tons, up more than 3% from the previous season. Average sugar content is lower, however, and cane sugar output is projected to be up only marginally at 3.1 million tons. Acreage is up in Louisiana and Hawaii but down slightly in Florida and Texas, giving an overall increase of 1.6% to a total of 771,200 acres for 1983/84. The average cane yield is up in all states except Louisiana which suffered a dry summer. A record sugar output of 1.32 million tons is expected in Florida and the Texas crop appears better than a year ago, with rice borers under control. In Hawaii, prospects are of a more normal 1,040,000-ton crop following the previous season's heavy rains which reduced production to 983,000 tons.

In 1984/85 beet acreage seems more likely to decline than to increase because support levels are not likely to keep up with inflation and production cost increases. There is also some question as to how many factories will operate in 1984/85. Domestic cane area is expected to decline slightly and with cane yields not likely to increase much over the 1983/84 level of 39.8 tons/acre, cane sugar output could be marginally lower. Together, beet and cane sugar production could total 5.5-5.8 million tons in 1984/85.

Sugar consumption in fiscal 1983 is estimated at 8.96 million tons, including 91,000 tons of imported sugar blends, compared with deliveries of 9.21 million tons in 1982. Decline in sugar use was particularly notable in beverage use, down 275,000 tons, most of which is attributable to substitution by high fructose syrups. Domestic use of sugar in 1984 is forecast to fall by 200-400,000 tons, the higher end of this range assuming additional approval of use of HFS. Demand for the latter shot up in 1983 when major soft drink companies approved its use in cola and other drinks. Output is projected at 3.6 million tons, dry basis, 500,000 tons above 1982 and 1,000,000 tons above 1981 production.

Mauritius sugar production, 1983[1]

The 1983 sugar cane harvest began on June 6 and ended on December 1, 1983; the 21 factories crushed 5,254,665 tonnes of cane to yield 604,741 tonnes of sugar, tel quel, or 639,816 tonnes, raw value. The cane crop was 1,327,197 tonnes less than that of the previous season when sugar outturn reached 687,940 tonnes, tel quel, or 728,597 tonnes, raw value. This reduction was due to the very severe drought which prevailed from February 1983 which reduced cane yield to 66.9 tonnes per hectare. The average commercial sugar recovery of 11.51% was the highest since 1974 and helped to offset to some degree the disastrous effect of the drought on cane output.

Brazil 1983 ISA export quota fulfilled[2]

The Export Director of the Brazilian Sugar and Alcohol Institute announced in early January that the 1983 ISA export quota of 2.8 million tonnes, raw value, had been fulfilled with a record 814,000 tonnes of sugar shipped in December to bring the total for the year to 2,800,613 tonnes. The previous monthly shipments record was 552,555 tonnes in October 1981.

Brazil would not have fulfilled its quota had the USSR not agreed to accept early shipment of around 200,000 tonnes of raws originally due to be shipped in 1984. These December 1983 shipments were the first to the USSR since July; in the first seven months of 1983 Brazil supplied 800,000 tonnes to that destination.

[1] *Mauritius Sugar News Bull.*, 1983, (11).
[2] F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 54, 56.

Influence of suspended matter in beet raw juice on the determination of purity

By JAN GRABKA and JAN DOBRZYCKI
(Technical University, Lodz, Poland)

Introduction

One of the main indexes concerning the elimination of non-sugars is the purification effect calculated from the purity quotients of raw and thin juice. The value of this index is limited when the dry substance content of juice is not determined with adequate precision.

Brix determination by the known refractometric method is connected with some difficulties. Its principle assumes that the light refraction indices of non-sugars and of sucrose are equal at equal concentration, which is true only with juice purity near 100. Vukov[1] compared the refractometric dry solids content (RDS) of various solutions containing 5% w/w true dry solids. In the case of sucrose the indication was 5% but oxalic acid showed 3.95%, sodium oxalate 7.4%, potassium oxalate 4.7%, sodium glutamate 6.4% and sodium carbonate 7.35%, respectively.

Different formulae have been suggested[2-5] for conversion from RDS to true solids but the correlation is not close enough. The reason for this failure is the diverse chemical composition of non-sugars and differences in their contraction during solution. Pectic substances reveal differences of 10 to 30% in refractive index by comparison with sucrose, at equal concentration[6]. The RDS error depends not only on the molecular mass of the pectin but also on its degree of esterification and on the pH value of the solution.

Raw juice contains many colloidal and dispersed substances of various sizes, up to the mechanically suspended beet pulp. In the presence of colloidal matter and suspensions a diffuse dividing line is observed in the field of view in the refractometer. Surface active colloidal matter increases the aeration of juice which also worsens the contrast and readability of the dividing line.

At the 16th ICUMSA Session filtering or centrifuging of samples of cane molasses was suggested[3] in order to increase the precision of refractometric determination. This operation has been not generally adopted, however. The South African Laboratory Manual[7] describes the analysis of cane juice with addition of 1% kieselguhr and filtration preceding the refractometer reading.

J. Grabka

J. Dobrzycki

Grabka's preliminary investigation and statistic analysis of 1500 refractometric readings has shown that both centrifuging and filtration with kieselguhr decrease by about 0.15% RDS the refractometric readings in beet raw juice. The standard deviation of the readings decreased only slightly.

The aim of experiments described in this paper was to determine the influence of centrifuging or filtering upon the purity quotient of beet raw juice.

Experimental

Refractometer readings after elimination of suspended matter

Factory raw juice from Lesmierz sugar factory, obtained during the 1981 campaign, was screened through a 0.25 x 0.25 mm sieve and stored at −20°C. For each experiment a portion of this juice was thawed, thoroughly mixed and warmed to +20°C. Some experiments were made with raw juice obtained in the laboratory J-extractor from beets stored at +5°C.

From each juice three portions of about 150 cm^3 each were prepared:

(1) original juice, deaerated 15 min at 20 kPa abs. pressure,

Table I. Influence of centrifuging upon refractometric dry solids RDS in beet raw juice (z — centrifugal acceleration)

	Centrifuging time, min			Total change after 15 minutes
	0	3	15	
z = 20,400 *g* RDS	13.76	13.64	13.61	
△ RDS		−0.12	−0.03	−0.15
z = 20,400 *g* RDS	13.78	13.66	13.64	
△ RDS		−0.12	−0.02	−0.14
z = 900 *g* RDS	13.80	13.74	13.66	
△ RDS		−0.06	−0.08	−0.14
z = 900 *g* RDS	13.85	13.78	13.70	
△ RDS		−0.07	−0.08	−0.15

[1] Vukov: "Physics and chemistry of sugar beet." (Akadémiai Kiadó, Budapest.) 1977, p. 54.
[2] *Proc. 15th Session ICUMSA*, 1970.
[3] *Proc. 16th Session ICUMSA*, 1974.
[4] Roche: *Ind. Alim. Agric.*, 1970, **87**, 847.
[5] Wieninger: *Jahresber. Zuckerforsch.-Institut Fuchsenbigl*, 1974/75, 89.
[6] Petrov: *Hemijska Industrija*, 1970, **3**, 136.
[7] "Laboratory manual for South African sugar factories. (S. African Sugar Association, Durban.) 1977, Item 8.3.2.1.

(2) juice centrifuged 5 min at 20,400 *g*, and
(3) juice treated with 1% kieselguhr and filtered through paper, the first fraction of filtrate being rejected.

The time of centrifuging (5 minutes) was fixed in preliminary trials (Table I). The centrifuged juice was limpid, grey or even yellow in case of higher purity. In contact with air the juice darkened slowly with a brownish coloration.

After 3 minutes centrifuging at 20,400 *g* the main part of the suspended matter was eliminated; a further 12 minutes centrifuging changed the refractometer readings by only 0.025%. At 900 *g* acceleration the change after 3 minutes of centrifuging attained 0.065% RDS, i.e. about one half of the total change, which averaged 0.145% RDS.

Stabilization of refractometer readings

During the first minutes after introducing the sample of raw juice between the prisms the refractometer readings shows a tendency to rise while, at the same time, the border between bright and dark field of view becomes more and more diffuse.

A pause of 1 to 2 minutes before reading takes place, as prescribed in the Service Manual of the Carl Zeiss precision refractometer with sodium lamp, is insufficient. Readings rise distinctly between 60 and 180 seconds (Table II) by 0.03% RDS on average in original raw juice. The increase is not caused by temperature change because for samples prepared at 25°C or 15°C, with a prism temperature 20°C, a similar rise in RDS was observed every time.

Table II. Increase in RDS readings during first 3 minutes after placing the sample of raw juice on the prism; each figure is mean value of 18 experiments

	Time after placing sample, seconds		
	0 – 60	60 – 180	total 0 – 180
Original, untreated juice			
ΔRDS, average	0.020	0.030	0.050
Variance S^2		0.000322	
Standard deviation S		±0.018	
Filtered juice			
ΔRDS, average	0.020	0.00722	0.02722
Variance S^2		0.000092	
Standard deviation S		±0.0096	
Centrifuged juice			
ΔRDS, average	0.0139	0.0067	0.0206
Variance S^2		0.000156	
Standard deviation S		±0.0125	

The accompanying diffusion of the border line has been explained by Wiklund[8] as an effect of adsorption of colloidal matter on the surface of the prism or of sedimentation of suspended matter. In our experiments the rise in readings was smaller in the case of centrifuged or filtered raw juice. In several samples so prepared there was no change in RDS at all.

Comparison with densimetric determination

Table III contains the results of parallel determination of dry solids by refractometric and densimetric methods. A Stützerbach pycnometer with vacuum insulating jacket was used. Centrifuging decreased the refractometer readings by 0.20% and the densimetric dry solids content of raw juice by 0.19%. These results did not confirm the Wiklund hypothesis of adsorption of colloids on the prism, because, if this were the case, the drop in refractometer reading should have been greater than in the densimetric determination.

Table III. Refractometric and densimetric determination of dry solids: average from 22 various beet raw juices

	Original juice	Filtered juice	Centrifuged juice
Densimetric dry solids	12.86	12.28	12.67
Refractometric dry solids	12.81	12.26	12.61
Difference	+ 0.05	+ 0.02	+ 0.06

Filtration with kieselguhr eliminated a greater amount of dry solids, more than 0.5% DS in both methods.

Influence of suspension upon purity determination

In further experiments 5 readings for each sample placed in the refractometer were made every 30 seconds between 60 and 180 seconds. A total of 22 different raw juices were analysed, each: untreated, centrifuged and filtered with kieselguhr. The 66 samples were then measured by refractometer and the sugar content determined by polarimetry after clarifying the juice with lead acetate solution or Herles reagent. A Hilger and Watts Ltd. saccharimeter was used. The results are shown in Table IV.

Table IV. Statistical analysis of results. Refractometric dry solids RDS, sucrose S and purity quotient Q in beet raw juice before and after filtration with kieselguhr or centrifuging

	Original juice y_1	Filtered juice y_2	Centrifuged juice y_3
Determination of refractometric dry solids (RDS)			
Average $\overline{RDS}$ %	12.835	12.233	12.612
Difference $\bar{d}_{21} = \overline{y_2 - y_1}$		− 0.602	
" $\bar{d}_{31} = \overline{y_3 - y_1}$			− 0.223
Student's test		10.38	17.95
Significance of $\bar{d}$		+++	+++
Determination of sucrose (S)			
Average $\bar{S}$	10.95	10.63	10.97
Difference $\bar{d}_{21}$		− 0.32	
" $\bar{d}_{31}$			− 0.02
Student's test		4.31	2.13
Significance of $\bar{d}$		+++	–
Calculated purity quotient (Q)			
Average $\bar{Q}$	85.49	86.74	86.96
Difference $\bar{d}_{21}$		+ 1.25	
" $\bar{d}_{31}$			+ 1.47
Student's test		10.84	11.70
Significance of $\bar{d}$		+++	+++
22 various juices, $\alpha = 0.01$, $t_{0.01} = 2.831$			

[8] *Socker Handl.*, 1949, 5, 41.

The changes caused by centrifuging or filtering are statistically significant; to the differences the Student test with $\alpha = 0.01$ was applied. The only exceptions are sugar contents in untreated (average 10.95%) and centrifuged (10.97%) juice. The centrifuging eliminates non-sugars only.

Application of kieselguhr influences not only dry solids content but also sugar content by adsorption.

The confidence intervals (confidence level of 0.99) of average differences $\bar{d}_{31}$ in Table IV are:

drop in dry solids % $0.188 \leqslant \bar{d}_{31} \leqslant 0.258$

rise in purity quotient $0.12 \leqslant \bar{d}_{31} \leqslant 1.83$

Discussion

As shown in Table I, centrifuging during 5 min at 20,500 *g* is sufficient to eliminate suspended matter, changing the refractometer readings from those of raw juice.

During the first few minutes after placing a drop of raw juice in the refractometer a slow rise in the reading has been observed (Table II). Perhaps it is a subjective effect of slow diffusion of border line between dark and bright in the field of view. In pure sucrose solutions the readings are constant during this time.

The average increase of 0.05% is almost negligible, yet it seems advisable to read the refractometer indications after a specified time, e.g. 3 minutes after placing the the sample onto prism, in order to obtain consistent results. In centrifuged samples the rise in readings is negligible.

Elimination of suspension from beet raw juice by means of centrifugation (Tables III and IV) decreased the RDS readings by 0.2% (confidence interval 0.16 – 0.24% RDS, $\alpha = 0.01$, n = 22). A similar error caused by suspended matter was observed in densimetric determinations (Table III).

Centrifuging does not affect the sugar determination (Table IV). The decrease of RDS connected with elimination of suspended non-sugars leads to a significant rise in purity quotient of the juice: the mean value from 22 pairs of analyses was 1.5 purity units (confidence interval 1.1 to 1.8 units). One can see that during factory juice purification a considerable part of the calculated "purification effect" is due to simple mechanical separation of suspended matter. Similar changes in raw juice purity quotient after separation of beet pulp were observed by Schiweck[9].

Preliminary filtration with kieselguhr preceding the refractometric determination of RDS, as suggested in the South African Manual[8], cannot be recommended because of errors connected with adsorption of sucrose.

Conclusions

(i) Elimination of suspended matter from raw juice by centrifuging causes a decrease in refractometer readings of about 0.2% RDS. Determination of purity quotient preceded by simple centrifuging gave results some 1.5% higher than without centrifuging. In research work on juice purification concerning the elimination of dissolved non-sugar, the samples of raw juice should be centrifuged before analysis.

(ii) A considerable part of the calculated purification effect is due to simple mechanical separation of suspended matter.

(iii) During the first few minutes after placing the sample of raw juice on the refractometer prism the border line between bright and dark fields of view gets more and more diffuse and the reading rises slowly by ca. 0.05% RDS. When preliminary centrifugation of the sample is adopted this change is negligibly small.

(iv) Elimination of suspended matter before analysis of beet raw juice by means of kieselguhr is not recommended because part of the sucrose is adsorbed as well.

Summary

The refractometric dry solids content was measured in a number of raw juice samples (n = 22) before and after centrifuging for 5 minutes at 20,400 *g*. The average fall in the measurements was 0.223 ± 0.035% DS ($\alpha = 0.01$). The sugar content was not affected. The purity coefficient rose by 1.47 ± 0.36 units. Separation of suspended matter by use of kieselguhr as filter aid influenced the sugar content and is not recommended. With untreated juice the readings rose by an average of 0.05% DS in the first three minutes after the sample was placed on the prism; with centrifuged juice this rise did not exceed 0.02%.

Influence des matières en suspension dans le jus vert de betteraves pour la détermination du quotient de pureté

On a mesuré par réfractométrie la teneur en matières sèches pour un certain nombre d'échantillons de jus vert (n = 22) avant et après centrifugation durant 5 minutes à 20,400 *g*. La chute moyenne observée dans les mesures était de 0,223 ± 0,035% MS (α = 0,01). La teneur en sucre ne fut pas affectée. Le quotient de pureté augmentait de 1,47 ± 0,36 unités. La séparation des matières en suspension par utilisation de kieselguhr comme adjuvant de filtration influençait la teneur en sucre et n'est pas recommandée. Avec du jus non-traité, les lectures augmentaient en moyenne de 0,05% MS dans les trois premières minutes après l'introduction de l'échantillon sur le prisme. Avec du jus centrifugé cette augmentation n'excédait pas 0,02%.

Einfluss der Suspension auf die Reinheitsbestimmung im Rohsaft

In verschiedenen Rohsaftproben (n = 22) wurde refraktometrisch Trockensubstanzgehalt vor und nach dem Zentrifugiéren bestimmt (5 min, 20,400 *g*). Die mittlere Senkung der Messergbnisse war 0.223 ± 0.035% TS (α = 0.01). Zuckergehalt wurde nicht geändert. Der Reinheitsquotient stieg um 1.47 ± 0.36 Einheiten. Abscheidung der suspendierten Stoffe mittels Kieselerde beeinflusste den Zuckergehalt und ist nicht ratsam. Im unbehandelten Rohsaft stiegen die Anzeigen durchschnittlich um 0.05% TS in ersten 3 Minuten nach dem Auftragen der Probe auf das Prisma – nur um 0.02% im zentrifugierten Saft.

Influencia de materia en suspensión en jugo crudo de remolacha sobre la determinación de su cociente de pureza

En varias muestras de jugo crudo (n = 22) los contenidos de sólidos secos se han determinado por refractometría antes y después de centrifugación durante 5 minutos a las 20,400 *g*. La disminución media de los contenidos de sólidos fué 0.223 ± 0.035% (α = 0.01) mientras que el contenido de sacarosa no sufrió modificación. El cociente de pureza aumentó en 1.47 ± 0.36 unidades. Separación de materia en suspensión por uso de kieselguhr como filtro-ayuda afectó el contenido de sacarosa y no es aconsejable. Con jugo crudo no-tratado, había un aumento medio de 0.05% en la lectura de sólidos secos durante los primeros tres minutos después de deposición de la muestra sobre el prisma; con jugo centrifugado este aumento no excedió 0.02%.

[9] Schiweck: *Zucker*, 1976, **29**, 549.

Treatment of sugar factory waste water by biochemical techniques

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Introduction

With continued industrial expansion, the problem of disposal of wastes has been greatly increased in Egypt. The discharge of significant quantities of untreated waste water into the river Nile or its branches may have a damaging effect on aquatic life as well as adversely affecting the beneficial uses of the river water.

Waste water from Kom Ombo cane sugar factory in Upper Egypt contributes greatly to the severe pollution of the Nile. Raw wastes from this factory provided the material for the present investigation. The constituents of the waste are mainly organic matter and suspended solids. Discharge amounted to 100,000 m^3/day during the working season, and the organic load was found to exceed 50,000 kg/day.

Most of these organic pollutants are dissolved biodegradable organic matter, and many workers have used biotechnological means for purification of such effluent[1,2]. Gurnham[3] recorded that the lagoon system using single or multiple basins has been the common method of treating sugar wastes. Tippens *et al.*[4] studied the treatment of sugar refinery waste using Activox activated sludge treatment. Kirsch & Sykes[5], Huss[6] and Fardyce[7] used the Anamet process which is an anaerobic-aerobic-methane process for sugar waste treatment.

Objective

The main objective of the present study was to evaluate the use of biological activated sludge treatment followed by chemical coagulation for the treatment of sugar factory waste water to permit its reuse in the sugar factory or to permit safe discharge in the Nile.

Material and method

1. Biological treatment was conducted in batch laboratory sludge columns. Acclimated activated sludge was built up to give a MLSS of about 2.5 g.litre^{-1}.
2. Chemical coagulation was carried out using a jar test procedure. This was intended to give the optimum coagulant dosage required.
   Ferric chloride (40% solution, w/w), aluminium sulphate [$Al_2(SO_4)_3,18H_2O$] and hydrated lime [$Ca(OH)_2$] were used as coagulants.
3. Chemical analysis was performed according to the American Standard Methods[8].

Results and discussion

Biological treatment

A batch laboratory study using 2-litre activated sludge columns was carried out. The effect of residence time from 2 to 24 hours was investigated. The available results (Table I) tend to show that about 50% reduction in COD and BOD values could be attained after 2 hours. On raising the aeration period to 24 hours, the removal efficiency was raised to 83.8% and 81% for COD and BOD, respectively.

The BOD, nitrogen:phosphorus ratio in the waste water was 100:1.8:0.68. The study was done without addition of extra nutrients and this ratio proved to give successful results. The same findings were observed by Tippens *et al.*[4]

Chemical treatment

As the sugar effluent after biological treatment still carries some organic and suspended matter, chemical coagulation was attempted. Experiments were carried out to determine the ratio of coagulant dose to flocculation effect and the amount of sludge produced. The

Table I. Effect of different retention periods on the efficiency of biological treatment of sugar waste

Detention time	pH	COD	% Removal	BOD	% Removal	TOC	% Removal	Phosphate	Organic N
0	6.8	2600		1200		465		8.1	22.4
2 hr	7.0	1372	51.1	630	47.5	325	30.1	3.2	14.5
4 hr	7.1	1132	56.5	528	56.0	315	32.3	1.7	10
24 hr	7.0	420	83.8	230	81	150	67.7	0.4	10

F. A. Nasr

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1 McGinnis: "Beet sugar technology" (Reinhold, New York), 1951.
2 Lettinga *et al.*: *H_2O*, 1977, **10**, 526.
3 "Industrial waste water control", Vol. 2, Ed. Baddour (Academic Press, New York), 1965.
4 *Sugar J.*, 1979, **42**, (1), 21-24.
5 *Progr. in Industrial Microbiology*, 1971, **9**, 155.
6 *Sugar J.*, 1979, **41**, (8), 9-11.
7 *Paper presented at Gen. Meeting, Amer. Soc. Sugar Beet Tech.*, 1981.
8 "Standard methods for the examination of water and waste water", 14th edn. (APHA, AWWAWPCF, Washington), 1975.

optimal flocculation pH was adjusted according to Leentvaar *et al.*[9]

An illustration of the results obtained with alum is given in Figure 1. COD and TOC reduction values reached 23% and 19.4%, respectively, when 100 mg.litre^{-1} was used at pH 6. The overall efficiency of the combined treatment reached 86.7% and 73%, respectively. The disadvantage of using alum as coagulant is the possibility of sulphate reduction coupled with release of H_2S when the oxygen supply is insufficient[10].

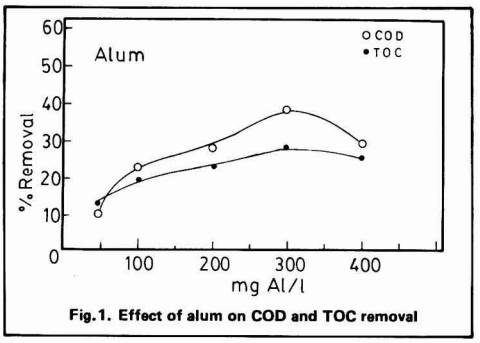

Fig. 1. Effect of alum on COD and TOC removal

When ferric chloride was used at pH around 5 the data obtained showed successful results (Fig. 2); COD and TOC reductions of 60% and 51.7% were obtained at a dose of 200 mg.litre^{-1}. Slight improvement was observed on increasing the dose to 400 mg.litre^{-1}. On calculating the total efficiency of biological treatment followed by ferric chloride coagulation, it was found that 93.5% and 83.9% reductions in COD and TOC values were obtained.

