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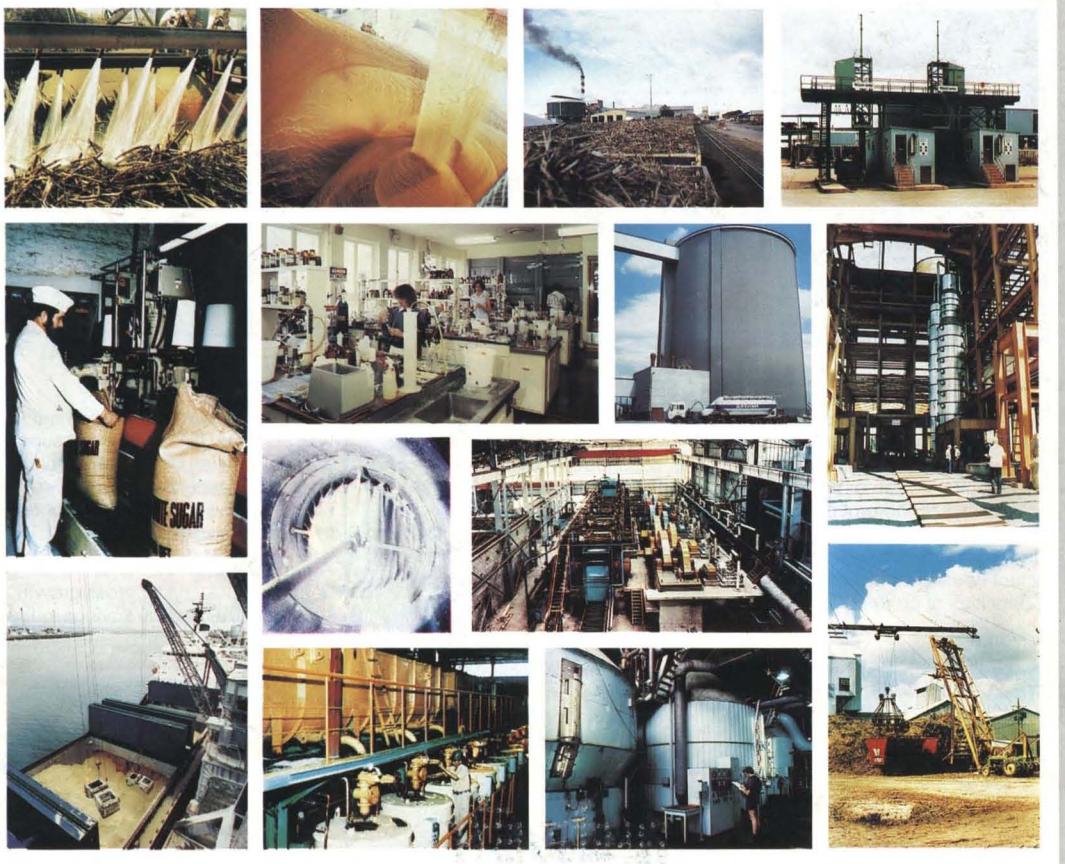
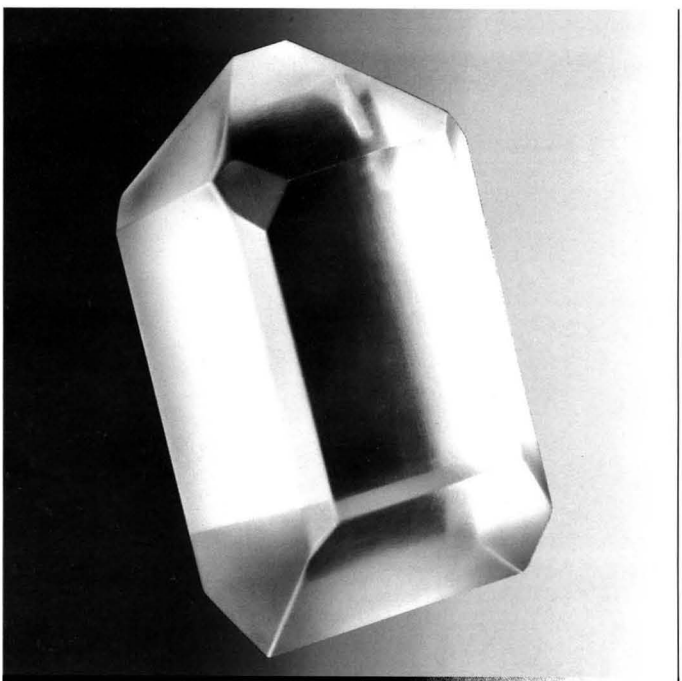
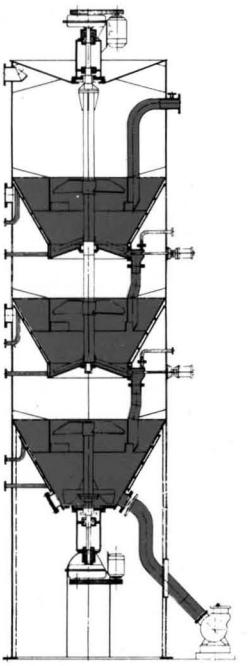