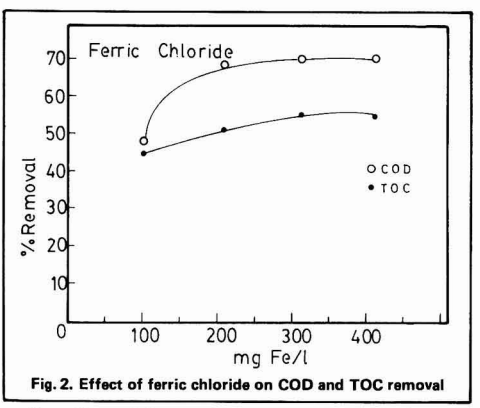

Fig. 2. Effect of ferric chloride on COD and TOC removal

The effect of lime treatment on the effluent was also investigated. The experiments, however, showed (Fig.3) that 500 mg.litre^{-1} lime gave a COD removal of only up to 16%. The disadvantage of lime treatment is the high effluent pH together with the increased hardness of the treated water[11].

As nitrogen plays an important role in the cost of discharging polluted waters into surface water or into the local sewer system, the elimination of organic and inorganic nitrogen compounds was examined. All data showed a linear relationship (Fig. 4) between COD and Kjeldhal nitrogen removal.

As shown in Table II, the amount of sludge produced depends on the dose and kind of coagulant. The SVI was around 250 ml.g^{-1} with ferric chloride, 450 ml.g^{-1} with

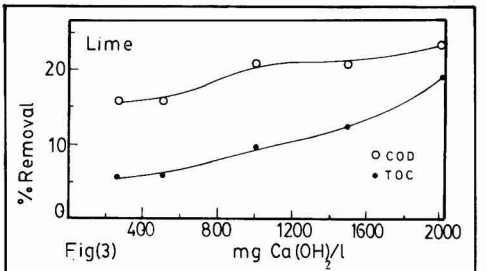

Fig. 3. Effect of lime on COD and TOC removal

Table II. Percentage removal of COD, TOC and organic nitrogen

Coagulant	Dose, mg.l^{-1}	% Removal			Sludge % by volume	SVI
		COD	TOC	Organic N		
$FeCl_3$	100	47.6	45.7	50	4.2	232
	200	60.0	51.7	60	4.4	280
	300	70.0	54.9	65	4.0	250
	400	70.0	54.9	55	4.4	244
Alum	50	10	13	10	2.6	425
	100	23	19.4	25	2.0	460
	200	28.2	23.0	30	5.0	500
	300	38	28.2	35	5.4	450
	400	29	26.5	40	5.6	482
$Ca(OH)_2$	250	16	6.2	16.6	1.4	32
	500	16	6.2	16.6	1.4	40
	1000	21	10.1	21.2	1.8	40
	1500	22	12.5	20.0	2.0	33
	2000	23.5	19.6	24.0	2.8	28

alum and 30 ml.g^{-1} with hydrated lime. The volume of the sludge and its dry solids content were measured after 30 minutes sedimentation.

Economic aspects

Although the capital cost of a physico-chemical waste water treatment plant is lower than that of a mechanical/biological plant, the recurring costs of a physico-chemical plant are in most cases higher. The recurring costs of the coagulation/flocculation step consist mainly of the cost of the coagulants. The cost given in Table III for the various doses of coagulant were

Table III. Coagulant efficiency and cost at different dosages

Coagulant	Dose, mg.l^{-1}	Coagulant efficiency (kg COD removed/kg coagulant)	Coagulant cost per kg COD removed
$FeCl_3$	100	1.99	0.51
	200	1.26	0.81
	300	0.98	1.05
	400	0.73	1.41
Alum	50	0.84	0.193
	100	0.97	0.167
	200	0.58	2.8
	300	0.53	3.04
	400	0.30	5.36
$Ca(OH)_2$	250	0.26	3.17
	500	0.13	6.34
	1000	0.08	9.66
	1500	0.06	13.84
	2000	0.04	17.27

9 Leentvaar *et al.: J. WPCF*, 1979, **51**, 2457.
10 Idem: *Water Res.*, 1978, **12**, 35.
11 Minton & Carlson: *ibid.*, 1973, **7**, 1821.

calculated using the following prices: ferric chloride (40% solution w/w) $103.85 per tonne, alum [98% $Al_2(SO_4)_3 18H_2O$] $162.27 per tonne, and lime [98% $Ca(OH)_2$] $85.26 per tonne.

Coagulant efficiency is defined as the total amount of COD removed per unit coagulant expressed as kg COD/kg coagulant. Table III surveys the efficiency and cost of each of the three coagulants used in this study; it shows that coagulant efficiency decreased with rising coagulant dose.

In view of the coagulant cost, the following dose is recommended: 100-200 mg $FeCl_3$ per litre, 50-100 mg alum per litre or 250-500 mg $Ca(OH)_2$ per litre. The choice of the coagulant dose at equal cost per kg COD removed depends on the desired effluent quality and/or the sludge handling and disposal facilities. With respect to the coagulant cost per kg COD removed, the use of ferric chloride as coagulant, especially with small doses (which favour the floc settling rate) is the most suitable. These results are similar to those obtained by Leentvaar *et al.*[9]

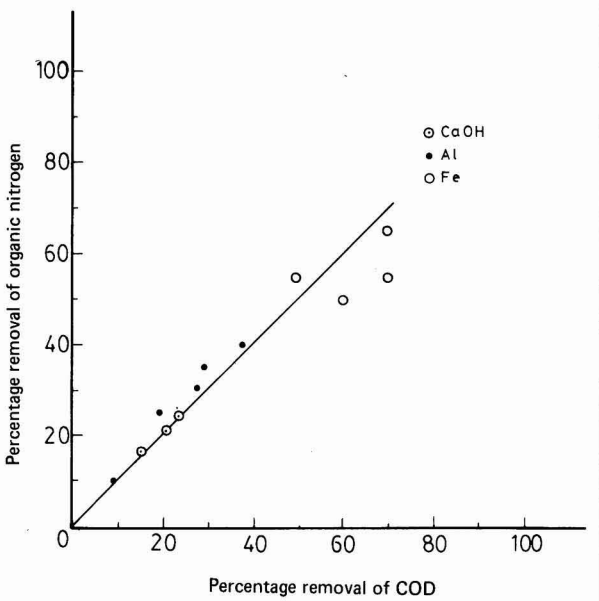

Fig. 4. Relationship between COD removal and nitrogen removal by different coagulants

Summary

Highly polluted waste water from a sugar factory has been treated with activated sludge followed by chemical coagulation. Ferric chloride, alum and hydrated lime were used as coagulants at their optimal pH values and dosages. The results obtained showed that this process proved to be very efficient in removing organic pollutants. The COD, TOC and organic nitrogen removal achieved were 93.5%, 83.9% and 82%, respectively. With respect to the coagulant cost per kg COD removed, the use of ferric chloride as coagulant, especially in small doses, is preferred.

Traitement des eaux résiduaires de sucrerie par des techniques biochimiques

Des eaux résiduaires de sucrerie hautement polluées ont été traitées par boues activées suivi d'une coagulation chimique. Du chlorure ferrique, de l'alun et de la chaux hydratée ont été utilisés comme coagulants à leur pH et dosage optimaux. Les résultats obtenus montrent que ce procédé est très efficace dans l'élimination des polluants organiques. L'élimination du COD, CTO et de l'azote organique était respectivement de 93,5%, 83,9% et 82%. Par rapport au coût de coagulant par kg de COD enlevé l'utilisation de chlorure ferrique est préférée comme coagulant surtout en faible dose.

Biochemische Behandlung von Zuckerfabriksabwässern

Die stark verschmutzten Abwässer einer Zuckerfabrik wurden mit aktiviertem Schlamm behandelt, anschließend folgte eine chemische Ausflockung. Eisentrichlorid, Alaun und Hydratkalk wurden als Flockungsmittel bei ihren optimalen pH-Werten zugegeben. Die erzielten Ergebnisse zeigten, daß sich dieses Verfahren als sehr wirksam erwies, um organische Verunreinigungen zu entfernen. Die Erniedrigung von CSB, SBT und organischem Stickstoff betrug 93,5%, 83,9% bzw. 82%. Hinsichtlich der Flockungsmittelkosten je beseitigtem kg CSB zieht man die Verwendung von Eisentrichlorid als Flockungsmittel vor, besonders bei kleinen Dosierungen.

Tratamiento de efluente de una azucarera por técnicas bioquímicas

Efluente de una azucarera de alto grado de contaminación se ha tratado con lodo activado y entonces por coagulación química. Cloruro férrico, alumbre y cal hidratada se han empleado como agentes coagulantes en su valores optimales de pH y dosaje. Los resultados obtenidos demuestran que este proceso estuvo muy eficaz en la remoción de contaminación orgánica. Las remociónes de DQO, CTO y N orgánico que se logran estuvieron 93.5%, 83.9% y 82%, respectivamente. Respecto al costo de agente coagulante por kg de DQO eliminado, el uso de cloruro férrico se prefiere.

Italy sugar production, 1983[1]. – The Italian sugar beet growers association estimated at the end of the 1983 beet harvest that sugar production would total 1,240,000 tonnes, white value, slightly up on the 1982 output in spite of a beet area reduced by 30,000 hectares. The increase is due to higher beet yields and a sugar content substantially higher at 16% *vs.* 12.9%. The beet area is likely to be reduced further in 1984.

Tate & Lyle wish to sell Belize sugar holdings[2]. – Tate & Lyle PLC, which started operations in Belize in 1964 with the purchase of an old sugar operation in Corozal, wants to divest itself of the majority of its holdings in Belize Sugar Industries Ltd. (BSI). Tate & Lyle, which controls 97.25% of BSI, wants to retain between 15 and 25% of the holdings and continue to manage the industry under contract. The depressed state of the market has apparently made Tate & Lyle rather nervous about its position as major stockholder in Belize's principal industry. Although the company has tried to convince the government and 4000 cane farmers to buy 85% of the stock, the government is less than enthusiastic.

[1] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 610.
[2] *World Sugar J.*, 1983, **6**, (5), 33.

Recent developments in pan boiling automatics

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Introduction

The extensive automation of sugar production during the past 20-30 years has included automation of the actual sugar crystallization. The traditional process of discontinuous crystallization is now well known and gives no special problems, but the methods available for measurement of the crystallization conditions at any given moment are still the cause of difficulties, since the control parameters used are all based on transducers for indirect measurement of supersaturation and the crystal content. This is one of the questions dealt with by the CITS sub-committee for "Transducers for automatic control". So far, this body has concluded that conductivity is the most simple and frequently used parameter for control of crystallization from syrup of a lower purity, i.e. typically *B*- and *C*-product massecuites with purities lower than 89-90. For massecuites with purities between 90 and 99.9, there is greater dispute about control factors, the most frequently selected being:

Boiling point elevation, a temperature difference measurement,

Consistency, measured by process rheometers developed for the purpose,

Refractive index, a measurement of Brix in mother liquor using process refractometers,

Electrical conductivity, measured by highly sensitive electrodes,

Power consumption, for the built-in stirrer of the pan, or

Specific gravity, based on radioactivity measuring techniques.

Thus, the commission is looking for more specific transducers for this area. In DDS we have tested and improved several of these measuring methods and demonstrated their individual strengths and weaknesses.

Because of our special production conditions, by which white sugar is manufactured directly from *A*- and *B*-product massecuites, we mainly operate with purities lower than 95. This, coupled with uniform factory operation, means that we are able to use conductivity satisfactorily for the majority of crystallizations. When refining white sugar or raw sugar and in connexion with sales of know-how and equipment for sugar crystallization we do, however, need also to be able to control the crystallization of very high-purity massecuites.

Results we have obtained with the different measuring methods have shown that they are either directly unsuitable, have essential disadvantages as regards operational reliability, are too complicated in use, involve too high operational costs or are simply too expensive in investment costs. Consequently, we have tried to develop a measuring method which is fully up to the standard of the conductivity measurement. The method is based on determination of the momentary dielectric constant of the massecuite, a phenomenon which has been described in the literature. The result of our efforts has enabled us today to offer an instrument for control of concentration and crystal content based on changes in the dielectric constant of the massecuite.

G. R. Moller

Theory

The dielectric constant of a substance is normally expressed as the relative dielectric constant:

$$\epsilon_r = \epsilon' - j\,\epsilon''$$

In the formula the quantity ϵ'' is an expression for the electric loss in the substance, since

$$\epsilon'' = \frac{\sigma}{\omega \epsilon_0}$$

where σ is the conductivity of the substance

ω is the actual frequency, and

ϵ_0 is the dielectric constant for vacuum.

Normally, the loss is described by the angle δ, since

$$\text{tangent } \delta = \frac{\epsilon''}{\epsilon'}$$

For most substances both ϵ' and ϵ'' are dependent both on the frequency and on the temperature. This dependence means, of course, one more difficulty in measuring the dielectric constant of a mixture such as massecuite.

According to Onsager[1] the dielectric constant for a substance consisting of several components can with a certain approximation be described by the expression

$$\epsilon_r = \epsilon_1 \times \phi_1 + \epsilon_2 \times \phi_2 + \epsilon_3 \times \phi_3 + \ldots + \epsilon_n \times \phi_n$$

where $\epsilon_1, \epsilon_2, \ldots \epsilon_n$ are expressions for the individual dielectric constants of the various components, while $\phi_1, \phi_2, \ldots \phi_n$ express the relative concentration by volume of the same components in the substance. Thus, in our case we may expect a dielectric constant composed of contributions from crystal sucrose, dissolved hydrated sucrose, water, and from the impurities present, i.e.

$$\epsilon_r = \epsilon_{sc} \times \phi_{sc} + \epsilon_{ds} \times \phi_{ds} + \epsilon_w \times \phi_w + \epsilon_i \times \phi_i$$

where $\epsilon_{sc} \times \phi_{sc}$ is the contribution from crystal sucrose

$\epsilon_{ds} \times \phi_{ds}$ is the contribution from the dissolved sucrose

$\epsilon_w \times \phi_w$ is the contribution from the water, and

$\epsilon_i \times \phi_i$ is the contribution from the impurities.

However, if we are looking only at very pure solutions with a low ash content, which is often the case in sugar refining, the contribution $\epsilon_i \times \phi_i$ may be ignored. The

Paper presented at 17th General Assembly, CITS, 1983.

[1] *J. Amer. Chem. Soc.,* 1936, **58**, 1486.

above expression is, however, valid only for solutions which comply with Raoult's law, which states that the interaction between water-water molecules, water-sugar molecules and sugar-sugar molecules has to be the same, a condition which is not met in concentrated sugar solutions. In spite of this fact, we have tried to establish the dependence of crystallization on the dielectric constant from an approximate calculation of the dielectric constant.

In the calculations, the following values have been used:

$$\epsilon_{sc} \sim 3.3$$

$$\epsilon_{ds} \sim 26$$

$$\epsilon_{w} \sim 60$$

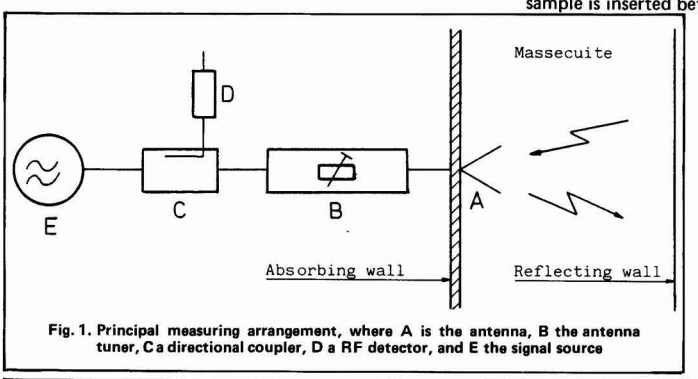

Fig. 1. Principal measuring arrangement, where A is the antenna, B the antenna tuner, C a directional coupler, D a RF detector, and E the signal source

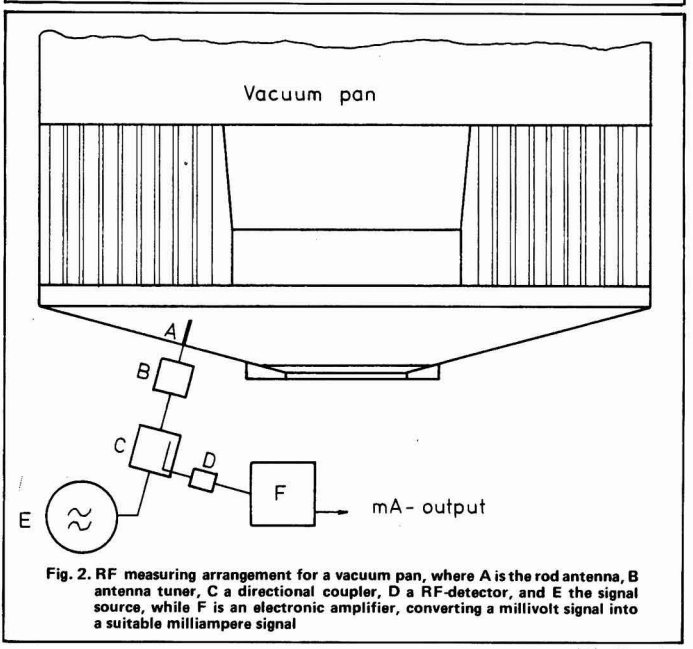

Fig. 2. RF measuring arrangement for a vacuum pan, where A is the rod antenna, B antenna tuner, C a directional coupler, D a RF-detector, and E the signal source, while F is an electronic amplifier, converting a millivolt signal into a suitable milliampere signal

The value ϵ_{ds} has been found and determined by Soldatov & Romanovskii[2] by analysis of the behaviour of sucrose solutions in the latent period, while ϵ_{sc} and ϵ_{w} are found in "Handbook of Chemistry and Physics"[3].

Measuring arrangement

Because of the extreme conditions prevailing in a pan with highly viscous massecuite under vacuum, we chose a measuring method for which a transducer needing a very simple contact to the interior of the pan can be used. The transducer was designed as a very simple cylindrical rod, in high-frequency technology called a rod antenna. This was directly connected to an impedance tuner, a directional coupler and a RF detector, elements which are all known in high-frequency technology. The principle is shown in Fig. 1.

The measuring arrangement constitutes a conventional reflection measurement, as used for determination of water content in plate-formed materials, wooden boards, etc. The first step in the method is to adapt the antenna at the measuring point by adjusting the tuner B for detection of a minimum reflected signal. Then the sample is inserted between the antenna and the reflecting wall, and the change in the size of the reflected signal will be a measure of the relative dielectric constant of the sample. The principle can be formulated by the expression:

$$P_R = P \times \frac{(Z_A - Z_C)}{(Z_A + Z_C)}$$

where P_R is the size of the reflected signal, P is the power of the transmitted signal, Z_A is the electrical impedance of antenna and sample, while Z_C is the characteristic impedance of the actual measuring system. From the expression it appears that the quantity P_R will vary as a function of Z_A, the other quantities being maintained constant. Once tuner B has been adjusted, the quantity $(Z_A - Z_C)$ can be reduced to zero at actual dielectric constants. Thus, any further change in dielectric constant will cause a change in the size of the detected signal.

Fig. 2 shows the same measuring arrangement for a vacuum pan; from this it is seen that the antenna is mounted in the bottom of the pan at a place where good circulation conditions prevail and where, consequently, we may expect a massecuite that is representative. Moreover, the location of the measuring point ensures that the measurements are made in a demarcated area with constant physical dimensions, limited by pan walls and calandria.

The antenna unit used is seen in Fig. 3. Only the white cylindrical rod is inserted in the pan, while the square-sectioned part contains antenna tuner (B), directional coupler (C) and detector (D).

2 *Ukr. Fiz. Zh.*, 1975, **20**, 261-265.

3 "Handbook of chemistry and physics", (Chemical Rubber Publishing Co., Cleveland) 1976-77, p. 57.

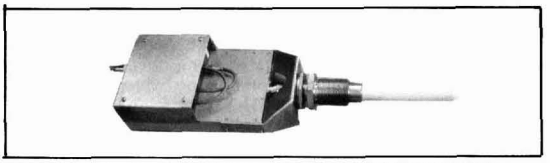

Fig. 3. RF antenna unit for measurement of dielectric constant

For practical and technical reasons the measuring frequency chosen should be of high value in order to obtain only small losses and the physical length of the antenna should be reasonable. After a number of preliminary experiments we decided to measure at approx. 150 MHz. The rod antenna used had a length of approx. 200 mm, which means that at this frequency and at the actual dielectric constants the length of the antenna was between 1/8 and 1/4 of a wavelength.

Test results

Tests for determination of the dependence of the RF measuring method on the dielectric properties of the massecuite were carried out in a small 100-litre test pan (Fig. 4).

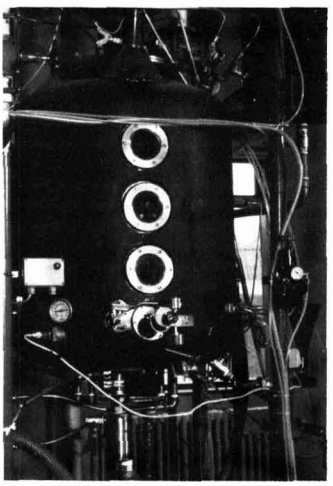

Fig. 4. 100-litre test pan

For the experiments we used a syrup made from ordinary white sugar dissolved in water of very poor conductivity. The purity or the ash content was varied during the test by addition of small quantities of KCl. In all experiments the conductivity was measured at 30°Bx and 25°C with a standard laboratory instrument. The test pan was equipped, as a normal vacuum pan, with a ring-formed calandria, automatic vacuum control and stirrer. In the individual tests the temperature of the massecuite was kept constant by successive changes of vacuum.

Figs. 5 and 6 show two sets of measurements for determination of the relation between RF signal (mV) and syrup Brix. At Brix values higher than approx. 78°, the curves show a unique relationship between RF signal and Brix. Furthermore, it is seen that, as expected, the signal depends on temperature and ash content. From Fig. 6 it also appears that the best linear relationship with Brix was obtained in a syrup of low ash content.

Figs. 7 and 8 give the corresponding measurements shown as functions of temperature and ash content, with syrup Brix as parameter. These curves show a simple, almost linear, relationship between RF signal and temperature and between RF signal and conductivity.

As the individual sets of curves show almost the same slope regardless of Brix, a compensation for temperature and conductivity may be introduced regardless of the actual Brix.

All curves in Figs. 5 to 8 have been measured during concentration of syrup without the presence of sugar crystals, corresponding to the period "Concentration for seeding" in actual vacuum pan operation.

The following curves show the RF signal in the presence of crystals. The measurements were made at a constant temperature of 75°C and on a syrup of poor conductivity.

Thus, Fig. 9 shows the RF signal measured as a function of the momentary crystal content with a constant mother liquor Brix of 78.8%. The result is a surprisingly simple relation between crystal content and RF value. The scatter seen in the measurements at the low crystal contents may probably be attributable to inaccurate determination of the crystal content.

On the basis of these measurements we tried to calculate ϵ_r according to Onsager's formula[1] in consideration of the individual volume contents. The results of these calculations appear in Figs. 10 and 11, where Fig. 10 shows the dependence of the measured RF value on the calculated dielectric constant ϵ_r for crystal contents between 10% and 33%.

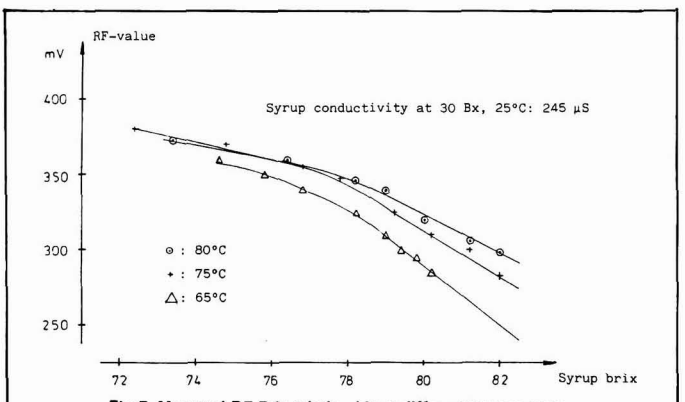

Fig. 5. Measured RF-Brix relationship at different temperatures

Correspondingly, Fig. 11 shows the variations of the RF value with and without the presence of crystals, since the range ϵ_r = 37 to 35 corresponds to a highly concentrated syrup before graining, while ϵ_r = 32 to 28 corresponds to a massecuite with 10-20% crystals.

In both parts of the curve is seen again an almost linear correlation between RF value and dielectric constant, but with a deflection at the moment where the crystallization starts, in the nucleation zone. A corre-

sponding phenomenon was previously observed by Bouldoires[4] on examination of crystallization of sugar during production of chocolate and soft drinks.

At the present time we are unable to give the reason for this deflection, but we can refer to the following three possible causes:

(1) The formula of Onsager cannot rightly be used, because Raoult's law has not been complied with because of the very high concentration of sugar.

(2) The system is changing from one phase to two phases.

(3) In the supersaturated zone there is a strong mutual molecule orientation which is the first step in nucleation. This orientation has a remarkable influence on the reflected signal.

It is especially this zone that must be subjected to a closer examination, but it will be the most difficult field to analyse. However, from the results it appears that we are able to describe the crystallization process by measuring the dielectric constant of the massecuite.

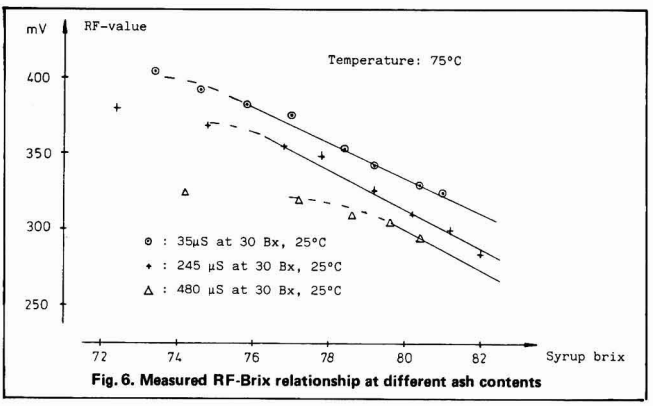

Fig. 6. Measured RF-Brix relationship at different ash contents

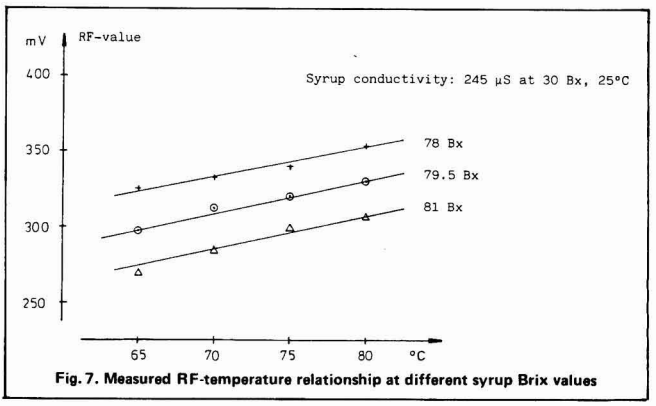

Fig. 7. Measured RF-temperature relationship at different syrup Brix values

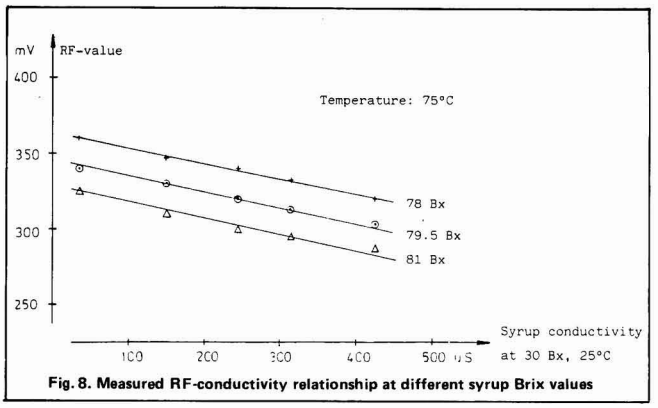

Fig. 8. Measured RF-conductivity relationship at different syrup Brix values

Practical results

During the past few years the measuring arrangement (Fig. 2) with the antenna unit (Fig. 3) has been used for control of the crystallization of massecuite with a purity higher than 90. The measuring signal is converted from a millivolt signal and is extended as a standardized 4-20 mA signal to a generally known pan boiling unit. For the pan boiling automatics the following set-point values for control of the concentration (see Fig. 12) are needed:

Seeding value (Grain set)

Dilution value (Principal set)

Final value (Tightening set)

In addition, the target concentration sequence is set, i.e. the set-point change which has to control the growth of crystals concurrently with the increasing massecuite level.

In order to be able to make allowance for many different concentration sequences, the actual set-point is made on the basis of the following function:

$$\text{Actual set} = PS \times [1 - X(\frac{L}{K})^{Y}]$$

where *PS* (principal set) is the set value immediately after the first crystal formation and stabilization, X is a variable proportionality factor ($0 \leqslant X \leqslant 1$), K is a constant, L is a signal which is changed in proportion to the massecuite level, but with a shifted zero ($0 \leqslant L \leqslant K$), and y is an adjustable exponent for formation of the required shape of the curve ($0.2 \leqslant y \leqslant 5$).

The result of such a control is given by the curve in Fig. 13, showing a series of typical concentration sequences and the corresponding massecuite level recorded on an *A*-product pan at a purity of approx. 93.

[4] *Food Process Eng.*, 1979, 13.

In Fig. 14 the corresponding curves are shown, but in this case recorded in refining of cane sugar with a purity of 99.2.

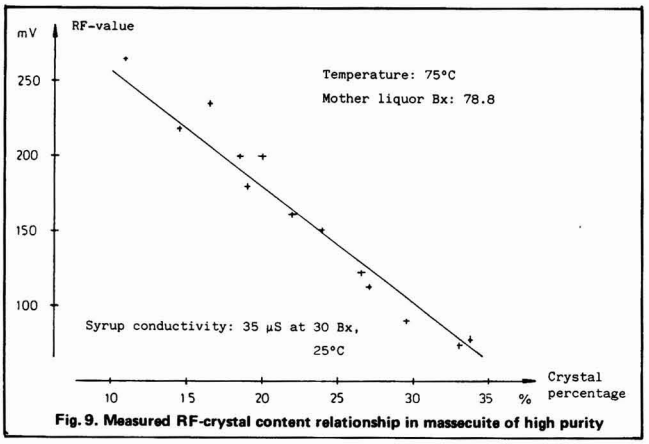

Fig. 9. Measured RF-crystal content relationship in massecuite of high purity

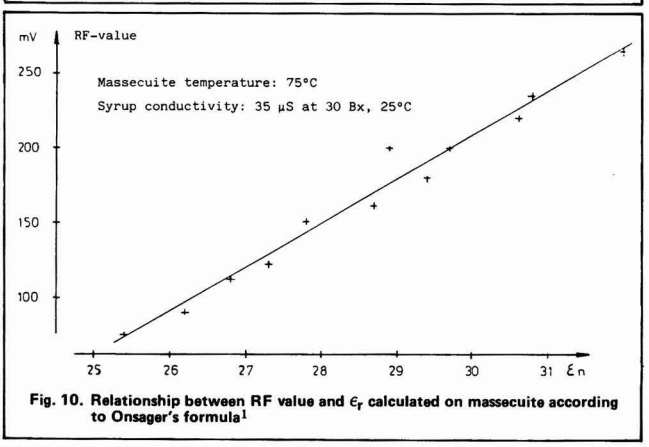

Fig. 10. Relationship between RF value and ϵ_r calculated on massecuite according to Onsager's formula[1]

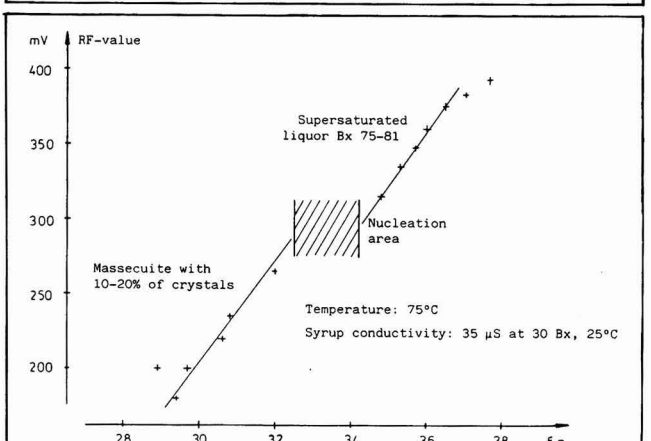

Fig. 11. Relationship between RF value and ϵ_r in highly concentrated syrup and massecuite in crystalllization

It is seen that in principle the curves are identical, apart from the length of the time axis, which is dependent on the crystallization rate and which of course will influence the appearance of the curves.

Fig. 15 shows the crystal quality obtained from a massecuite processed according to Fig. 14. Drawn on a special test graph, the crystal distribution shows a mean aperture (M.A.) of 0.43 mm and a coefficient of variation (C.V.) of 26.3, a very good result for this kind of product. The analysed sugar was produced in a 60-tonne DDS vacuum pan with mechanical stirrer at a steam pressure of only 1.2 ata. The total boiling time was approx. 3 hours using a remelt syrup with a purity of 99.2 and a Brix of approx. 65.

The concentration curves (Figs. 13 and 14) show the regularity at which the process is controlled, while the level curves express the rate of crystallization and the filling of the pan involved.

On the basis of the RF measuring method we have proved that good and uniform operating results can be obtained together with a very high quality of processed sugar. Consequently, we expect that the use of this transducer for control of pure massecuites will spread widely during the coming years.

Conclusion

In continuous automation of sugar production it is still a problem to determine the controlling parameters supersaturation and crystal content during the crystallization process. Many proposals for transducers based on measurement of secondary parameters, e.g. conductivity and viscosity, have been given, but none has been outstanding as regards price, simplicity and reliability.

Especially for crystallization of refinery products, DDS has developed a new transducer based on the change in the dielectric constant of the massecuite, a parameter which is shown to be distinctly related to supersaturation and crystal content. The transducer, which is fixed to the bottom of the vacuum pan, has no moving or pressure-sensitive parts. Thus, a reliablity is obtained which is fully up to the standard of the well-known conductivity transducer.

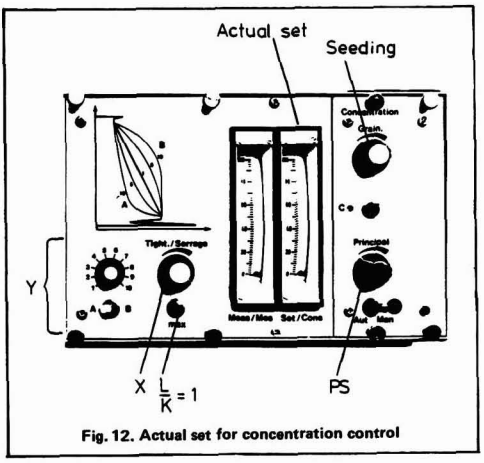

Fig. 12. Actual set for concentration control

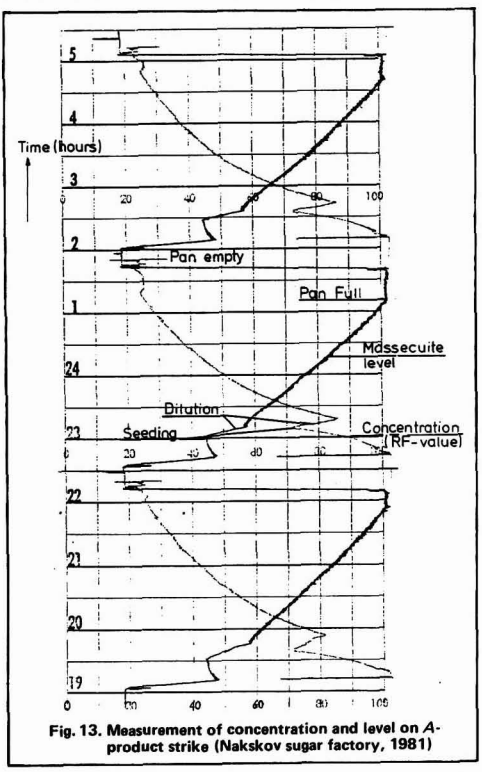

Fig. 13. Measurement of concentration and level on *A*-product strike (Nakskov sugar factory, 1981)

The equipment has been gradually tested and brought into operation in several sugar factories in the cane as well as the beet sugar industry.

Summary

For various reasons the demand for control of the crystallization has not been fully satisfied by the transducers most frequently used, which are based on conductivity, boiling point elevation or viscosity/consistency.

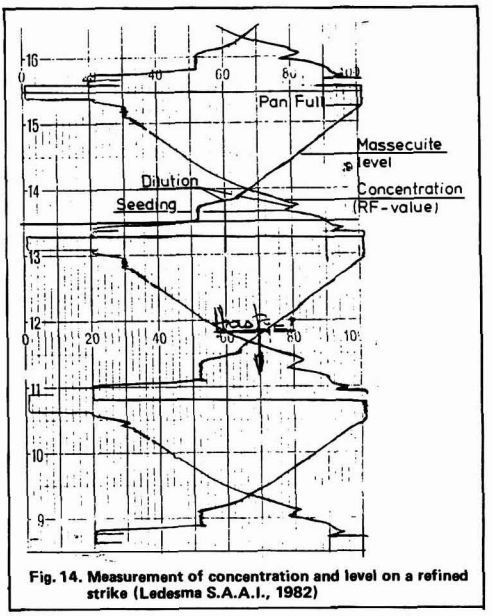

Fig. 14. Measurement of concentration and level on a refined strike (Ledesma S.A.A.I., 1982)

This paper gives the background for the development of a new type of transducer based on measurement of changes in the dielectric constant of massecuite and explains how this parameter can be used for control of the crystallization of very pure massecuites. A new transducer has been developed which as regards simplicity, reliability and maintenance is fully up to the standard of the conductivity transducer accepted everywhere in the sugar industry.

Développements récents en contrôle automatique de la cuisson

Pour des raisons différentes la demande concernante le contrôle de la cristallisation n'a pas été pleinement satisfaite par les capteurs les plus souvent utilisés qui sont basés sur conductivité, élévation du point d'ébullition ou viscosité/consistance. Cet exposé donne le contexte pour la mise au point d'un nouveau modèle de capteur basé sur mesurage des variations de la constante diélectrique de la masse cuite, en expliquant le mode d'emploi de ce paramètre pour le contrôle de cristallisation de très pures masses cuites. Un noveau capteur a été développé, et celui correspond — en vue de simplicité, solidité et entretien — à la qualité exigée du capteur de conductivité partout dans l'industrie sucrière.

Neuere Entwicklungen im Bereich der Kochautomatik

Aus unterschiedlichen Gründen hat man den Forderungen betreffs Kontrolle der Kristallisation mit Hilfe von Gebern, die auf Leitfähigkeit, Kochpunkterhöhung oder Viskosität/Dickflüssigkeit basiert sind, nicht voll nachkommen können. Die gegenwärtige Darstellung gibt die Hintergründe für die Entwicklung eines neuen Geber-Typs, der die Änderungen der dielectrischen Konstante der Füllmasse misst, und erläutert, wie dieser Parameter zur Kontrolle der Kristallisation von sehr reinen Füllmassen verwendet werden kann. Ein neuer Geber ist entwickelt worden, und dieser entspricht — was Einfachheit, Zuverlässigkeit und Instandhaltung betrifft — dem Standard der Leit fähigkeitsgeber, die überall innerhalb der Zuckerindustrie anerkannt sind.

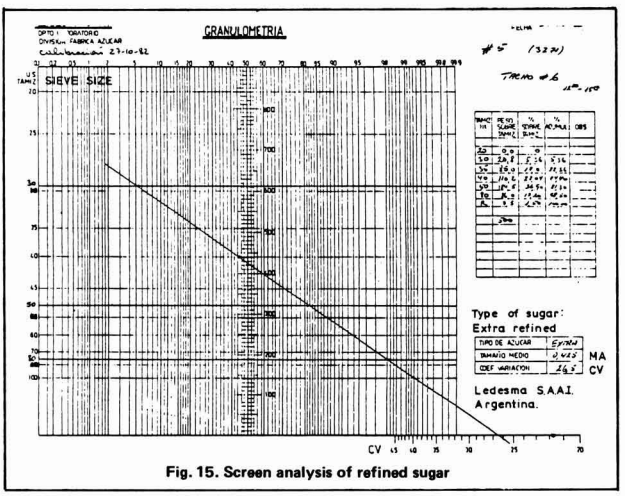

Fig. 15. Screen analysis of refined sugar

Desarrollo reciente en el campo de control automático de la cocción

Por varias razones la exigencias de control de la cristalización no han sido satisfechos por los transductores aplicados más frecuentemente que se basan en la conductibilidad, elevación del punto de ebullición o en la viscosidad/consistencia. Este artículo provee el contexto para el desarrollo de un nuevo tipo de transductor basado en la medición de cambios del constante dieléctrico de masa cocida y explica como este parámetro puede usarse para el control de la cristalización de masas cocidas muy puras. Un nuevo transductor se ha desarrollado que, en términos de sencillez, confiabilidad y entretenimiento, logra las normas de los transductores basado en conductibilidad aceptado en todas partes de la industria azucarera.

Hawaii sugar company ownership change

Theo. H. Davies & Co., Ltd., a unit of Jardine, Matheson & Co. of Hong Kong, and Francis S. Morgan announced recently that Morgan has purchased the assets of TheoDavies Hamakua Sugar Company. The sale involves total assets of $95.5 million which, after deducting liabilities, amount to a purchase price of $69.6 million. TheoDavies will receive an initial cash payment of $49.6 million, which will be used to repay debt and for reinvestment. Morgan has been group vice president, agriculture, of TheoDavies since 1972 and had managed the company's agricultural operations for more than 20 years.

A new company, to be known as Hamakua Sugar Company, will operate the largest plantation on the island of Hawaii and second largest in the state, accounting for 15% of Hawaiian sugar production. More than 35,000 acres of cane are under cultivation, processed by two modern factories located at Haina and Ookala. The plantation workforce numbers almost 1000.

With the exception of a new name, operations at Hamakua Sugar will continue unchanged. TheoDavies will provide administrative assistance in insurance, treasury and tax areas during a brief transitional period.

Morgan, a fifth-generation Hawaii sugar man, will continue the tradition by involving his family in plantation operations. His son-in-law, Jack Poppe, is a longtime employee and currently the operations manager at Hamakua Sugar. His great-grandfather was a partner in starting the first sugar factory on Oahu and his grandfather was the chief executive of Theo H. Davies & Co. at the turn of the century when the founder of the company returned to England.

"We have a lot of hard work ahead of us to return to a reasonable level of profitability, but I am confident that sugar will continue to be an important part of Hawaii's economy for the foreseeable future," Morgan said. Depressed world sugar prices coupled with an absence of U.S. price supports resulted in substantial losses in 1981 and 1982. However, the plantation earned a modest profit in 1983.

Francis S. Morgan

"Perhaps the most important aspect of this sale," Morgan said, "is that it will bring the challenges of the Hawaiian sugar industry to a more personal level. Everyone involved – employees, union leaders, government officials and even the general community – knows we are totally dedicated to Hawaii and the sugar industry but do not have unlimited resources. The result, we hope, will be an unprecedented spirit of cooperation".

The specific cake resistance of South African filter muds

By G. R. E. LIONNET
(Sugar Milling Research Institute, Durban, Natal, South Africa)

Introduction

One of the side-effects of the introduction of diffusion in the South African sugar industry has been a significant change in both the quantity and quality of clarifier muds. A measure of mud filtration characteristics has become desirable and led to the investigation of the suitability of specific resistance to filtration as a quantitative measure of filtrability. This concept has been used by a number of investigators. Swanwick & Davidson[1] applied this quantity to the study of sewage sludge. More recently, Carleton & Cousens[2] used the same principle to investigate the performance of a number of filter stations, including a table filter for sand and drum filters for chalk; while Purchas[3] discusses the application of filtration theory to industrial problems.

In the sugar industry, Schoenrock *et al.*[4] have used the specific resistance concept to study the filtration of first carbonatation sludge, while Bennett[5] used it to compare carbonatated liquor filtrabilities. Finally, Thomas[6] applied this basic theory to get a better understanding of the factors influencing the filtration of cane muds.

In view of the usefulness of the specific resistance concept in the situations mentioned above, it was decided to investigate its application to cane mud filtration in South Africa. This paper gives details of the tests performed and the results obtained.

Theory

Filtration usually results in the formation of a cake on the filtering medium. The surface of this cake acts as the filter medium, solids being deposited and adding to the thickness, while the liquor passes through. The flow of liquor through the channels is streamline and may therefore be represented by Poiseuille's equation, in the form[7]

$$\frac{dV}{A\,d\theta} = \frac{P}{\mu\,[\alpha(W/A) + r]} \qquad (1)$$

where the instantaneous rate of filtration per unit area is expressed as the ratio of the driving force, pressure, to the product of viscosity and the sum of cake resistance plus filter medium resistance.

α represents the average specific cake resistance and is a constant for a particular cake in its immediate condition. It is related to the pressure by the expression

$$\alpha = \alpha^1\,P^S \qquad (2)$$

where S is the cake compressibility, varying from 0 for incompressible cakes to 1 for very highly compressible cakes.

W is related to V by the material balance

$$W = w.V = \frac{\rho\,c}{1-Mc}\,.V \qquad (3)$$

For constant-pressure filtration, equation (1) can be integrated to yield

$$\frac{\theta}{V/A} = \frac{\mu\alpha\,w.\,V}{2PA} + \frac{\mu r}{P} \qquad (4)$$

Thus, if $\theta/(V/A)$ is plotted as the ordinate against V/A as the abscissa, a straight line having the slope $\mu\alpha w/2P$ and an intercept on the vertical axis of $\mu r/P$ should be obtained if the slurry investigated follows the above theory. Since μ, w and P are known, α and r can be calculated from

$$\alpha = \frac{2P}{\mu w} \times (\text{slope}) \qquad (5)$$

$$r = \frac{P}{\mu} \times (\text{vertical intercept}) \qquad (6)$$

Two comments need to be made at this stage. First, in the material balance for equation (3), the assumption of constant average cake resistance and the resulting

Nomenclature

A	:	Area of filtering surface, m^2
P	:	Pressure drop, Pa
V	:	Volume of filtrate, m^3
W	:	Mass of dry cake corresponding to V, kg
c	:	Mass fraction of cake solids in feed
M	:	Mass ratio of wet cake to dry cake
r	:	Resistance/unit area of filter medium, m^{-1}
S	:	Cake compressibility
α	:	Average specific cake resistance, $m.kg^{-1}$
α^1	:	Constant
ρ	:	Density of filtrate, $kg.m^{-3}$
μ	:	Filtrate viscosity, Pa.s
w	:	Mass of dry cake solids/unit volume of filtrate $kg.m^{-3}$
θ	:	Time, sec

G. R. E. Lionnet

[1] *Water and Waste Treatment J.*, 1961, 386-389.
[2] *Filtration and Separation*, 1982, 136-142.
[3] *ibid.*, 1980, 147-151.
[4] *Sucr. Belge*, 1979, **98**, 101-106.
[5] *I.S.J.*, 1967, **69**, 101-104.
[6] *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 45-55.
[7] Perry: "Chemical Engineers Handbook." 5th Ed. 1957-1960.