VOLUME LXXXIX/ISSUE No. 1063 JULY 1987

Clear as crystal: Our programme for optimum crystallization





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News and views

International Sugar Council meeting

The International Sugar Council met in London in May under its new Executive Director and adopted an estimate of world sugar production of 102.3 million tonnes, raw value, and a consumption estimate of 101.9 million tonnes. Net free demand in 1987 was estimated at 16.9 million tonnes against almost the same amount in available supplies, indicating little change in the level of stocks by the end of the year. An important topic for discussion arose from the dissatisfaction of importing members over financing of the ISO. The cost — some £800,000 per year — is borne equally by importers and exporters but, since there are more of the latter than the former, the importers have complained that they carried an unfair burden. Since it would be time-consuming to try to amend the present agreement, it was decided to set up a preparatory committee to look into areas where a new agreement will need to differ — for example, affording changed voting strengths corresponding to changed contributions — in order to provide a basis for negotiation of a new agreement at a meeting to be convened in London in September. This will still be an administrative agreement, without economic terms, as is the current agreement, but thought might also be given as to the possibility of introducing a fully effective agreement if a basis for it can be found.

Philippines sugar crop target[1]

Philippines sugar production in the 1987/88 crop year ending August has been set at 1.6 million tonnes, up from a provisional 1.3 million tonnes in 1986/87, according to the chairman of the Sugar Regulatory Administration (SRA), Arsenio Yolo. A survey during the 1986/87 milling season, which ended in April, showed that the estimate was almost certain to have been met. At least 1.2 million tonnes of the 1987/88 crop is earmarked for domestic consumption, about 130,000 tonnes is to be set aside for the US sugar quota, 150,000 tonnes for strategic reserves and 50,000 tonnes to be sold on the world market.

Yolo said that if the government approved a long-standing SRA recommendation to manufacture alcohol, the project would take up another 150,000 tonnes, slightly raising the target. Approval of the project has been delayed but it is expected by July. A proportion of 5% of alcohol could be added to gasoline; this would cut the oil import bill by about 300 million pesos. Three major Philippines distilleries are ready to start manufacturing alcohol if the project is approved. It would result in employment for about 100,000 people, sharply reducing the number thrown out of work by depressed world sugar prices and a moribund domestic industry.

Production quotas, set for the first time in 1987/88, had been submitted to President Aquino but, according to Yolo, "there is really no need for such quotas; we are right now producing just slightly over our own consumption level." Domestic prices have been driven up because of speculation following the SRA's bid to control production, and the Philippines is no longer concerned so much with the world market. Producers in the Negros region have diversified into corn and prawn farming and cloth manufacture, and diversification into products other than alcohol is also possible within the sugar industry, according to Yolo.

The Philippines has urged a new agreement to revive world prices; although prices could well reach about 11 cents a pound by the end of 1987, this is lower than production costs in the Philippines which range from 12 to 14 cents a pound. Despite next year's increased production target, some Philippines sugar factories are expected to shut down. At least four of the 41 factories were not working during the 1986/87 season and two or three more are expected to follow suit during next season.

US sugar crop expansion[2]

On March 31, the US Department of Agriculture issued its first estimate of sugar beet sowings for the 1987 crop. These amounted to 1,249,000 acres, which compares with 1,233,000 acres sown in 1986. The area actually harvested from the 1986 crop was about 40,000 acres less than planted. US beet sugar production in the 1986/87 crop year has most recently been estimated by the USDA at 3,330,000 short tons, raw value, or 11% more than in the preceding year and well over the estimate issued by the Department in November 1986. Prospects are for a further increase in 1987. A further expansion in sugar cane area is expected for the coming crop although no estimates have so far been released.

The Florida crop which has just ended set a new record for the state at 1,476,000 tons, raw value, surpassing the previous season's record of 1,413,000 tons. The absence of any weather-related damage during the past winter undoubtedly contributed to the record output and has also given the cane an unusually good start for the next season which will begin in the autumn. The area harvested in Hawaii may decline slightly this year, but will likely be offset again in 1987 by increased yields, according to the Hawaiian Sugar Planters' Association[3].