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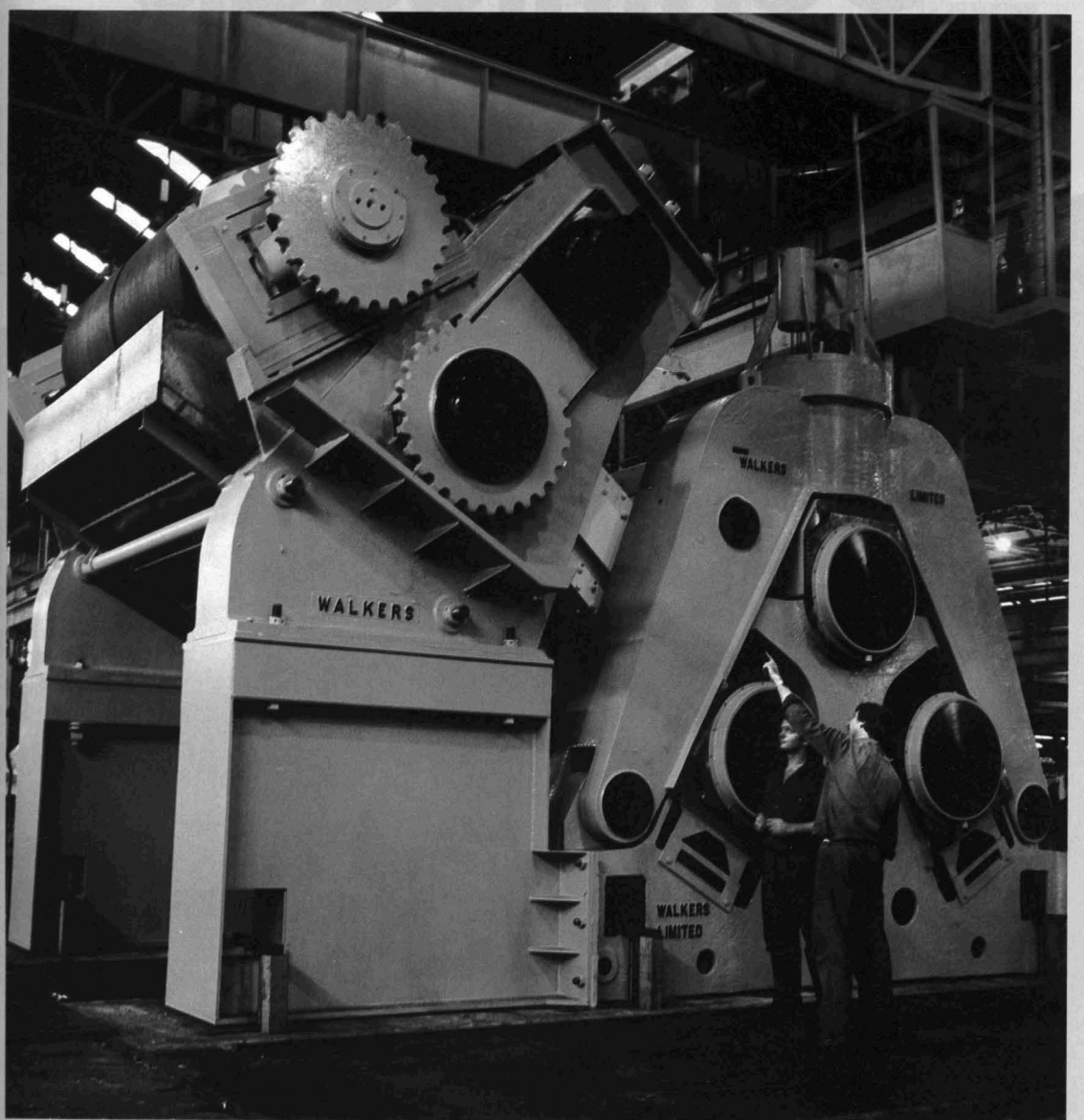

s/c/a/

C.R.M. (Constant Ratio Milling) with the 2 or 3 roller heavy pressure feeder, is the latest in cane sugar engineering out of Walkers Limited, Queensland, Australia.

Manufacturing in sizes ranging up to 1400 x 2750, the C.R.M. "New Breed" is one of the largest crushing mills in the world.

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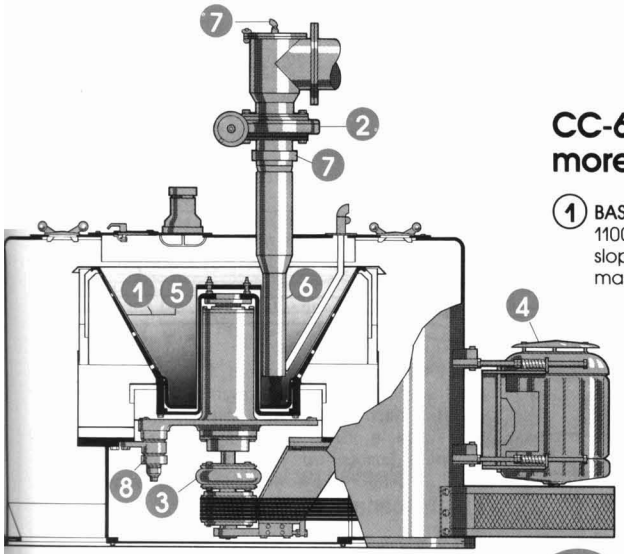

CC-6 features plus proven features for more capacity.....more productivity

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2. **FEED CONTROL** Variable-orifice valve. Automatic or manual setting
3. **BASKET DRIVE** Flexible coupling to spindle
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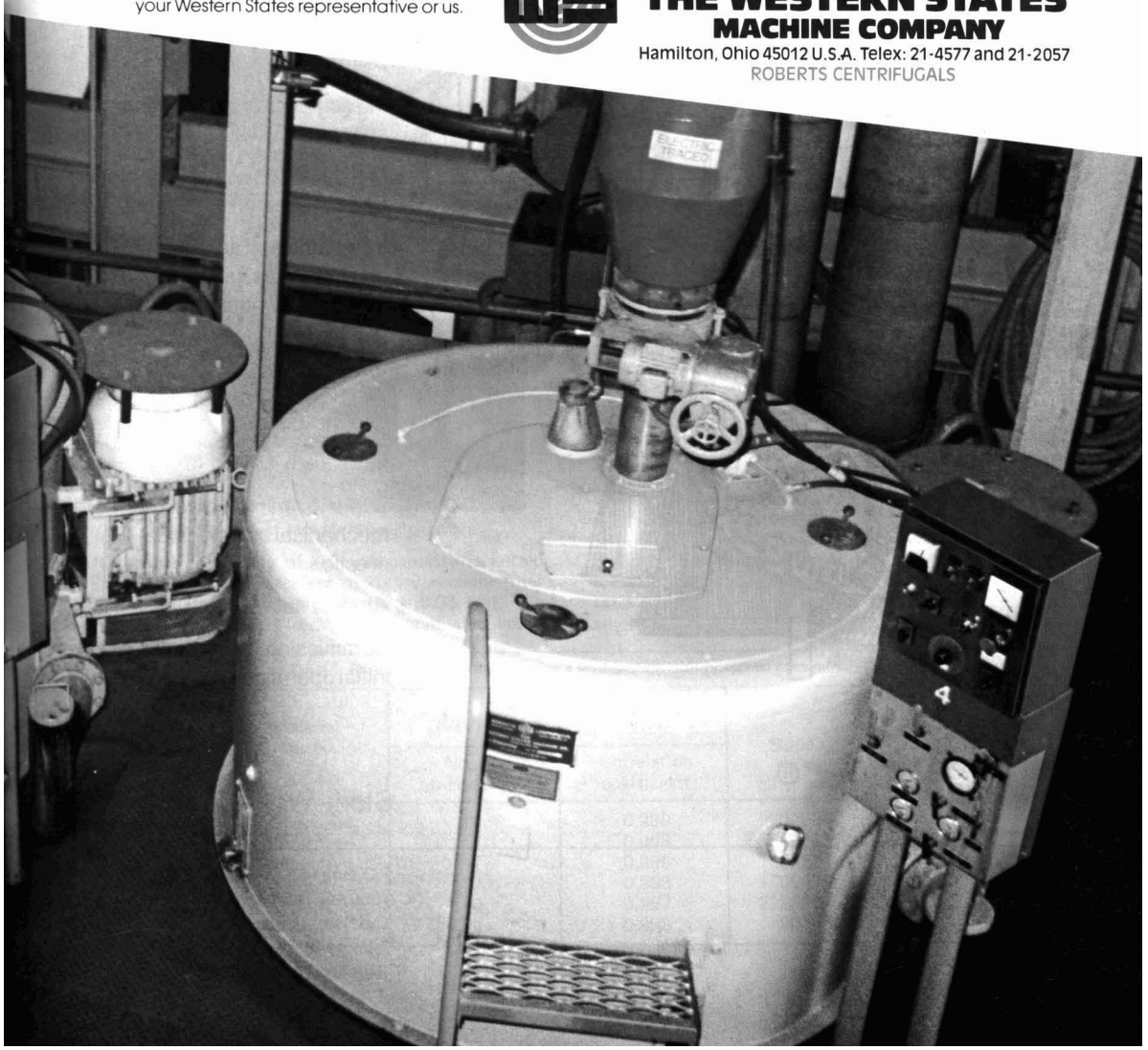

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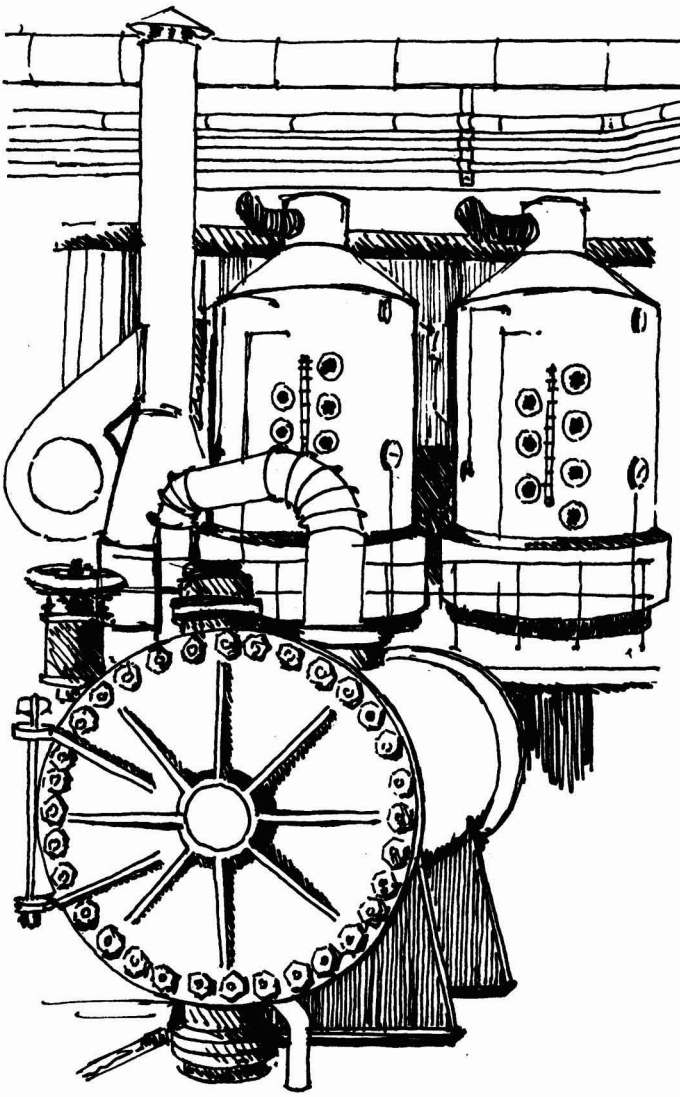

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equations depend for their validity on the premise that the cake is either incompressible or is compacted uniformly throughout its thickness. Compressible cakes do not compact uniformly and therefore violate the assumptions. Perry states, however, that the error is negligibly small for most materials encountered in normal plant practice.

Second, the accurate determination of the intercept, to be used in equation 6, is difficult because of large experimental errors in observing the exact time of the start of filtration and the time/volume correspondence during the first moments when filtration rate is high.

Experimental

The design of the apparatus must be such that the pressure and temperature remain constant throughout the run. Also, since slurries have been found to "age"[2] the tests need to be done at the plants. The apparatus must therefore be easily transportable and assembled. The equipment used is shown in Figure 1.

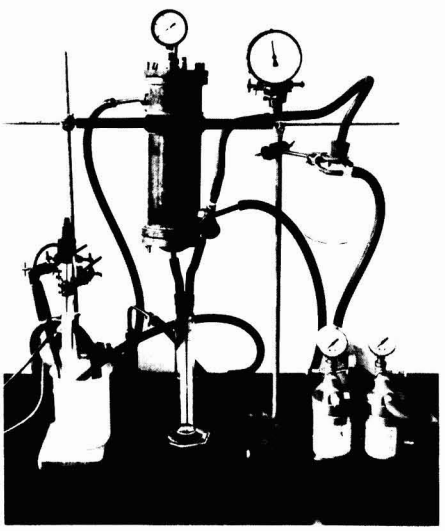


Fig. 1. Equipment used for filtrability tests

It consists essentially of a 2 litre-capacity jacketted cylinder, with a circular piece of rotary vacuum filter screen (95 holes/cm^2; hole diameter = 0.05 cm). The outlet of this cylinder leads into a graduated vessel which is itself connected to a vacuum system. A thermometer may be inserted into the mud for accurate temperature measurement, while the vacuum is set using a precalibrated gauge.

The procedure for a run is as follows:—

(i) The equipment is set up and water at 70°C is circulated through the jacket.

(ii) The vacuum is adjusted at the desired level.

(iii) A metal container, with a lid, is used to obtain a catch sample of about 3 litres of mud or filter feed. The sample is brought to 70°C by placing the container into a water bath at that temperature. Vigorous stirring of mud or feed could damage the floc and must therefore be avoided. A swirling motion is used.

(iv) When the sample has reached 70°C, it is mixed by swirling and poured into the jacketted cylinder. The top of the cylinder is fitted and a digital thermometer probe is inserted into the mud.

(v) The vacuum is switched on and times are read when 10, 20, 30, etc. cm^3 of filtrate have flowed into the graduated container.

(vi) A sample of mud is taken from the sample container for a suspended solids analysis. A sample of filtrate is also needed for viscosity and Brix determinations.

Results and discussion

The suitability of this approach was investigated in a number of factories, both with untreated clarifier mud and with filter feed (i.e. muds treated with bagacillo, lime and flocculant). Some of the results obtained are shown in Table I.

The results for the first sample (May 1982) are plotted in Figure 2.

A number of tests have been carried out in 11 of the 17 South African factories and, in all cases, the correlation coefficients have been very high.

The high correlation coefficients confirm the linear relation, as predicted by equation 4. It is therefore evident that the theory may be applied, at least in principle, to cane muds. It remains to be shown that the variation from sample to sample is small enough to allow meaningful comparisons to be made between different sets of conditions. This was investigated by doing a number of tests at different factories where different conditions prevailed. Some of the results obtained with filter feed are listed in Table II and are shown graphically in Figure 3.

Table I. Results obtained by applying a standard filtrability test to cane muds

Date	Material tested	For plot of $\theta/(V/A)$ *vs.* V/A		Slope	Average specific cake resistance ($m.kg^{-1}$)
		No. of observations	Correlation coefficient		
May 1982	Filter feed	14	0.999	702030	15.9×10^{10}
June 1982	Filter feed	7	0.998	843781	11.3×10^{10}
May 1982	Filter feed	7	0.999	1094694	6.1×10^{10}
June 1982	Mud	7	0.998	1005476	14.7×10^{10}
May 1982	Mud	6	0.997	2283964	12.0×10^{10}
May 1982	Mud	19	0.998	90345	1.1×10^{10}

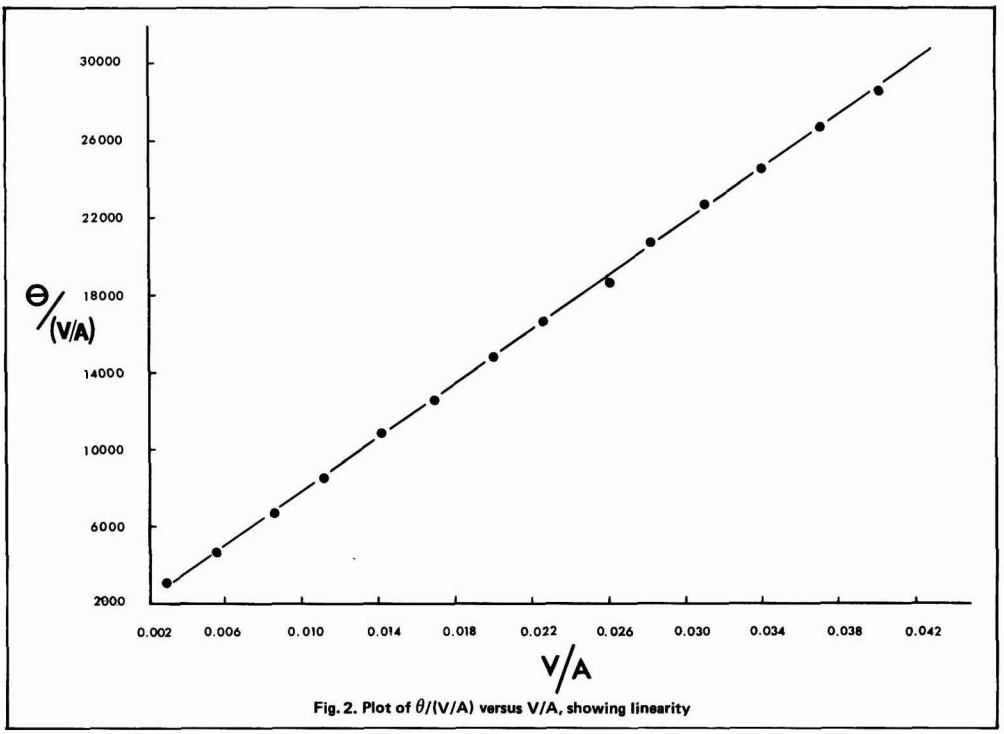


Fig. 2. Plot of $\theta/(V/A)$ versus V/A, showing linearity

Table II. Comparing the results obtained at different factories

Date	Type of factory	Specific cake resistance (Mean ± 5% confidence interval)
Sept 1982	Milling	$5.2 \times 10^{10} \pm 1.9 \times 10^{10}$
Sept 1982	Milling	$5.6 \times 10^{10} \pm 1.2 \times 10^{10}$
Sept 1982	Milling	$19.9 \times 10^{10} \pm 7.1 \times 10^{10}$
Sept 1982	Cane diffusion	$28.9 \times 10^{10} \pm 18.1 \times 10^{10}$
Jan 1983	Cane diffusion	$44.6 \times 10^{10} \pm 17.1 \times 10^{10}$
Jan 1983	Cane diffusion	$50.0 \times 10^{10} \pm 28.1 \times 10^{10}$
Sept 1982	Bagasse diffusion	$30.1 \times 10^{10} \pm 1.0 \times 10^{10}$

It is evident from these results that the variation at any one factory can be large, particularly for the muds from factories employing cane diffusion. It is also evident, however, that the variation between factories can be much larger.

If the concept of specific cake resistance is to apply meaningfully to cane mud, then it must be able to represent correctly, and to quantify, the effects of those factors that are known to influence the filtration of cane muds. For example it must show the improvements to filtration caused by the addition of bagacillo and/or of flocculant to raw muds. This was therefore also investigated. Some of the preliminary results obtained are given in Table III which shows that the specific cake resistance varies as would be expected. It is therefore concluded that the concept may be used to quantify and optimize mud filtrability.

Cake compressibility and its importance to specific cake resistance have been briefly mentioned. Tests were carried out to obtain an indication of the value of S in equation (2) by measuring the specific cake resistance (α) at a number of different vacuum levels (P). A plot of log α *versus* log P should then give a straight line, with slope equal to S. The value of S as determined on filter feed at three different factories, varied from 0.5 to 0.8, with an average of 0.7, which indicates that the feed material is compressible. The results obtained, however, confirm Perry's comment that the error is usually negligibly small.

Conclusion

The concept of specific cake resistance, as derived from basic filtration theory, may be applied to South African cane muds. It could be used to compare the quality of muds or of filter feed, not only to establish seasonal effects which are often claimed to be present by operating personnel without being quantified, but also to measure the effects of diffusion as opposed to milling. It could also be used to investigate mud conditioning in an attempt to optimize filtration, particularly for those muds which are presently causing problems.

The experimental method is relatively straightforward and is reliable if the required precautions are taken. Furthermore, the equipment is simple and each run requires only about 20 minutes. Finally the range of the factors to be investigated may be made as large as required while the levels of each factor may be controlled within small limits, which is usually impossible on a full scale.

Summary

The concept of average specific cake resistance, which is derived from filtration theory and is used to quantify filtrability in a number of industries, is shown to apply

Table III. Using the specific cake resistance concept to measure the effect of adding bagacillo and/or flocculant to mud

No bagacillo; no flocculant	Bagacillo only added	No bagacillo; no flocculant	Flocccculant only added	No bagacillo; no flocculant	Bagacillo and flocculant added
94×10^{10}	8.3×10^{10}	88×10^{10}	15×10^{10}	28×10^{10}	3.2×10^{10}
88 "	13.9 "	36 "	1.7 "	42 "	2.5 "
15 "	2.9 "	15 "	0.8 "	68 "	9.1 "
30 "	13.5 "	30 "	13 "	94 "	18.6 "
				43 "	12.1 "
Mean: 56.8×10^{10}	9.4×10^{10}	42.2×10^{10}	7.6×10^{10}	55.0×10^{10}	9.1×10^{10}

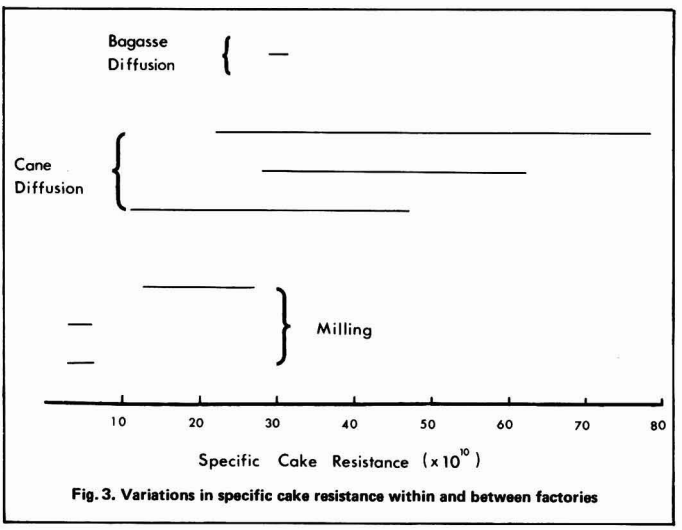


Fig. 3. Variations in specific cake resistance within and between factories

to the filtration of South African cane muds. The equipment used to measure average specific resistance and some of its applications are discussed.

La résistance spécifique des écumes de filtration en Afrique du Sud

On montre que le concept de résistance spécifique moyenne, dérivé de la théorie de filtration et utilisé pour quantifier la filtrabilité dans un nombre d'industries, peut être appliqué à la filtration des écumes de canne en Afrique du Sud. Le matériel utilisé pour mesurer la résistance spécifique moyenne et quelques unes des applications sont discutées.

Der spezifische Filterkuchenwiderstand in südafrikanischen Schlämmen

Das Konzept des durchschnittlichen spezifischen Filterkuchenwiderstandes, der aus der Filtrationstheorie abgeleitet ist, und der verwendet wird, um die Filtrationsfähigkeit in einer Reihe von Industrien zu quantifizieren, kann auf die Filtration von südafrikanischen Rohrschlämmen angewendet werden. Das Gerät für die Messung des durchschnittlichen spezifischen Widerstandes und einige der Anwendungen werden diskutiert.

La resistencia específica de la filtro-torta de las cachazas de Sud-Africa

El concepto de una media resistencia específica de la torta, que se deriva de la teoría de filtración y se usa para cantificar la filtrabilidad en varias industrias, se demuestra aplicable a la filtración de cachaza en Sud-Africa. El aparato empleado para medir la media resistencia específica y algunas de sus aplicaciones se discuten.

CORRESPONDENCE

Honolulu, Hawaii

The Editor, *International Sugar Journal.*

Sir,

The paper "Solution flow and exchange and heat transfer in a heating tube of an evaporation-crystallizer" by Dr. Ing. Klaus E. Austmeyer and Prof. Dr. Dietrich Schliephake in *International Sugar Journal,* 1983, Vol. 85, pp. 328-333, is a highly significant contribution to knowledge of crystallization of sucrose in vacuum pans.

It is my thought that its value would be enhanced and that it would be a service to the practising technologists of the sugar industry if the authors chose to revise the abrupt final paragraph, which states in part, ". . . the original concept of complete survival of the injected particles associated with the slurry seed method is untenable. Reproducibility of this seed method is rendered very doubtful . . ."

To those experienced in sugar boiling it is inconceivable that all, or even a high percentage, of the slurry particles would survive injection into a vacuum pan. Under a given set of controlled conditions, however, the survival is of sufficient statistical significance to provide a useful technique.

Since we standardized the slurry seeding procedure in Hawaii, more than thirty years ago, it has been in continous use and the technique has spread throughout the world sugar industry.

It is our experience that the order of magnitude of the surviving nuclei is about one third of those injected. Of course, the method of slurry preparation is vital. The authors also do not describe their procedure.

Very truly yours,
John H. Payne

BREVITIES

USSR sugar supplies for Afghanistan[1]. — The Soviet Union has agreed to supply Afghanistan with 60,000 tonnes of sugar, 11,700 of which would be covered by low-cost loans. A further 20,000 tonnes of sugar will be provided free. In calendar year 1982 the USSR exported 147,387 tonnes of sugar to Afghanistan.

Aid for the Italian sugar industry[2]. — The Italian government is preparing to set up a 43,000 million lire state holding company to help restructure the domestic sugar industry, according to the Deputy Agriculture Minister. A draft bill to form the state corporation has been circulated to interested ministries and will soon be discussed by the full cabinet. A combination of bad harvests and low prices has pushed several small sugar companies into financial difficulties[3] and the Montesi Group which owns a number of sugar factories called in early October for the appointment of state administrators.

Brazil-USSR sugar deal[4]. — The President of the Brazilian Sugar and Alcohol Institute has announced the signing of a contract with the USSR for the sale of 750,000 tonnes of sugar (350,000 tonnes of refined and 400,000 tonnes of raw sugar) over the period of June 1984. The contract calls for shipment of 100,000 tonnes of refined sugar in December and the remaining sugar in the first half of 1984, at a price to be based on the average price of the New York No. 11 contract for the month prior to shipment. Brazil will not exceed its ISO export with this sale, however, because a shipment of 100,000 tonnes to Venezuela had been cancelled.

Zambia sugar industry plans[5]. — The Commonwealth Development Corporation is to lend up to £3.6 million to Zambia Sugar Co. Ltd. (ZSC) to help it undertake a major rationalization and redeployment of its plant and equipment to meet the growing local demand for sugar products which is expected to outstrip the capacity of its two plants at Nakambala and Ndola in the foreseeable future. As the Ndola refinery is nearing the end of its economic life, refining operations are to be concentrated on the newer factory located on the company's 10,000-hectare cane estate at Nakambala. Expansion of this facility, which is Zambia's only producer, will not only enable it to supply all of the country's needs for refined and non-refined sugar but also allow it to export significant tonnages to neighbouring Zaire, Rwanda and Burundi. This is CDC's third major loan to ZSC and the expansion in refinery capacity will help to back up an interest CDC and the company also have in a new irrigated cane smallholder development nearby.

Barbados government price support for the sugar industry[6]. — The domestic sugar industry, one of Barbados' main hard currency earners, is once again debt-ridden and in need of a government price support scheme to relieve some of the problems. The Agriculture Minister told cane farmers that the industry needs such a policy and informed them that he was prepared to take the matter to the cabinet. The sugar industry, which has been superseded by tourism as the country's main hard currency earner, was given a 14 million Barbados dollars (US $7 million) subsidy in the form of a price support scheme. Although total production is likely to increase to 90,000 tonnes in 1983/84 from 88,378 tonnes in 1982/83, exports will decline from 89,291 tonnes to 78,000 tonnes.

Thailand sugar supplies and export quota[7]. — The International Sugar Organization Executive Committee has postponed until April 1 its decision on Thailand's request for an increase in its export quota which was 200,000 tonnes, raw value, for 1983. It is reported that Thailand may leave the ISO after the present International Sugar Agreement expires if the request for additional export entitlement is not met. Although Thailand successfully reduced cane production by 24% in the 1982/83 season, the country's sugar output, after deducting local consumption, was still higher than the quota allocated by the ISO.

Mauritius sugar exports, 1983[8]

	1983	1982
	tonnes, tel quel	
Canada	14,997	13,563
Comoro Is.	100	0
Finland	0	12,258
France	132,461	107,483
Ghana	3	0
New Zealand	13,300	0
Seychelles	498	175
UK	419,557	432,638
US	27,119	30,713
Total, tel quel	608,035	596,830
Total, raw value	643,592	632,599*

* As reported to the International Sugar Organization.

West Germany sugar production, 1983/84[9]. — According to the preliminary report published by the West German Sugar Association, 1983/84 sugar production fell to 2,703,583 tonnes, raw value, against 3,580,035 tonnes last campaign. Additionally, some 20,000 tonnes will be produced by desugarization of molasses. White sugar output totalled 2,053,466 tonnes against 2,727,130 tonnes in 1982/83, while raw sugar production fell to 493,830 tonnes from 566,496 tonnes in the previous campaign. Beet deliveries totalled 16.3 million tonnes in 1983/84 against 22.7 million tonnes in 1982/83 but the sugar content was higher at 17.16% *vs.* 16.15%. The beet area has been reduced from 428,602 ha in 1982 to 403,104 ha in 1983, and the average beet yield was 40.3 tonnes/ha against 52.9 in 1982/83.

Tasaconex 84. — This is a short title for the Tropical and Subtropical Agriculture Convention and Exhibition which will take place at Ardingly, Sussex, England, during July 18-20, 1984. The program will include papers on biological control, plantation crop production, plant breeding for the future, post-harvest handling and storage of plant products, marketing of agricultural products, financing of agricultural projects, etc. The convention is limited to 300 participants and further information is available from Fairlight World Seminars, 15 Sussex Chambers, Havelock Road, Hastings, Sussex TN34 1DE, England.

International Dextran Workshop. — In a Workshop sponsored by Sugar Processing Research Inc., to take place in New Orleans during October 19 (following the 1984 S.P.R.I. meeting of October 16-18) in response to the increasing worldwide interest in problems associated with dextrans in sugar production, experts will hold discussions on the following areas of dextran problems and solutions: Field and cane delivery; Factory and cane yard; Bactericides, enzymes and chemical additives; and Refinery and customer problems. There will also be a final general session for exchange of results and ideas and the opportunity for informal discussions among participants. Technologists, scientists and all interested parties involved in sugar and cane production, manufacture and refining, and suppliers to the industry are invited to participate. The registration fee for the Workshop is $250 per person (waived for personnel of S.P.R.I.-sponsoring companies). Further details are available from S.P.R.I., Box 19687, New Orleans, LA 70179, U.S.A. (Telephone 504-589-7037).

US molasses trade. — In January the US International Trade Commission published a supplement to its molasses trade and tariff information summary, originally published in August 1981. The supplement reveals that US imports of molasses increased slightly from 1.1 million short tons to 1.2 million tons between 1980 and 1982; the value fell, however, from $95 million to $64 million. Exports declined from 298,000 to 277,000 tons during the period, the values being $29 and $21 million, respectively. Molasses production increased from 2.2 to 2.4 million tons in 1981 and then declined to 2.2 million tons in 1982. Mainland consumption mirrored this, rising from 2.7 million tons in 1980 to 3.0 million tons in 1981 and falling to 2.8 million tons in 1982; the trend was caused mainly by price trends in the US and world sugar markets.

1 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 592.
2 *Reuter Sugar Newsletter*, October 13, 1983.
3 See *I.S.J.*, 1983, **85**, 226.
4 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 594.
5 *Standard Chartered Review*, November 1983, 9-10.
6 *World Sugar J.*, 1983, **6**, (5), 33.
7 *Standard Chartered Review*, January 1984, 34.
8 *Mauritius Sugar News Bull.*, 1983, (12).
9 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 29-30.

Thailand sugar exports, 1983[1]

	1983	1982
	tonnes, tel quel	
Algeria	0	10,000
China	86,831	521,494
Comoro Is.	700	0
Egypt	44,406	0
Hong Kong	2,986	2,000
Indonesia	42,499	63,925
Japan	632,378	356,968
Korea, South	159,023	93,250
Laos	810	2,625
Madagascar	10,500	0
Malaysia	85,740	99,615
Morocco	83,000	68,000
New Zealand	20,000	15,000
Philippines	123,210	0
Saudi Arabia	20,900	35,685
Singapore	1,550	0
Sri Lanka	66,328	6,800
Tunisia	12,000	0
USA	14,800	276,441
USSR	125,848	409,247
	1,533,509	1,961,050

US sugar ingredient labelling. — The Sugar Association Inc. in Washington, DC, has applied to the Food and Drugs Administration Commissioner to rule that "sugar" in an ingredient label means sucrose, derived from cane or beet. With the increasing use of starch-based sweeteners, beverages are being labelled as containing sugar which have no sucrose content or contain sucrose mixed with other sweeteners which are not identified by their common or usual name. FDA policy, reaffirmed as recently as April 1983, is that "sugar" on a food label means sucrose but the Sugar Association's petition is intended to ask the FDA to take the necessary steps to protect consumers and sugar manufacturers and prevent further deception.

West Indies Sugar Technologists Conference in 1985. — Sugar technologists are invited to participate in the 1985 meeting of the West Indies Sugar Technologists to be held in Trinidad during March 3-7. Submission of papers for discussion at the meeting will be warmly welcomed. Business sessions will be at the Hilton Hotel in Port-of-Spain while field tours will be arranged for delegates. Further information is available from Mr. I. D. Lawrie, Caroni (1975) Ltd., Brechin Castle Estate, Couva, Trinidad.

Brazil-Japan sugar contract[2]. — The Brazilian Sugar and Alcohol Institute has reached agreement with a Japanese company to ship 100,000 tonnes of raw sugar annually from 1984 to 1986 inclusive.

Swaziland sugar industry[3]. — Sugar production is the main agricultural activity in Swaziland and the country's biggest industry. Over the period of the third National Development Plan (1977/78-1982/83) cane production increased by 63%. With the completion of the third sugar factory (Simunye) in 1980, the total capacity of the industry rose to approximately 405,000 tonnes. Local consumption is small (20,000 tonnes), 120,000 tonnes have a secure market in the EEC each year under the Lomé Convention, and the balance of 265,000 tonnes is sold on the world market. The 1982/83 crop is estimated at 373,000 tonnes, some 5% down on the previous year, because of drought.

Spanish sugar production target, 1984/85[4]. — The Spanish Ministry of Agriculture has set a production target of 8.15 million tonnes for the 1984/85 sugar beet crop, sufficient to produce about 1,060,000 tonnes of sugar. The target for 1983/84 was 9.2 million tonnes of beet and actual output is estimated at 8.45 million tonnes. The reduction in the target is intended to meet domestic demand while avoiding a surplus which would be expensive to store and costly to export at prevailing world prices.

EEC price increase accepted by ACP exporters[5]. — The African, Caribbean and Pacific sugar producers have now accepted the price increase of 4% offered for their exports by the European Economic Community for the current marketing year which commenced on July 1, 1983. Prices will thus be in line with the price increase for the Community's beet sugar producers. The ACP countries have expressed disapproval of the style of the "negotiations" which they do not see as real, since their production and transport costs are not considered.

Uganda sugar complex rehabilitation[6]. — The International Finance Corporation (IFC) has confirmed it will lend $8,000,000 towards the $75 million rehabilitation of the Lugazi sugar complex sited 40 km east of Kampala in Uganda. The decision follows a recent pledge of $8 million from the Arab Bank for Economic Development in Africa. Co-financing has been agreed by India ($2.6 million), the African Development Bank ($17 million), the International Development Association ($3.7 million) and the Kuwait Fund for Arab Economic Development ($10 million). The Lugazi sugar complex is operated by Uganda Sugar Corporation, a joint venture of the Uganda government (51%) with the Mehta Group (49%) which have injected $2.3 million and $4 million, respectively, to strengthen the USC equity base. The project, due for completion in early 1985, will create more than 6000 jobs and is hoped to satisfy domestic demand. It will rehabilitate the USC 9182-hectare cane estate by clearing 2722 ha of overgrown fields and the drainage systems in 1800 ha of swamp, and by replanting the entire cane area. The corporation hopes to rebuild the entire complex and install a 2000 tonnes/ day sugar refinery. On completion of the complex annual foreign exchange savings of $8.7 million should result.

EEC supply quotas for India and the Ivory Coast[7]. — The EEC Council of Ministers has approved the granting of a quota of 10,000 tonnes to India as a supply quota; this is a partial restoration of its original quota of 25,000 tonnes which was cancelled completely some years ago and may be supplied during the current season up to June 30, 1984. The Ivory Coast has been awarded a supply quota increase of 10,000 tonnes; however, only 2000 tonnes is deliverable this season.

Brazil-China sugar barter deal[8]. — Brazil is reported to have signed a deal with China for the supply of 35,000 barrels of oil per day in exchange for Brazilian petrochemicals and commodities including sugar and soya. The five-year deal was to come into force in 1984.

IFC finance for sugar projects[9]. — The International Finance Corporation, the investment bank affiliate of the World Bank, invested $70.41 million in loans and equity in 14 new agribusiness projects during the fiscal year ended June 30, 1983. In addition, the Sugar Corporation of Uganda Ltd. received $75 million for the development of a sugar factory and plantation and Fiji Sugar Corporation Ltd. received $25.5 million for developing sugar factories and storage facilities. The National Corporation for Corn Sweeteners in Egypt received $74 million for the development of high fructose corn syrup production.

Cuban sugar season delay[10]. — Only 11 of the Cuban sugar factories had started operations in the 1983/84 season by November 21 when it had been planned that 23 would be in operation. The delay was due to wet weather which affected several regions.

Peru sugar output drop[11]. — Raw sugar production in 1983 was expected to reach only 450,000 tonnes, representing a drop of 130,000 tonnes from the previous year. The main factor behind the decline was the damage caused by flooding earlier in the year. Without the floods, production would probably have reached 700,000 tonnes but instead Peru has had to import at least 210,000 tonnes of raw sugar.

Improved USSR beet crop[12]. — Soviet sugar beet procurements in 1983 are expected to have totalled 74 million tonnes, up from the 1982 level of 64,148,000 tonnes, according to the US Agricultural Counsellor in Moscow. The majority of regions in the USSR are reported to have experienced favourable conditions in 1983 for high beet yields and sugar production and it is not impossible that extraction rate could be 0.5% above the 10.6% of 1982/83. On a basis of 11.1% extraction, white value, and a 74 million tonnes crop, USSR beet sugar production could be about 8.2 million tonnes, white value, or 8.9 million tonnes, raw value. This is substantially higher than the latest estimate of 8.4 million tonnes by F. O. Licht GmbH.

1 C. Czarnikow Ltd., *Sugar Review,* 1984, (1684), 15.
2 *Reuter Sugar Newsletter,* November 17, 1983.
3 *Abecor Rpt.,* November 1983.
4 *World Sugar J.,* 1983, **6**, (6), 34.
5 F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 624.
6 *World Sugar J.,* 1983, **6**, (6), 35.
7 F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 624-625.
8 *Reuter Sugar Newsletter,* November 3, 1983.
9 *World Sugar J.,* 1983, **6**, (6), 33, 36.
10 F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 629.
11 *World Sugar J.,* 1983, **6**, (6), 36.
12 F. O. Licht, *International Sugar Rpt.,* 1984, **116**, 30-31.

CANE SUGAR MANUFACTURE

A study on vacuum pan performance at Sudhono sugar factory. P. Carebet. *Maj. Perusahaan Gula,* 1979, **15,** (1/2), 11-19 *(Indonesian);* through *S.I.A.,* 1983, **45,** Abs. 83-575. — The performance of vacuum pans used for boiling *A*-massecuites were compared. Two old calandria pans (Nos. 3 and 4) both have automatic control of boiling; No. 4 also has automatic vacuum control. Pan 4 gave a higher recovery (66.8% *vs.* 63.2%) and lower syrup % massecuite than pan 3, although the cooling time in the crystallizer was shorter. Less wash water % massecuite was used during centrifugalling (1.5% *vs.* 2.1%) and the *A*-sugar pol was lower (96.4 *vs.* 96.9). The crystals tended to be smaller but more uniform in size. Two old coil pans, No. 5 with automatic control and No. 6 without, were compared. Pan 5 gave massecuites with cleaner, larger and more uniform crystals, which resulted in faster centrifugalling, less wash water % massecuite being required and higher Brix syrup; in other respects the performance were similar.

Steam economy in a sugar mill: a review according to its fuel consumption. —. Istadi. *Maj. Perusahaan Gula,* 1979, **15,** (3/4), 67-74 *(Indonesian)* through *S.I.A.,* 1983, **45,** Abs. 83-574. — The function of steam is to convey heat from the fuel which is burned in the boiler to the place where heat is to be used. The steam economy of cane sugar factories is examined from the points of view of boiler efficiency and steam quality, and of the most economical use of steam in multiple-effect evaporators and juice heaters.

Natural convection, two-phase flow, and crystallization in a vacuum pan sugar crystallizer. J. J. Bunton. *Ph. D. Thesis* (Louisiana State University), 1981, 331 pp; through *S.I.A.,* 1983, **45,** Abs. 83-717. — A mathematical model of a vacuum pan for sugar boiling is developed. It is based on the fundamentals of the physics of two-phase flow. Because of the complexity of the model, a digital computer should be used to obtain a time-dependent solution. The model generates profiles of velocity, pressure, temperature and supersaturation, in response to the operating conditions and the design of the pan. The object is to enable the effects of pan design, control systems and operating conditions on the crystal size distribution of the product to be studied. The emphasis is on the development of numerical methods; the numerical code employs a dynamic grid system designed for free surface flows, and is compatible with viscous two-phase flows in the pan. The modelling equations are two-dimensional for the volume above the calandria, but elsewhere one-dimensional and lumped equations are used. The development of a distributed population balance equation from velocity and growth rate profiles is discussed. Sensitivity studies in which pan design and operating conditions were varied demonstrated that, in the cases studied, the factors which most affected pan performance were the volume fraction of crystals, level in the pan, heat load, pan pressure and whether or not the major diameter of the pan was flared. These factors were considered significant on the basis of their effects on the velocity and growth profiles, and on the maximum, minimum and average supersaturation.

Characteristics, treatment of waste water from khandsari sugar units. B. V. S. G. Rao, V. Kothandaraman and C. A. Sastry. *Indian J. Environmental Health,* 1981, **23,** (4), 288-299; through *S.I.A.,* 1983, **45,** Abs. 83-732. In-plant surveys were carried out at four typical khandsari sugar units. Volumes and characteristics of the types of effluent from each unit are tabulated. Effluent volumes ranged from 0.8 to 1.2 litres/kg sugar produced; most of it came from washing of filter bags. The composite effluent had pH 3.7-5.2 and BOD 18,000-25,500 mg/litre. Settling for 3-4 hours decreased the BOD by about 25% and the suspended solids by 84%. The effluent could then be treated in a two-stage anaerobic lagoon, followed by an aerated lagoon or oxidation pond; alternatively, after the primary anaerobic lagoon it could be treated in an extended aeration system. In each case the final BOD was 25-35 mg/litre.

Optimum velocity for juice circulation in clarified juice heaters. II. Technical economic aspects. A. Valdes D. *CubaAzúcar,* 1981, (April-June), 3-6 *(Spanish).* — Pilot plant trials, designed to allow for differences of scale, were carried out whereby heat transfer coefficients and hydraulic pressure drops were measured for varying juice velocities between 1.5 and 3 $m.sec^{-1}$. Economic aspects were considered, on the basis of a working life for the equipment of 15 years. High juice velocity raised the heat transfer coefficient and permitted a smaller surface area, but required additional expenditure on energy to provide a higher pressure. From these two considerations an optimum velocity of 1.2-1.5 $m.sec^{-1}$ is recommended for juice heater design.

Filter-cake as corrosion inhibitor. R. Mondui and R. Caro. *CubaAzúcar,* 1981, (April-June), 16-20 *(Spanish).* The maximum effect — a reduction of steel corrosion to one-eleventh — was found when 2% of cachaza was added to boiling 3% HCl, additional cachaza providing no benefit. The effect was a reduction of acid corrosion and it did not provide inhibition of increased corrosion resulting from the presence of additional Cl^- ions. The inhibitory fraction in the filter-cake contains basic N in its molecular structure and is predominantly adsorbed chemically onto the surface of the steel. When other inhibitors or vinasse is not available, cachaza may be used as a corrosion inhibitor in the acid used for evaporator scale removal.

Influence of mechanochemical treatment on the electrochemical behaviour of some steels. J. C. Bango B. *CubaAzúcar,* 1981, (Oct.-Dec.), 12-15 *(Spanish).* — A laboratory study was made of the electrochemical behaviour of two lathe-machined steels in the presence of a synthetic cane juice. It is concluded that sucrose exerts a protective action which increases with Brix.

Chemical method for retarding the deterioration of sugar industry products. I. Alkaline treatment of syrups. J. A. Urrutia, E. L. Ramos and L. R. Orozco. *CubaAzúcar,* 1981, (Oct.-Dec.), 16-22 *(Spanish).* — By bringing syrup to a constant alkaline pH for some time, the raw sugar produced has a higher pH, greater buffer action and lower amino-acid content, leading to less deterioration in storage. The factor F (buffering power divided by amino-acids content) is linearly related to the stability D of the sugar (the time required for induction of deter-

ioration) and may be used as a means of assessing the efficiency of treatment.

Study of the factors which affect the velocity of boiling in the raw sugar manufacturing process. J. A. Bordón, E. Díaz and J. A. Léon. *CubaAzúcar,* 1981, (Oct.-Dec.), 30-36 *(Spanish).* — Trials were carried out to determine the effects on low-grade boiling rate of viscosity, purity, ash, gums, crystal content and crystal size, and these effects expressed in the form of similar equations, a table of the relative coefficients being provided, and the relationships being expressed in graph form.

Calculation of the optimum conditions of operation of a multiple-effect evaporator. H. Pérez A. and O. Jiménez C. *CubaAzúcar,* 1981, (Oct.-Dec.), 37-41 *(Spanish).* — The second computational linkage of a simulation executive program using the Powell optimization method, subject to restrictions, is presented. It is exemplified by calculating the optimal operating conditions of a quadruple-effect evaporator, ensuring that economy has a desired value without making simplifying assumptions. Some results are illustrated which permit, among other things, appreciation of the convenience of taking advantage of clear juice preheating.

Use of radio-isotopes in the area of crystallization and the determination of the distribution of surface-active agents in it. J. Delgado, J. Lodos and S. López R. *CubaAzúcar,* 1981, (Oct.-Dec.), 47-51 *(Spanish).* — A 20 millicurie source containing radio-active iodine was added to massecuite at the same time as surface-active agent and the pattern of detection with time shown to follow Gaussian distribution curves for all sampling points along the crystallizer at which radioactivity was measured. The peaks were smaller as the sampling points were further along the crystallizer from the feed, as was to be expected, and it is concluded that the method can be used for the study of problems related to flow and retention time in crystallizers.

The influence of surface-active agents on the velocity of evaporation of pure and impure sucrose solutions. R. González Q. and J. Lodos F. *CubaAzúcar,* 1982, (Jan.-March), 3-10 *(Spanish).* — Laboratory tests showed that addition of two surface-active materials (Espumol C and Espumol I) increased the rate of evaporation of pure sucrose solutions of 30-60°Bx, and the latter also had a positive effect with impure solutions of low Brix. Industrial tests showed that heat transfer and evaporation efficiency ($kg.m^{-2}.min^{-1}$) were improved by Espumol C, B and E, the first of these giving the best performance.

Waste waters and their treatment. A. Guillermo. *CubaAzúcar,* 1982, (Jan.-March), 46-52 *(Spanish).* Methods for reducing excessive quantities of waste water produced in a sugar factory are discussed, as are the principles and methods of treatments of such effluents.

Colour development in clarification and evaporation. E. Rubio. *CubaAzúcar,* 1982, (April-June), 29-32 *(Spanish).* — Colour measurements in the various trays of a 5-tray clarifier, repeated 20 times, showed practically no differences apart from a slight tendency to a darker colour in the last tray. Comparison of colour of juice, pre-evaporator juice and syrup confirmed the increase in colour during evaporation; over 20 samples, the average clarified juice colour of 4.49 units % Brix rose to 6.14 units in the pre-evaporator and reached 24.87 units % Brix in syrup.

Study on the influence of surfactants on the surface tension, contact angle and evaporation of sucrose solutions and final molasses. J. Lodos F., I. Díaz A. and E. González. *CubaAzúcar,* 1982, (July-Sept.), 8-14 *(Spanish).* — Reductions in surface tension of 50%-30% for concentrations of 25-70°Bx, respectively, and in contact angle (about 15°), using Espumol C and Espumol D, are in line with the marked increases obtained in evaporation rate (approximately 100% at 100 ppm).

Determination of the surface of an evaporator with different expressions for the overall transfer coefficient. L. Hernández C. *CubaAzúcar,* 1982, (July-Sept.), 15-19 *(Spanish).* — In the designing of an evaporator, in order to calculate the heating surface required, it is necessary to know the overall heat transfer coefficient which depends, inter alia, on the juice Brix and temperature and heating steam temperature. Values reported in the literature are expressed as a function of juice Brix and steam temperature or juice Brix and temperature, and they have been used to derive overall heat transfer coefficients. These have been used to calculate heating surfaces for a quadruple effect which are compared with values obtained from capacity indexes for the sugar industry published by the Cuban Ministry of Sugar.

Preliminary study of colorants in direct white sugar obtained by use of Colactivita. M. Blanco C., V. Prieto and J. Pérez Z. *CubaAzúcar,* 1982, (July-Sept.), 51-55 *(Spanish).* — Colactivita is a lignite-based decolorizing material and has been used to produce white sugar directly from cane juice. Colorants in solutions of this sugar and raw sugar produced from the same juice were separated by use of adsorbent resins, eluted and examined by U.V. spectroscopy to identify the groups present.

Analysis of a more efficient heating-evaporating-boiling system for Central Pablo Noriega. G. González M. and C. Vázquez B. *CubaAzúcar,* 1982, (Oct.-Dec.), 3-10 *(Spanish).* — From a survey of available alternatives it is concluded that the most efficient evaporation system to use at Central Pablo Noriega is a quintuple-effect with bleeding from the first three vessels to provide all the vapour needed for heating of mixed and clarified juices and for the pans. For mixed juice heating a three-stage system is preferred since this permits easy installation and the use of existing equipment.

Cane quality and factory performance. S. J. Clarke. *J. Amer. Soc. Sugar Cane Tech.,* 1983, **2,** 46-48. — The quality of cane processed by a raw sugar factory is a major determinant of its efficiency and capacity. Both mill extraction and boiling house performance are adversely affected by cane of inferior quality. Various quality parameters have been suggested for mill performance, mainly based on the character of the fibre in the cane. It is pointed out that, while factors such as dirt content, staleness, etc., affect processing, they are additional to the intrinsic nature of the cane and that selection processes in cane breeding are usually based on agricultural criteria — diseases resistance, yield, etc. — and not on fibre and juice characteristics related to factory performance. Such criteria are suggested, including pith:fibre ratio, node proportion, etc., in respect of fibre, and ash content, organic acids and phosphate, etc., in respect of juice.

BEET SUGAR MANUFACTURE

The sugar industry is Syria. S. Sadek. *Gaz. Cukr.*, 1983, **91**, 130-131 *(Polish)*. – A brief account is given of the seven sugar factories, together with their year of construction, daily slice and type of diffuser, and information is given on beet agronomy. Performance data for the 1982 campaign are presented.

(Trends in) Use of optimizing methods in the sugar industry. Z. Pierscionek. *Przem. Spozyw.*, 1982, **36**, (7/8), 271-273 *(Polish)*; through *S.I.A.*, 1983, **45**, Abs. 83-593. – Discussion of mathematical programming (simulation) as the best way to optimize stages of beet processing includes its application to transport of beet and sugar, number, location and size of beet reception points, date for start and end of the campaign at a particular factory, and deciding between alternative plans for developing the industry.

Intensifying the heat- and mass-exchange processes of beet sugar manufacture in order to increase the sugar yield. L. I. Trebin, I. G. Bazhal and L. A. Kupchik. *Promyshlennaya Teplotekhnika*, 1982, **4**, (4), 45-48 *(Russian)*; through *S.I.A.*, 1983, **45**, Abs. 83-619. – It is noted that, if the average crystal size in final massecuite is larger (e.g. 0.6 rather than 0.5 mm), the liquid phase can have a higher viscosity (e.g. 93 rather than 71 poise) without impairment of centrifugalling; water addition during or after crystallization can be decreased (e.g. from 3% to 2% on massecuite) leading to lower molasses yield and purity (by e.g. 0.35% on beet and 2.4 units, respectively). A 15-25% increase in M.A. can be obtained by means of temperature fluctuations during boiling and crystallization. Increasing M.A. from 0.38 to 0.44 mm decreased sugar loss in molasses from 2.05 to 1.9% on beet.

Possibility of using pipes made of ferritic chromium steels in sugar industry evaporators. T. S. Devyatkina, I. A. Permyakova, I. K. Klebanova *et al. Zashchita Metallov*, 1982, **18**, (4), 650-653 *(Russian)*; through *S.I.A.*, 1983, **45**, Abs. 83-626. – The corrosion behaviour of ferritic chrome steel 08Kh18Tl, untreated or annealed from 760 or 900°C for 1 hour, was compared with that of carbon steel St3 and austenitic steel 08Kh18N10T, towards possible contacting media. In boiling thick juice at pH 8.5, corrosion rates ($mg.m^{-2}.hr^{-1}$) were 7-25 for untreated samples, and 5-8 for the 760°-annealed, compared with 330-740 for St3. In 3% HCl without inhibitor, the untreated sample lost 468.5 $g.m^{-2}.hr^{-1}$ and the 760°-annealed lost 14.45 $g.m^{-2}.hr^{-1}$, compared with 416.9 for St3 and 9 for the austenitic steel; inhibitor KhOSP decreased these to 4, 1.34, 3.1 and 1.31, respectively. In 10% HCl with inhibitors, the ferritic steel, whether treated or not, corroded faster than St3. Some voltage-current graphs are interpreted.

Study of the characteristics of supercavitating pumps for chemical reactors with circulation loops. A. F. Nemchin. *Khimicheskoe Mashinostroenie* (Kiev), 1980, **32**, 82-90 *(Russian)*; through *S.I.A.*, 1983, **45**, Abs. 83-627. Advantages of supercavitating pumps for reactors with circulation loops are discussed. A mathematical solution is provided to optimizing radial distribution of circulation for minimum inductive losses, via variation of gap and extent of cavitation. Graphs for selection of the most appropriate supercavitating pump for a task are presented. A main defecator with inbuilt supercavitating pump is shown; by comparison with existing plant at Yagotin, this defecator caused more extensive degradation of non-sucrose yet only a quarter as much sucrose loss, thanks to a shorter residence time, and juice colour was lower by up to 30%.

Selection of the power of ultrasonic equipment for reduction of foam formation. M. N. Chepurnoi, V. E. Shnaider, I. M. Fedotkin and M. I. Klimenko. *Izv. Vuzov, Pishch. Tekh.*, 1983, (2), 121 *(Russian)*. – Preliminary investigations showed that the major factor affecting the intensity of scale deposition in an evaporator was the relative velocity of movement of the scale-forming particles suspended in the juice. Application of acoustic vibrations to the main stream of these particles gave a system which could be regarded as a superimposed undisturbed and an acoustic stream. Analysis of this system gave an equation for calculation of particle movement, from which it was possible to find the relationship between (1) the relative speed of the particles and (2) the physical properties of the particles and of the juice carrying them as well as between (1) and the intensity of ultrasonic radiation. A computer was used to calculate the relative viscosity of particles of varying size in a juice flowing along a 30-mm diameter pipe and exposed to an ultrasonic field of varying intensity. The effect of the field was greater the lower the initial velocity of the juice and the greater the intensity of the sonic field; increase in particle size and density caused a reduction in the effect. A nomogram was drawn showing the relationship between coefficient of scale formation and length of evaporator operating time, juice physical properties and ultrasonic vibration intensity; from this it is easy to establish optimum levels of ultrasonics and thermal parameters of evaporation.

Anaerobic treatment of waste water from a beet sugar factory. I. Treatment of recycling flume water. S. Oikawa, K. Maekawa and Y. Saito. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 81-85 *(Japanese)*. Anaerobic treatment of beet flume water with activated sludge was carried out on a laboratory scale using a stirred vessel for upflow treatment, followed by a clarification tank. Results showed that no nutrient had to be added; that about 40 days was needed for acclimatization of the sludge, using digested sewage sludge as seed; that BOD reduction exceeded 90% at a loading of 10 kg BOD per m^3 per day; that a sudden change in load did not affect normal treatment; that there was very little surplus sludge; that the Sludge Volume Index was below 20 $mg.ml^{-1}$, so that separation of sludge from effluent was easy; and that gas containing more than 60% methane was produced that could be used as fuel.

Use of process computers in the sugar industry. J. Krolop, R. Kleinwächter and K. D. Pauschke. *Lebensmittelind.*, 1983, **30**, 276-277 *(German)*. – Details are given of a Robotron PRS 4000 process computer installed at Güstrow sugar factory in East Germany for purposes of data generation as well as direct process control. The system is used for the daily sugar balance determination and has been applied to evaporator control using a PR

2100 computer for data handling, for which process analysis had to be undertaken because of the lack of previous experience of computerized control of this station. The evaporator control system is described; establishment of a mathematical model, based on the control scheme and designed for optimization of the evaporation process, is also outlined. Some advice is given on the use of a process computer, and the major advantages are listed.

Sugar storage in silos. VIII. Experimental study of moisture limits in crystal sugar. S. Sormova, O. Mikus and V. Kavan. *Listy Cukr.*, 1983, **99**, 131-135 *(Czech).* Experimental data obtained from measurement of the effect of relative humidity on refined sugar friability are discussed; samples of different size fractions and quality were examined. Semi-quantitative evaluation was also made of the effect of granulometry and of the ash content on equilibrium relative humidity. The results serve as guidelines for temperature and moisture conditions in unventilated silos used for long-term storage of sugar.

Improvement of the process for treatment of water for diffusers based on impurity classification. I. A. Oleinik. *Sakhar. Prom.*, 1983, (6), 11-13 *(Russian).* — The adverse effect of untreated press water on diffusion is discussed and advice given on methods of treatment according to the size range of the impurities, which are grouped into four categories: coarse particles and bacteria; organomineral complexes and viruses; volatile substances, gases, organic impurities and certain products of microbial action; and cations, anions, other organic impurities and further products of microbial action. Virtually all means of physico-chemical separation are included.

Method of controlling the raw juice purification process by varying the temperature in hot main liming. N. A. Arkhipovich and L. I. Tanashchuk. *Sakhar. Prom.*, 1983, (6), 13-15 *(Russian).* — For degradation of a maximum quantity of invert sugar and removal of the degradation products, so as to ensure a thermostable juice in evaporation, it is recommended to adjust the temperature of hot liming to accord with the initial invert content in the raw juice. Recommended temperatures are given for invert contents in the range 0.1-1.5%, based on empirical equations relating reaction rate constants to temperature and time.

A device for juice withdrawal from a diffuser. N. S. Karpovich, B. A. Melent'ev, V. S. Dan'shin, G. K. Gorskii, M. A. Totkailo and V. N. Usychenko. *Sakhar. Prom.*, 1983, (6), 20-22 *(Russian).* — Problems created by poor quality cossettes in a tower diffuser, e.g. prevention of normal percolation of juice and disruption of the thermodynamic and temperature conditions, are discussed. A continuous system designed by the authors involves a special juice withdrawal device which comprises an eccentric rotating camshaft which opens a juice aperture once per rotation and allows juice to flow out of the diffuser to a holding tank whence juice is recirculated to the tower. The hourly withdrawal rate is 25-30 m^3 of juice. The device is attached to the fixed baffles about half-way up the tower, while the port for re-entry of the juice is at a point diametrically opposite. Tests have shown that the system allows the diffusion screens to be regularly flushed with juice so as to move adhering pulp, while removal of juice, even for a short while, can be used to raise the temperature within the diffuser and particularly in the prescalding section.

PKR rotary machines for white sugar screening. S. I. Temper, S. M. Lantsman and L. K. Gorskii. *Sakhar. Prom.*, 1983, (6), 24-26 *(Russian).* — Details are given of a 16-rpm rotary sugar screen with a rated hourly throughput of 40 tonnes.

The effectiveness of using pan vapour to heat raw juice. V. N. Gorokh, A. A. Knyazev, B. F. Us and K. O. Shtangeev. *Sakhar. Prom.*, 1983, (6), 26-30 *(Russian).* Factors influencing the effectiveness of using pan vapour to heat raw juice are examined, and equations and a nomogram are presented for determination of vapour consumption for process requirements as a function of the scheme. Use of a contact heater for a raw juice is less successful than a surface heater since it always leads to an increase in steam usage; the greatest saving in steam with a surface heater is achieved when the required Brix is reached in evaporation without final-effect vapour discharge to the condenser — the thick juice Brix should not fall further than 1° for every 5°C rise in the temperature of raw juice heated by pan vapour. However, for maximum economy, use of reheat steam from the fourth evaporator effect for raw juice heating should not be discontinued.

Reducing the consumption of sodium chloride for chemical treatment of water used in sugar factory power houses. V. N. Plemyannikov, L. P. Ignat'ev and V. A. Shelikhovskii. *Sakhar. Prom.*, 1983, (6), 30-32 *(Russian).* — Methods for storage of salt used to regenerate cation exchange resins for boiler feed water treatment are discussed in an examination of ways of improving process economy. Causes of high losses in resin regeneration are also examined and remedial measures considered. One effective method discussed is liming of raw water which has a high carbonate content.

Experiment on storage of washed beet under industrial conditions. V. A. Chubukin, B. V. Zaichikov, N. M. Sapronov and S. P. Dzezhkevich. *Sakhar. Prom.*, 1983, (6), 38-40 *(Russian).* — Washed beets of poorer quality than the unwashed beets used as control were stored in a ventilated pile for 39 days in October-December and found to lose less sugar (daily and overall) than the control whilst having juice of much higher purity. However, it is stressed that results from just one campaign are insufficient to warrant making any recommendations, particularly since both weather conditions and beet quality can differ from one year to another.

Noise problems for sugar factories within the approval procedure laid down under the federal emission prevention law. K. H. Uppenkamp. *Zuckerind.*, 1983, **108**, 621-623 *(German).* — When the older sugar factories in West Germany were constructed, many were isolated from towns and villages and so had no effect on the inhabitants. In the meantime, however, with development of urban areas, the factories have become surrounded by residential areas and thus subject to strict regulations concerning, inter alia, noise abatement. By means of examples, the author explains the procedures for seeking and obtaining official approval for any fundamental change involving sugar factory equipment and noise levels, and indicates where the applicant has to be wary of misinterpretation of the law to his disadvantage.

SUGAR REFINING

A vacuum-type heat exchanger for recovering heat from boiler flue gas. M. Takimoto and Y. Azuma. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 60-62 *(Japanese).* — A vacuum-type heat exchanger for recovery of boiler flue gas heat is described as having a high heat exchange efficiency and high corrosion resistance. It permits daily production of 600 tonnes of hot water having a temperature of 80°C from feed water at 50°C, representing a heat recovery of 18,000 x 10^3 kcal per day.

Some trials for saving electric power costs at a sugar refinery. T. Aki and K. Arai. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 63-66 *(Japanese).* At the authors' refinery, the centrifugals had consisted of one D.C. motor-driven machine, nine machines driven by pole-change motors, six by wound rotor types and eight driven by squirrel-cage motors. In 1980, fourteen centrifugals of the old type were replaced by four machines driven by D.C. motors in order to reduce power consumption. As a result, the number of blowers needed for motor cooling was cut from four to two, while eight 3200 kVA transformers were replaced by two 4000 kVA transformers. As a consequence, electricity consumption was decreased from 93 to 81 kWh per tonne of raw sugar. In addition, an automatic power factor regulator for the transformers increased the average power factor from 96% to more than 99%. The amount of electricity purchased from the utility was reduced, and a total annual saving of 27 million yen was achieved.

On the waste water plants for a sugar refinery. K. Tasaki, H. Suzuki and H. Makino. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 67-74 *(Japanese).* Since March 1981, Kawasaki refinery has operated the bulking free process (BFP) for activated sludge treatment of waste water, and the pellet blanket system (PBS) for flocculation as a third stage. The BFP has provided good sludge for sedimentation, giving a Sludge Volume Index of <80 ml.g^{-1} and a MLSS of about 80,000 mg.litre^{-1}. as a result, the plant could operate at a BOD load of 0.15 kg per kg/day, and normal treatment was unaffected by fluctuations in the feed load. Settling by PBS was at a high rate, and a total BOD removal of 99.9% was achieved. At Shibaura refinery, a trickling filter was installed for waste water treatment in 1978. Features of the Flocor module include its light weight, biological and chemical inertness, large surface area and high voidage. BOD removal of 99.9% has been obtained.

On the waste water treatment in a sugar refinery by a deep tank-type injector aeration system. S. Murakoshi. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 75-80 *(Japanese).* — The activated sludge treatment used at Kawasaki refinery of Taito Co. Ltd. is described and its performance discussed. The aeration system used was one developed by Bayer AG, while a pressure-flotation system was also installed for a higher degree of treatment. Reasons for the adoption of the activated sludge process included the strict requirements of the public authorities, a high oxygen supply efficiency (up to 2.5-3.0 kg. O_2/kWh), low space requirements, and the possibility of operating the deep aeration tank at two levels (depths of 5 m and 10 m), so that after the campaign a blower of lower power consumption can be used. The system includes a number of surge tanks. The waste water is first divided into high- and low-COD effluent, and the fractions fed to different surge tanks from which they are transferred to the aeration tank; this permits easy control of the feed within a narrow COD range, while the overall volume capacity of the surge tanks is at most half that of a conventional system with only one surge tank. The COD of the low-COD waste water is continuously monitored by an auto-analyser; if the high-COD waste water mixes with it accidentally, the low-COD waste water is automatically switched to the surge tank for the high-COD effluent. The air injection system provides uniform fine bubbles of 0.12-0.15 mm diameter, and oxygen availability is high. In July 1981, when the installation was first operated, COD reduction of 93.2% was achieved from an average initial content of 210 mg.litre^{-1} and a maximum of 400 mg.litre^{-1}. Power consumption was 1800 kWh per day during the campaign and 800 kWh per day during the post-campaign period. All results are better than expected.

Affination and a chloride ion selective electrode. H. Manso J., R. Cuervo F. and A. Rodríguez A. *CubaAzúcar,* 1982, (July-Sept.), 3-7 *(Spanish).* — With a view to verifying the possibility of using a chloride ion electrode for control of raw sugar affination, 43 raw sugar samples as well as their affination liquors were analysed for different non-sugars. It was found that the chloride ion undergoes a wide variation during affination whilst giving the smallest dispersion of the non-sugars studied. Comparison of ideal affination of raw sugars taken at random with their actual industrial affination results demonstrated that cases of over- and under-affination are not rare in refinery operation. Various preliminary proposals are made of methods for installing a chloride ion measuring system for affination liquor as part of an affination control scheme.

Thermal stability of ozonized liquor. M. Hernández, R. Pérez, M. Gómez and R. Ramos. *CubaAzúcar,* 1982, (July-Sept.), 35-39 *(Spanish).* — Clarified refinery liquor was treated with ozone and its colour found to be reduced. The treated liquors were filtered and held at different temperatures for four hours, using as a control untreated liquor which had been filtered. It was found that at 60°C the colour of both liquors increased slightly as did reducing sugars content, while at 80° and 90°C the increases were greater in the treated liquor, being markedly greater at the higher temperature.

Diversification of the sugar industry by the production of liquid sugar. I. Galban D. and A. R. Sapronov. *CubaAzúcar,* 1982, (Oct.-Dec.), 11-19 *(Spanish).* — An account is given of the production of liquid sugar in various places and the most widely used scheme described which converts raw sugar through a refining process, it is mentioned that invert syrups may also be manufactured using ion exchange resins for catalysis of the inversion. Liquid sugar could be used within Cuba in place of crystal refined sugar and considerable savings are considered possible by eliminating the boiling house part of the process.

LABORATORY STUDIES

Determination of the phosphate content in sugar solutions. H. Gruszecka. *Gaz. Cukr.*, 1983, **91**, 86-87 *(Polish).* — The significance of phosphorus in sugar beet is discussed, and typical ratios of inorganic to organic P found in cane raw sugar, juice and molasses are indicated. Two methods are described for determining phosphate in juices and other intermediate products as well as water; both are based on measurement at 650 nm of the intensity of colour formed by reaction of phosphate and a reagent mixture which in one case consists of ammonium molybdate, sulphuric acid and stannous chloride, while in the other the stannous chloride is replaced with hydrazine sulphate. Both methods are suitable.

Determination of nitrates in molasses and molasses vinasse (for yeast production). L. D. Il'ina and N. G. Sitnik. *Fermentnaya i Spirtovaya Prom.*, 1981, (2), 6-7 *(Russian);* through *S.I.A.*, 1983, **45**, Abs. 83-704. — A method based on nitration of salicylic acid to give picrate is described; it takes 15 min, is accurate to ± 5%, and detects 2 μg NO_3^-. A 2 g quantity of molasses or 5 ml of vinasse is diluted with 15 ml water and refluxed 3 min with 0.5-0.8 g activated carbon and then filtered; to 1 ml of filtrate, in an ice-bath with constant stirring, is added 3 drops of ethanolic 10% salicyclic acid, 1 ml conc. sulphuric acid (slowly), and then 12-15 ml 12% NaOH; after 5 minutes the yellow-green colour is measured in a 1 cm cell, at 440 nm or with a blue filter. Calibration is performed using KNO_3 solutions containing 100-800 mg NO_3^- per litre. In the Ukraine in 1976/77, nitrate content was 0.05-0.16% in molasses and 0.02-0.075% in vinasse.

Contaminant yeasts of sugar cane products in Sri Lanka. A. W. Liyanage, M. R. Hettarchchi and P. M. Joyatissa. *J. Food Sci. Technol.* (Mysore), 1982, **19**, (6), 270-272; through *S.I.A.*, 1983, **45**, Abs. 83-707. — Yeasts were isolated from samples of jaggery (crude sugar lumps), molasses and cane syrups in Sri Lanka. Twenty-two strains were identified, belonging to the genera *Sporobolomyces, Candida, Torulopsis, Saccharomyces, Brettanomyces, Kluyveromyces* and *Hansenula.* The predominant species was *Saccharomyces cerevisiae,* of which ten strains were found.

Effect of glucose and fructose impurities on sucrose crystallization. M. N. Dadenkova, R. S. Burdukova and A. I. Shishlovskaya. *Fizika Zhidkogo Sostoyaniya*, 1982, (10), 142-144 *(Russian);* through *S.I.A.*, 1983, **45**, Abs. 83-797. — The angular distribution of light intensity is shown for sucrose solutions of supersaturation 1.01 containing 0, 2.5, 5 or 10% fructose or glucose on sucrose, after stirring for a preset time. The lower intensities observed with increasing impurity concentration indicate smaller non-homogeneities and thus slower crystallization. Average particle sizes are calculated, e.g. 121 nm for the pure solution, 95 nm for 10% fructose impurity and 25 nm for 10% glucose.

A kinetic study of the nucleation and growth of sucrose crystals in a continuous cooling crystallizer. R. W. Hartel. *Ph.D Thesis* (Colorado State Univ.), 1980, 188 pp; through *S.I.A.*, 1983, **45**, Abs. 83-796. — Studies on crystallization kinetics in the sucrose-water system are reported. Washout experiments of seed crystals in a continuous crystallizer indicated that a supersaturation of about 1.12 was required for secondary nucleation to occur at 53°C with mean residence 12.5 min. This critical value of the supersaturation decreased with increasing residence time and operating temperature. Activation energy for crystal growth, calculated from the Arrhenius equation, was 12.3 kcal/mole in the temperature range 40-54.5°C. Surface integration of growth units appeared to be the dominant mechanism of sucrose crystal growth, although volume diffusion may have had some influence on overall growth rate. Nucleation rate changed by about the 1.5 order in supersaturation, and was linearly related to crystal suspension density. The latter relation indicates that crystal-object rather than crystal-crystal collisions were the major source of secondary nucleation. Activation energy for secondary nucleation was calculated to be 18.2 kcal/mole. The relation between crystal size and growth rate was also investigated.

Complex formation in the system calcium hydroxide — sucrose — water. L. P. Reva, A. E. Arkhipets, L. G. Belostotskii and R. P. Mishchuk. *Izv. Vuzov, Pishch. Tekh.*, 1983, (2), 38-41 *(Russian).* — Since, in a limed sugar solution, the number of Ca^{++} ions will correspond to a given number of OH^- ions on the principle of electro-neutrality, any fall in the equilibrium concentration of the Ca^{++} ions must indicate the existence of a complex cation. To confirm this, the authors set out to calculate the concentration of the complex cation from the difference between the hydroxyl ion concentration and the known equilibrium concentration of Ca^{++}, given the pH of the solution. From the fact that the Ca solubility found at 0°C was close to that found by cryoscopic investigations and published in the literature, and from the close agreement between the enthalpy of formation (constant at 273-333°K) and the value found by thermochemical studies (also published in the literature), it is concluded that complex formation does take place. The stability constant of the complex $[Ca(C_{12}H_{22}O_{11})_4](OH)_2$ has been calculated at different temperatures.

On the melting point of sugar crystals. T. Nagai. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 9-11 *(Japanese).* — Coarse Crystal Superior (CCS) sugar, prepared from desalted liquor, had a lower melting point than the same type of sugar produced by the usual refining process. CCS sugar was prepared from three different types of liquor: from desalted liquor, from desalted liquor to which NaCl + KCl, $CaCl_2$ and Na acetate, respectively, had been subsequently added; and from non-desalted liquor. Coarse granulated sugar of 12-14 mesh from desalted liquor was used as seed. The 12-mesh CCS was analysed for m.p., conductivity ash and moisture. In all cases the m.p. of the outer region of the crystal was higher than that of the inner region, and the differences for the different liquors were smaller than in the case of the values for the outer region. Addition of salts tended to raise the m.p., but the highest value was that for the outer region of the crystal prepared from non-desalted liquor. No relationship was found between moisture content and m.p.

BY-PRODUCTS

Optimization of feed medium for *Saccharomyces cerevisiae* yeasts. Yu. P. Pechyulis and Ya. G. Radvilavichyute. *Izv. Vuzov, Pishch. Tekh.*, 1983, (2), 54-57 *(Russian).* — Experiments on bakers' yeast manufacture from molasses cultured with *S. cerevisiae* O are reported. Results showed that a relatively high molasses concentration, coupled with a long fermentation time, obviated the need for biocatalysts such as biotin and diaminopimelic acid (since there were sufficient in the molasses) as well as nitrogen and phosphorus. Even with a reduction in the fermentation time, the quantities of additives required were still relatively small in the presence of a high molasses concentration. Best results were a biomass yield of 46.2-54.7 g.litre^{-1} after 30 hours fermentation at an initial molasses concentration of 97.5 g.litre^{-1}.

Fermentation of molasses wort with a high dry solids concentration. V. N. Shvets, V. A. Baklan, V. P. Kolesnik and N. I. Pereguda. *Izv. Vuzov, Pishch. Tekh.*, 1983, (2), 80-83 *(Russian).* — Molasses of 79% dry solids and 51.8% sucrose content (53.1% fermentable sugars) was subjected to alcohol fermentation with yeast of strain V-30. An ethanol yield greater than 10% by volume was obtained, which result was in close agreement with earlier prolonged tests at a distillery using V-30 yeast.

Semi-continuous production of high alcoholic solution through fermentation accompanied by extraction from sugar cane chips in a novel immobilized bioreactor. S. Fukushima and K. Yamade. *Proc. 2nd Energy Conservation Conf.*, 1982, 969-973; through *S.I.A.*, 1983, **45**, Abs. 83-750. — The bioreactor had two parts: (a) a tubular extraction unit packed with cane chips of 2-4 mm diameter, (b) a rhomboid fermentation unit, connected to the top of the tubular unit and packed with 1-1.5 mm particles of Al alginate and entrapped yeast cells as biocatalyst. Extraction and fermentation were carried out batchwise under anaerobic conditions at pH 2.5 and 30°C, the solution being circulated through the two units. For each batch, the extraction unit was replaced by a new unit packed with fresh chips. The ethanol-containing solution was mixed with juice pressed from the spent cane and re-used. After 7 cycles using dried cane chips, a 16% w/v ethanol solution was obtained. The ethanol yield was 93% on sugar in cane.

Rapid continuous alcohol fermentation of cane juice in a novel bioreactor packed with immobilized mixed cells. S. Fukushima and H. Hatakeyama. *Proc. 2nd Energy Conservation Conf.*, 1982, 989-993; through *S.I.A.*, 1983, **45**, Abs. 83-751. — Juice was extracted from fresh cane or cane stored at 0°C. It was fermented in a 3-stage bioreactor under anaerobic conditions at pH 2.8 and 30°C. The bioreactor contained Al alginate particles entrapping a mixture of *Saccharomyces cerevisiae* Montrachet and *S. formosensis* M-111, which gave better results than either organism alone. In continuous runs, solutions containing 9.5 and 5.3% w/v of ethanol were produced with residence times of 4.5 and 3.2 hours, respectively, from juice containing 198 g/litre of sugars as monosaccharides. Better results were obtained with juice from fresh rather than stored cane. The system was operated continuously for more than 24 days without contamination occurring.

Integrated fodder-ethanol complex (IFEC). M. Sinner, —. Schreier and A. Ballweg. *Proc. 2nd Energy Conservation Conf.*, 1982, 984-988; through *S.I.A.*, 1983, **45**, Abs. 83-752. — A proposed complex which would use cane or sweet sorghum is described. The material would be coarsely crushed and fed to a thermal treatment vessel maintained at about 110°C by direct application of steam; juice would be separated from the fibrous matter by counter-current washing on a filter-conveyor. The fibre would be steamed at 180°-190°C for 10-20 min, increasing its digestibility to 55-65%. The juice, containing sugars from inversion of sucrose and degradation of polysaccharides, would be fermented to ethanol; yeast and concentrated vinasse from this process would be added to the steamed fibre which would be fed to cattle in a feed-lot. In addition there would be sufficient bagasse to generate steam and power for the whole complex.

Culture of *Candida* in vinasse and molasses: effect of acid and salt addition on biomass and raw protein production. S. M. Tauk. *Eur. J. Appl. Microbiol. & Biotechnol.*, 1982, **16**, (4), 223-227; through *S.I.A.*, 1983, **45**, Abs. 83-756. — Seven species of *Candida* were grown in media consisting of 3% molasses and/or pure vinasse, or vinasse plus various additives. Biomass outputs and protein contents are tabulated.

Studies on the fermentation of chopped sugar cane. I. Alli and B. E. Baker. *Anim. Feed Sci. Technol.*, 1982, **7**, (4), 411-417; through *S.I.A.*, 1983, **45**, Abs. 83-760. Tests were carried out with a view to the preservation of cane for use as fodder. With freshly harvested and chopped cane (whole plant) in laboratory silos holding 600 grams. The pH decreased rapidly during the first 24 hours fermentation. After 10 days the fermented cane ("canelage") contained about 9% ethanol on dry solids; water-soluble carbohydrates (WSC) had decreased from 52% to 3.6% and acid detergent fibre (ADF) had increased from 30% to 43%. Cane which had lain in the field for 48 hours before chopping and ensilage contained 37% less WSC than fresh cane. "Canelage" prepared by 10-day fermentation of this wilted cane had a similar composition to that from fresh cane. "Canelage" prepared in a commercial horizontal silo contained, after 53 days, 0.8% ethanol, 7.29% WSC, 2.68% crude protein, 1.15% acetic acid, 1.60% lactic acid and 42.4% ADF on dry solids.

Binderless lignocellulose composite from bagasse and mechanism of self-bonding. F. Mobarak, Y. Fahmy and H. Augustin. *Holzforschung*, 1982, **36**, (3), 131-135; through *S.I.A.*, 1983, **45**, Abs. 83-775. — The self-bonding of air-dry bagasse and bagasse pith during hot-pressing in a closely-fitting mould was studied. The pith fraction, which causes great trouble in the manufacture of paper or fibreboard, gave a dense, plastic-like product superior to those obtained from whole or depithed bagasse. Bending strength up to 130 N.mm^{-2} and water absorption as low as 10% were obtained at 25.5 MPa moulding pressure and 175°C. Increasing the initial moisture content of pith from 7 to 14% gave poorer strength and water resistance, while the reverse applied to depithed bagasse.

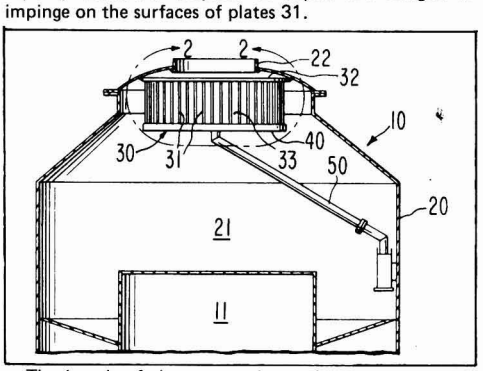
PATENTS

UNITED STATES

Beet juice colour removal. K. Shinbori, Y. Sugimoto, T. Ando and S. Sakai, *assrs.* Toyo Soda Mfg. Co. Ltd. and Japan Organo Co. Ltd. **4,264,373.** July 17, 1979; April 28, 1981. – The juice is brought into contact at 40°-100°C (60°-80°C) with an adsorbent which removes colour, the adsorbent being a dehydrated solid co-precipitated substance formed by insolublizing metallic compounds in an aqueous solution containing Ca and/or Mg and Al and/or Fe. The adsorbent may be regenerated by contact with an aqueous solution of inorganic salt (carbonate, sulphate or phosphate salts) and heating to 750°-950°C (800°-900°C). The adsorbent may be added in granular form to the juice and then removed or it may be used in the form of a column through which the juice is passed.

Evaporator entrainment separator. C. B. Almond, of Birmingham, AL, USA, *assr.* Envirotech Corp. **4,262,411.** September 13, 1979; April 28, 1981.

Within the vapour dome of an evaporator body and secured to the upper part of the dome near vapour exit 22 is an entrainment separator in the form of an annular plate 32 and a solid, slightly dished plate 30 from the lowest point of which a drain tube 50 conducts separated liquid into a suitable pot located in the vapour dome, from which it overflows into the body of the liquid being evaporated. Between plates 30 and 32 are a series of radial, vertical corrugated plates 31 so arranged that there is no straight-line path for vapour to pass from outside to the interior of the separator; since gaps 33 between adjacent plates 31 form the only passages for vapour, entrained droplets of liquid are obliged to impinge on the surfaces of plates 31.



The length of the corrugations raises the velocity of the vapour compared with direct linear passage and this aids separation; it must not be so high that the droplets are carried off the plates 31 by shear entrainment, however. A vertical wall 40 around the separator serves to retain the separated droplets which then drain to tube 50.

Calcium oxalate scale removal (from sugar factory evaporators). M. Kotake, T. Mori and K. Hayakawa, of Funabashi, Japan, *assrs.* Nissan Chemical Industries Ltd. **4,264,463.** December 15, 1978; April 28, 1981. – See UK Patent 2,011,480[1].

Solvent for cellulose extraction (from bagasse). G. T. Tsao, B. E. Dale and M. R. Ladisch, *assrs.* Purdue Research Foundation, of West Lafayette, IN, USA. **4,265,675.** October 3, 1979; May 5, 1981. – See UK Patent Application 2,018,777[2].

Animal feed block. L. V. Skoch, B. G. Harmon, C. W. Dickerson and N. S. Chou, *assrs.* Ralston Purina Co., of St. Louis, MO, USA. **4,265,916.** January 23, 1979; May 5, 1981. – (22-65% of) Molasses, (0-25% of) nutritive ingredients, (1-10% by weight of) a (water-soluble) phosphorus source [(5-10% of) ammonium polyphosphate or (1-5% of) tetrasodium pyrophosphate], (0.5-5% of) water-absorbent clay and [2-4% (2%) of] ferrous sulphate are mixed with [(5-30% of) fat and] [3½-15% (4%) of] finely-ground MgO having a surface area $>11\ m^2.g^{-1}$ (at least $20\ m^2.g^{-1}$), under high-speed shearing action [for 8 sec-3 min (15 sec-3 min)] to give a nutrient mixture which solidifies to a hard, weather-resistant block containing Fe, P and Mg in a molar ratio between 1:0.3:10 and 1:0.9:12.5.

Recovering and utilizing cellulose (from bagasse) using sulphuric acid. G. T. Tsao and T. Y. Chou, of West Lafayette, IN, USA, *assrs.* Purdue Research Corporation. **4,266,981.** October 3, 1979; May 12, 1981. – Cellulosic material (e.g. bagasse) is treated with dilute (sulphuric) acid under mild conditions to hydrolyse only the hemicellulose portion. The hydrolysed hemicellulose is removed from the solid residue and this blended with (0.2-5 ml/g of) concentrated (60-90%) sulphuric acid under mild conditions (at room temperature) to dissolve and partially hydrolyse the cellulose portion while leaving the lignin unaffected. (97% of) The cellulose is then precipitated from the separated sulphuric acid solution by addition of [0.5-5 volumes (2-5 volumes of] water and/or a water-soluble organic solvent (methanol). The acid is then concentrated for recycling while the precipitated cellulose is easily hydrolysed to glucose (using a dilute acid or enzymes).

Method for the chromatographic separation of soluble components in feed solution. K. Yoritomi, T. Kezuka and M. Moriya, of Chiba, Japan, *assrs.* Sanmatsu Kogyo Co. Ltd. **4,267,054.** April 23, 1979; May 12, 1981. Chromatographic separation of components A and B (glucose and fructose) in a mixture by means of their differential adsorption on a solid adsorbent having ion exchange or molecular sieve action, is achieved by sequentially introducing the feed mixture and a liquid desorbent into a column packed with the solid adsorbent and collecting the effluent in four fractions: (a) rich in component A which is relatively less adsorbed (glucose), (b) a mixture of component A and incrementally increasing proportions of component B (fructose) which is relatively more adsorbed, (c) a fraction rich in component B, and (d) a dilute fraction of the tail part of

[1] *I.S.J.*, 1983, **85**, 91.
[2] *ibid.*, 92.

Copies of specifications of United Kingdom patents can be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price £1.75 each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).

fraction (c) and the leading part of the next cycle of fraction (a). Fractions (b) and (d) are returned directly to the column and fresh feed solution added at the point of maximum concentration of A and B or where the ratio of A to B is the same as that in the feed. Fresh desorbent liquid is added where the concentration of A + B is lowest. Fractions (a) and (c) are recovered separately.

Support matrix for immobilized enzymes. (A) R. P. Rohrbach, of Forest Lake, IL, USA, *assr.* UOP Inc. **4,268,419.** November 16, 1979; May 19, 1981. (B) R. P. Rohrbach and M. Maliarik, *assrs.* UOP Inc., of Des Plaines, IL, USA. **4,268,423.** November 16, 1979; May 19, 1981.

(A) A polyamine binding layer (amino-polystyrene or polyethylene imine) is deposited on an alumina support in an aqueous solution, excess polyamine removed and the alumina support dried to provide a final water content of 1-30% (1-10%) on weight of the support. The dried support is brought into contact with a solution containing an excess of glutaraldehyde to provide cross-linkage with the polyamine, and the support then recovered for immobilization of an enzyme (glucose isomerase, etc.).

(B) (At least 5% on weight of support of) The polyamine layer, comprising polyethylene imine, tetraethylene pentamine, ethylene diamine, diethylene triamine, triethylene tetramine, pentaethylene hexamine, hexamethylene diamine or phenylene diamine, is deposited on an inorganic oxide (alumina, silica, glass or ceramic) support matrix in the presence of a cationic or non-ionic surfactant having a surface tension < 30 dynes/cm (an organic solvent), excess polyamine removed and the coated support matrix treated with a solution containing an excess of a bifunctional monomeric material (glutaraldehyde, succindialdehyde or toluene diisocyanate) to provide cross-linkage and leaving a free functional group which is capable of covalently bonding to an enzyme. The support may then be used for immobilization of enzymes (glucose isomerase, etc.).

Immobilization of enzymes of bacterial cells. I. Kaetsu, M. Kumakura and M. Yoshida, of Takasaki, Japan, *assrs.* Japan Atomic Energy Institute. **4,272,617.** July 16, 1979; June 9, 1981. – Enzymes and/or bacterial cells are immobilized by forming an aqueous mixture with a hydrophobic vitrifiable monomer in an amount of 76% of all monomers present and irradiating with ionizing radiation at $< -10°C$ ($-100°C$ to $-25°C$) to polymerize the monomer (butanediol, pentanediol, hexanediol, heptanediol; ethoxyethyl, methoxyethyl, acetoxyethyl, benzyl, phenyl, cyclohexyl, trimethylol propane, trimethylol butane, 2-ethylhexyl or neopentyl glycol acrylates, methacrylates or dimethacrylates, or mixtures of these).

Process for obtaining pressed beet pulp with high dry substance content. T. Cronewitz and H. Schiweck, of Worms, Germany, *assrs.* Süddeutsche Zucker-AG. **4,273,590.** February 19, 1980; June 16, 1981. – Beet pulp is mechanically pressed and mixed with a solution of one or more salts of polyvalent cations and acids [$CaCl_2$, $Al_2(SO_4)_3$, $AlCl_3$ or $FeCl_3$] [0.5-10% (1.5-4%) on weight of the pulp dry solids], so as to lower the pH [to 2.5-5 (3.5-4.5)], the pulp re-pressed and the expressed liquid [concentrated by evaporation and (partly)] recycled [with addition of further salt(s)] while the pH of the pressed pulp is raised to 6-8 by addition of $Ca(OH)_2$ or NaOH before drying.

Removing potassium salts from vinasse. A. Robertiello and L. Degani, of Roma, Italy, *assrs.* ENI Ente Nazionale Idrocarburi. **4,273,659.** September 12, 1979; June 16, 1981. – See UK Patent Application 2,030,127[3].

Immobilized glucose isomerase. T. Yoshioka, K. Teramoto and M. Shimamura, of Ohtsu, Japan, *assrs.* Toray Industries Inc. **4,275,156.** January 22, 1980; June 23, 1981. The enzyme is immobilized (as a 2000-50,000 U/g product) on an organic polymeric material [in the form of a fibre, particles or a film (a fibre)] comprising at least 50% by weight of a monovinyl aromatic compound (styrene, α-methyl styrene, vinyl toluene, vinyl xylene or chlorostyrene) in polymerized form, the compound having, as a side-chain, a β-aminopropionamidomethyl group [0.5-5 (2-5) meq/g of the polymer], of structure NR_1R_2-CHR_3-CHR_4-CO-NR_5-CH_2- where R_1 is H, a C_1-C_6 alkyl, a C_2-C_6 hydroxyalkyl, R_2 is a C_1-C_6 alkyl or C_2-C_6 hydroxyalkyl, phenylmethyl or a C_1-C_6 alkyl-substituted phenylmethyl, NZ_1Z_2-$(CH_2)_n$-where Z_1 and Z_2 are H or a C_1-C_6 alkyl and n = 2-6, R_3, R_4 and R_5 are all either H or CH_3, and the R_1R_2N may be a heterocyclic structure having a 6-membered ring of which position 1 is occupied by N and position 4 by CH_2, O or NR_6 where R_6 is H or a C_1-C_6 alkyl group. The balance of the polymer is an organic polymeric material (a polyolefine, polyamide, polyester or a co-polymer of these) and the enzyme may be cross-linked with an agent (glutaraldehyde, dialdehyde starch, tolylene di-isocyanate or hexamethylene di-isocyanate) capable of cross-linking with a protein. Fructose in an isomerized product obtained using the immobilized enzyme is preferentially adsorbed on an aluminosilicate zeolite and then desorbed.

Preparation of high fructose syrups from sucrose. R. E. Heady, of Argo, IL, USA, *assr.* CPC International Inc. **4,276,379.** June 9, 1978; June 30, 1981. – See UK Patent Application 2,077,269[4].

Method and apparatus for the analysis of saccharides. W. Walraven, of Breda, Holland. **4,278,438.** April 17, 1979; July 14, 1981. – See UK Patent 2,019,564[5].

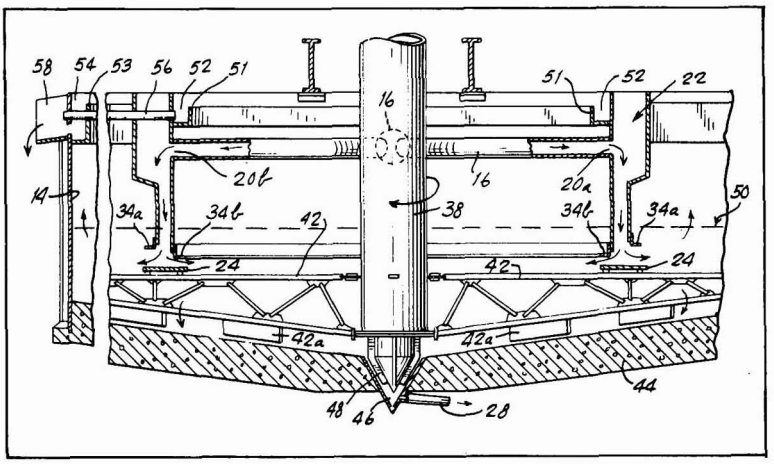
Clarifier. F. G. Eis, O. V. Bonney and W. A. Sackett, *assrs.* Amstar Corporation, of New York, NY, USA. **4,278,541.** November 2, 1979; July 14, 1981.

Juice enters the clarifier through pipe 16, a coagulating agent being added during this passage. Pipe 16 separates into two and the juice passes through exits 20a and 20b into the upper part of an annular feedwell 22 through which it descends, leaving the open lower end to meet the annular deflector plate 24. This, and the annular sleeves 34a and 34b, define passages through which the juice and agglomerated particles contained in it are radially directed both inwards and outwards without breakage of the agglomeration. The bottom of the clarifier contains the previously settled agglomerated solids and the interface between these and the clear juice is indicated at the level of the broken line 50 which is above the level of the bottom of feedwell 22.

The feed pipe 16 and feedwell 22 are supported on an upper bridge between the walls of the clarifier; this bridge also holds the support and drive arrangements for the central shaft 38 which rotates with its conical lower end, carrying scraper blades 48, within a conical sump 46. The shaft carries at its lower end rakes 42 which

[3] *I.S.J.*, 1983, **85**, 189.
[4] *ibid.*, 1984, **86**, 62.
[5] *ibid.*, 1983, **85**, 92.

support the annular deflector plate 24 and the series of blades 42a which direct the settled solids over the conical bottom 44 of the clarifier into sump 46. From this they leave by way of pipe 28 and a valve that is controlled, for example, by a photo-electric means which ensures that the valve is opened when the interface 50 rises above a pre-determined level. Clarified juice overflows the upper rims 51 and 53 into channels 52 and 54, connected by pipe 56, and is led away through duct 58.

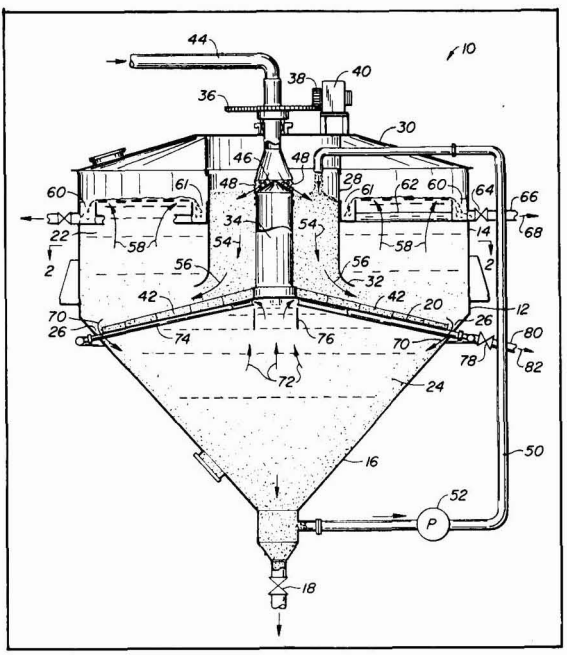


Preparing citric acid by fermentation of carbohydrates. C. Rottigni and G. Cardini, of Milan, Italy, *assrs.* Euteco Impianti S.p.A. **4,278,764.** October 25, 1979; July 14, 1981. — Citric acid is formed by submerged aerobic fermentation of carbohydrates (an initial sugar concentration of 200-250 g/litre) using *Candida* spp. *(C. lipolitica)* yeasts under controlled temperature conditions [28-32°C (29-30°C)] and at pH 5-7 (6-7), maintained by addition of measured quantities of $Ca(OH)_2$ during the fermentation, (plus an air feed of 0.5-1 vol/vol/min) to give a broth containing Ca citrate. At least part of the broth is subjected to a first centrifuging at 500-1500 rpm for 1-5 min to separate the Ca citrate, and then at 10,000-20,000 rpm for 1-10 min to separate the yeast cells which are then recycled.

Rapid continuous clarifier. H. Chen, of Pingtung, Taiwan, *assr.* Fabcon Inc. **4,279,747.** January 17, 1980; July 21, 1981.

The clarifier 10 comprises a tank 12 having an upper cylindrical part 14 and a lower conical part 16. Discharge from the bottom of the tank is controlled by valve 18. A dished annular tray 20 separates the two parts of the tank but they are linked by the narrow peripheral annular passageway 26 between the wall of the tank and the edge of the tray. Suspended from the cover 30 of the tank is a central vertical pipe 28 with a bell mouth 32. This forms a separate compartment within compartment 22 and centrally through it passes pipe 34 also supported by roof 30 but rotated by motor 40 through gearing 36, 38. The bottom of pipe 34 carries rakes 42 and a section near the top, located just above internal baffle 46, is provided with perforations 48. Feed is introduced through pipe 44 into the top of pipe 34 and is directed through perforations 48 by baffle 46.

A return pipe 50, having an in-line pump 52, connects the bottom of compartment 24 with the compartment within pipe 28 and sedimented material from this pipe is mixed with feed from apertures 48; it then passes downwards in the direction of arrows 54, out through bell mouth 32 and into compartment 22. Settled flocs form on tray 20 and are directed by rakes 42 to the gap 26 and into compartment 24. The clear juice separating rises through compartment 22 outside pipe 28 and overflows as shown by arrows 58 into the annular channels 60 and 61, connected by pipes 62, and are removed through valve 64 and pipe 66. In compartment 24 any juice trapped in an agglomeration is released and rises in the direction of arrows 72 to the top of the compartment where it collects in container 76 and is withdrawn through pipes 74 to a ring conduit and so by way of valve 78 to the pipe 80. The settled mud collects in the bottom of compartment 24; part is recycled through pipe 50 while the remainder is withdrawn through valve 18.



Process for treating cellulosic materials (bagasse) and obtaining glucose from them. G. T. Tsao, M. R. Ladisch, C. M. Ladisch and T. A. Hsu, *assrs.* Purdue Research Foundation, of West Lafayette, IN, USA. **4,281,063.** October 3, 1979; July 28, 1981. — See UK Patent Application 2,017,707[6].

Preparation and use of glucose isomerase. C. K. Lee, of Winston-Salem, NC, USA, *assr.* R. J. Reynolds Tobacco Co. **4,283,496.** September 19, 1977; August 11, 1981. Glucose is converted to fructose in the presence of an enzyme derived from a mutant strain of the micro-organism *Flavobacterium arborescens* ATCC 4358 (NRRL B-11022 and B-11023).

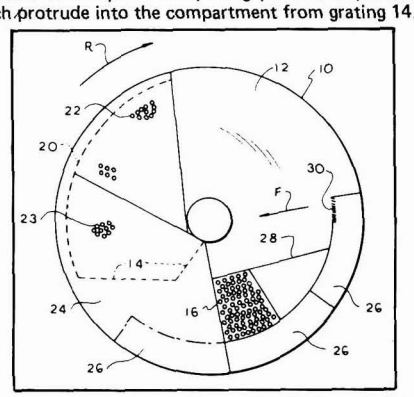
Separation of sugar components in a mixture. S. Kulprathipanja and R. W. Neuzil, *assrs.* UOP Inc., of Des Plaines, IL, USA. **4,287,001.** February 25, 1980; September 1, 1981. — A mixture of sugars (fructose and glucose) is separated by bringing the solution into contact with a crystalline aluminosilicate adsorbent (an X- or Y-zeolite) exhibiting adsorptive selectivity to one component which is then recovered by desorption (with water). The component is bound by an inorganic oxide binder material (amorphous silica-alumina or alumina) which tends to dissolve in the solution; this is prevented by prior treatment with an alcohol (ethanol) under esterification reaction conditions (2-15 hr at a temperature of 100°-250°C with a weight ratio of adsorbent to alcohol of 1:1-1:5 and a pressure sufficient to maintain the liquid phase), whereby an esterification reaction occurs between the alcohol and binder material, reducing the extent of dissolution of the latter and disintegration of the aluminosilicate.

Isomerizing glucose to fructose. S. P. Barrett and W. J. Nelson, *assrs.* Standard Brands Inc., of New York, NY, USA. **4,288,548.** November 15, 1979; September 8, 1981. — A deionized glucose solution is treated with an ion (strong- or weak-base anion) exchange material in the bisulphite/sulphite form [at pH 1-8 (3.5-6.5)] [at $<$ 80°C (25°-70°C) (50°-65°C)].

Purification of sugar syrups. G. V. Gudnason and J. E. Stell, *assrs.* The Coca-Cola Co., of Atlanta, GA, USA. **4,288,551.** March 10, 1980; September 8, 1981. [Between 80 and 95% (90%) of a quantity of] Impure sugar syrup [of $\geqslant$ 40°Bx ($\geqslant$ 30°Bx)] is maintained at a temperature of $\leqslant$ 72°C [60°-72°C (68°-70°C)] but not lower than that at which formation of a primary floc may proceed to substantial completion [0°-72°C (60°-72°C)]. The syrup is combined (in either order) with $\leqslant$ 25 ppm (50-100 ppm) of H_2O_2 by volume, and sufficient of a floc-forming chemical couple [(0.8-3.0% of) (1-2% of) an Al^{+++} source ($Al_2(SO_4)_3,18H_2O$) and (0.2-1% of) (0.3-0.6% of) lime] [a PO_4^{---} ion source (0.03-0.2% of (0.1% of) phosphoric acid) and an equal amount of lime] in sufficient amounts to give a primary floc (of aluminium hydroxide) (of calcium phosphate) (and raise the pH to 5.5-8). Into the (balance of the) syrup (at 65°C) is mixed (an effective amount of active carbon and) sufficient (beef liver) catalase [$\leqslant$ 2 ppm (2-25 ppm) (5-20 ppm) on sugar] to cause rapid decomposition of the H_2O_2 and rapid generation of oxygen bubbles (when the two amounts of syrup are mixed). [Within 180 seconds ($\geqslant$ 120 sec) ($\geqslant$ 60 sec) ($\geqslant$ 30 sec) of mixing or at the same time as the mixing takes place] Throughout the syrup is dispersed (without turbulence) sufficient [8-15 ppm (about 10 ppm); $\leqslant$ 25 ppm; 20-50 (30-40) ppm] of a polyelectrolyte (a polyacrylamide) to form a secondary floc in which are entrapped the oxygen bubbles. [The dispersion is stopped within 180 (after 60) seconds and] The secondary floc floats to the top of the purified syrup from which it is removed (with the active carbon). As an alternative, the H_2O_2 and catalase may be added to the smaller fraction of the syrup and the floc-forming couple to the larger. The secondary floc may be slurried in water at $\geqslant$ 72°C, treated with about 25 ppm of H_2O_2 and $\leqslant$ 2 ppm of catalase to give a rapid generation of oxygen bubbles; a polyelectrolyte is added and the floc separated by flotation, leaving a purified dilute syrup which is used to dissolve impure sugar to give more of the original syrup.

Beet cossette preheater. A. Longuet, of Bethune, France, *assr.* Fives-Cail Babcock. **4,289,734.** October 6, 1980; September 15, 1981.

The heater, which precedes a diffuser, is in the form of a drum in which cossettes pass in counter-current to a heating liquid, the two being admitted at opposite ends of the drum in the usual manner. The drum is provided with an internal screw conveyor with turns 12 and compartments formed by perforated gratings 14, side walls 22 and outer wall 20, all spaced slightly from the solid drum 10 and scroll surfaces 12. Heating liquid drains from the cossettes in the compartment as it rises with rotation of the drum in the direction of arrow R, aided by an increased perforated surface formed by provision of a septum comprising perforated plates 23 which protrude into the compartment from grating 14.



As the drum rotates, the grating 14 is trailed by a solid partition 16 forming a chamber 24 into which the liquid falls. The cossettes carried upwards fall by gravity into the next compartment where they mix with more liquid and are then lifted, drained and carried further downstream until finally discharged. The chamber 24 is connected to the next upstream through a passageway 26 which crosses the scroll section and is connected to septum 28, perforated at the leading end, where it is fastened to the trailing surface of partition 16. The liquid is carried along the passage way and through the perforations into the upstream compartment where it mixes with cossettes falling into it. As the drum rotates, septum 28 is lifted out of the mixture and the remaining liquid drains from passageway 26 through openings 30 in its trailing end. The mixture of cossettes and liquid is trapped by the new draining compartment as the drum rotates and the liquid is transferred by the next passageway 26 further upstream until it is discharged having lost its heating effect.

[6] *I.S.J.*, 1983, **85**, 92.

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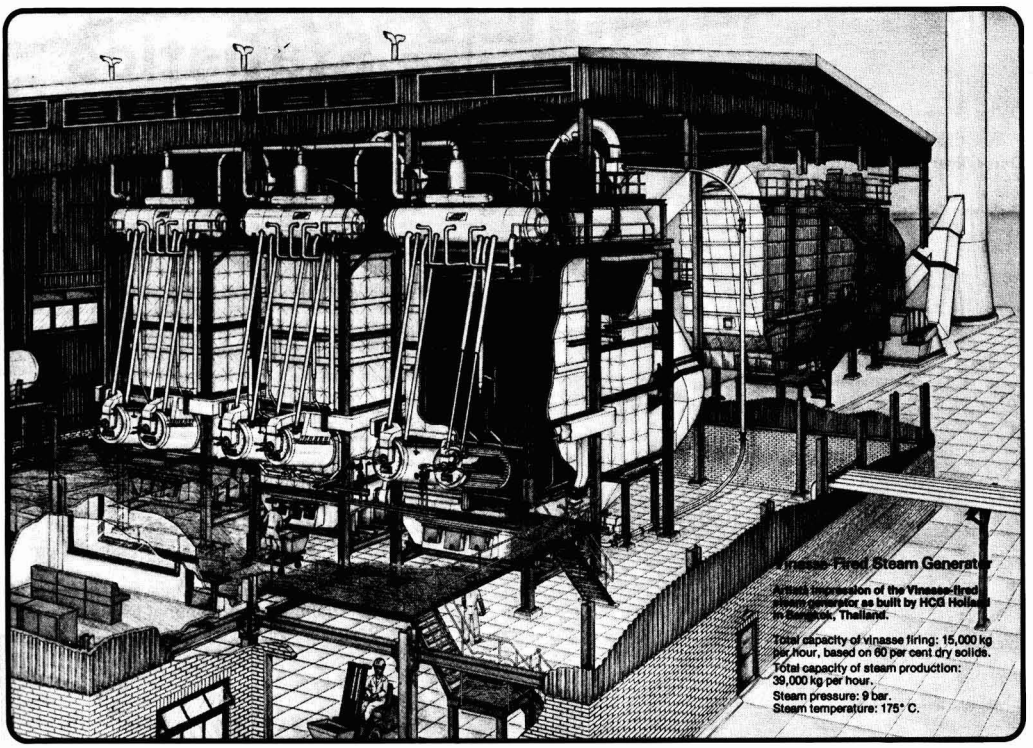

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Total capacity of steam production: 39,000 kg per hour.
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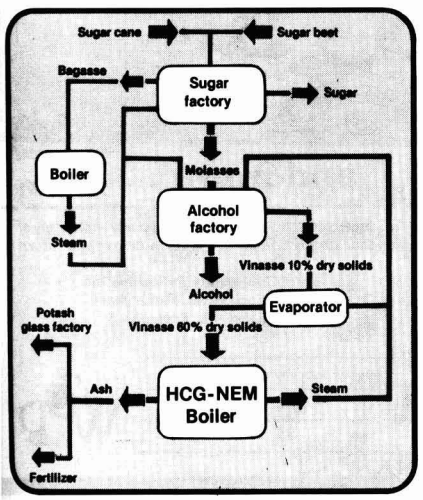

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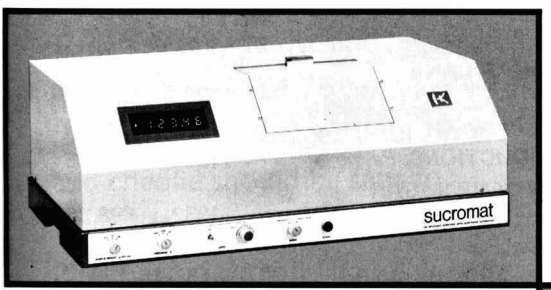

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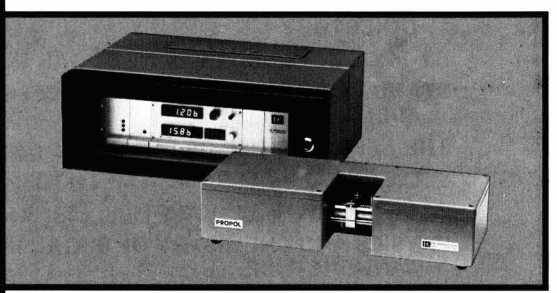

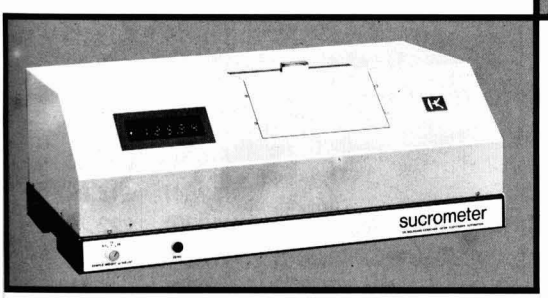

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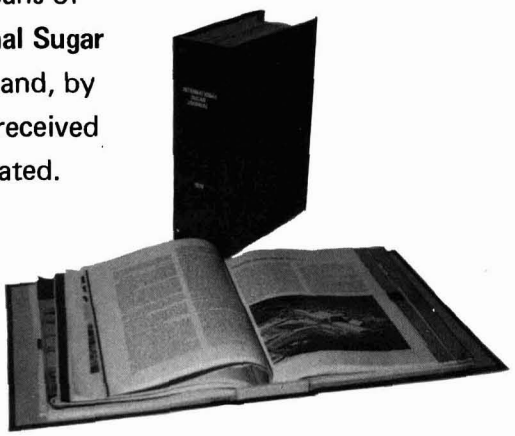

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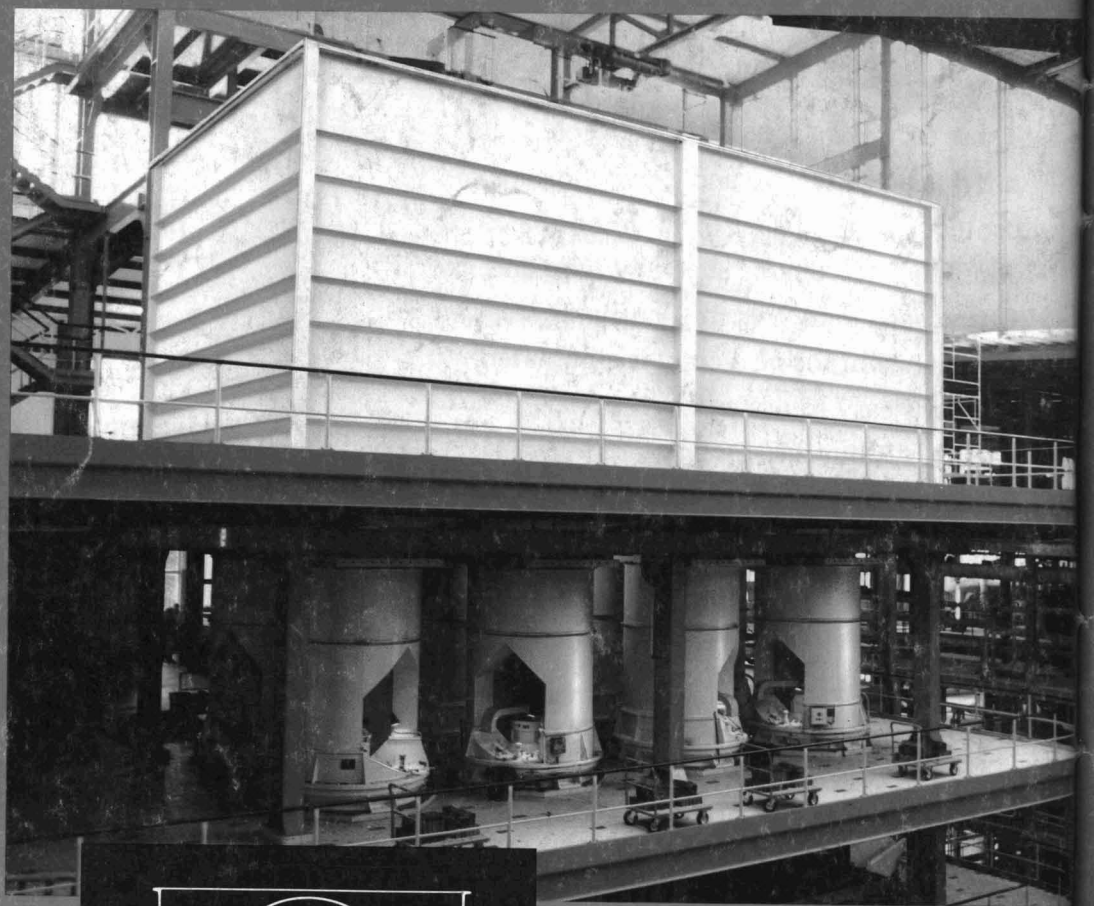

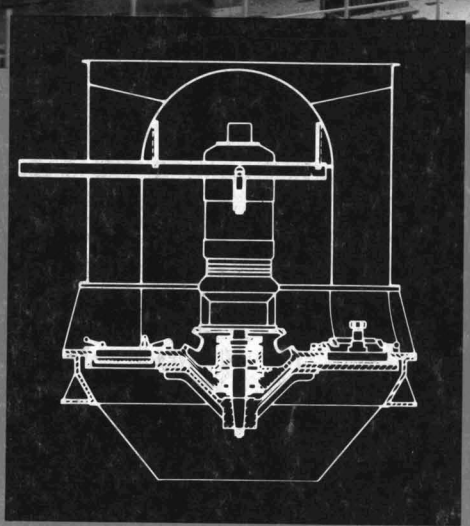

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