The Chairman of the House Agriculture Sub-Committee, responsible for the sugar program, has threatened to offer legislation next year to curb domestic sweetener output if growers fail to restrain output in 1987. However, the Administration has already proposed reducing the sugar loan rate, beginning with the 1987 crop, and to make compensation payments to farmers over a four-year period, but the proposal will probably not be accepted by either the House of Representatives or the Senate.

Kenya sugar situation[4]

The Kenyan sugar industry, for which high hopes were once expressed, has for the most part been very disappointing in recent years. Its problems have built upon one another so

1 *Reuter Sugar Newsletter*, March 27, 1987.
2 *Czarnikow Sugar Review*, 1987, (1760), 54.
3 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 163.
4 *Czarnikow Sugar Review*, 1987, (1760), 56.

that, with the exception of the Mumias complex, there is now an overall level of inefficiency leading to a run-down in operations. Last year the Chief Executive of the Kenya Sugar Authority made sweeping complaints about the state of the industry's infrastructure, research, management and lack of funds. There have been reports of the processing of unripe cane, with a consequent reduction in yields, and factories operating at less than half capacity. Farmers in turn have complained that prices they receive for their cane are so low that they can actually lose money on its production.

An attempt was made to ease the lot of farmers recently when the price of cane at the factory gate was increased by 13.7%, bringing its current price to 341 shillings (US$21.31) per tonne. Whether this will be sufficient to encourge them to grow more cane will no doubt be reflected in production figures for next year. At the same time the ex-factory price of white sugar was increased by 2% to 5380 shillings (US$336.25) per tonne, thereby squeezing factories' margins. Production and consumption figures for the past several years, according to the Kenyan Sugar Authority, were as follows:–

	Production	Consumption
	tonnes, white sugar	
1980	401,000	302,000
1981	369,000	325,000
1982	309,000	323,000
1983	326,000	328,000
1984	372,000	345,000
1985	347,000	385,000
1986	355,000	425,000

Production in Kenya is in various grades of mill whites.

The rapidly growing level of domestic consumption, coupled with effectively stagnant production, has led to Kenya becoming a substantial importer of sugar with 130,000 tonnes having been taken in the past year. A restraint on consumption has been that it has not always been freely available and this has led to a rapid growth in the glucose industry in Kenya.

One result of the drop in the availability of sugar in Kenya has been its failure to fill its premium priced outlet in the EEC. In the past several producers have imported sugar at times of domestic deficiency to enable them to meet their EEC outlet and it is considered perfectly acceptable by the Community authorities provided the sugar delivered to the EEC was actually produced in the quota-holding country.

Although Kenya has on some occasions in the past taken advantage of this procedure, this was several years ago. It last delivered sugar to the EEC in 1984 since when it has neither attempted counterpart deliveries nor declared force majeure.

Consideration is now being given to removing Kenya's quota. Under EEC/ACP arrangements the overall quota would remain unchanged at 1,304,700 tonnes, white sugar equivalent, and it is expected that Kenya's quota will be reallocated to other suppliers. The quantity involved is only 5000 tonnes, but there is likely to be keen competition to share in any reallocation owing to the high price paid by the EEC.

Kenya's quota was set originally at 10,000 tonnes but it was reduced to 4000 tonnes owing to non-fulfilment of the quota some years ago before being increased by 1000 tonnes in 1984 at a time when part of the quota of another supplier was being reallocated.

Steps toward a Portuguese beet sugar industry[5]

A special meeting was held recently in Ferreira do Alentejo to establish a new association of sugar beet growers, the Associacão de Produtores de Beterraba Sacarina do Alentejo Ocidental. This step was taken under the auspices of the local Chamber of Commerce, following the setting of an EEC sugar production quota for Portugal of 60,000 tonnes in 1990. The new association demands that a sugar factory be built in Portugal, and is backed by 300 interested parties including banks and other entities. The association is the first in Portugal to promote sugar beet cultivation. Owing to the difficulties with other crops in this region (tomatoes, cereals, etc.), sugar beet cultivation is seen as a possibility for the future.

Cuba sugar production behind schedule[6]

Cuban sugar production was one million tonnes behind schedule on April 28, according to official sources. The harvest, which had been plagued first by drought and then by excessive rain, was scheduled to end by April 30; however, it was extended into May and some factories have probably still operated in June in order to make up part of the shortfall. President Castro insisted on the need to fulfil trade commitments at any cost; he called for an emergency solution until the end of the harvest, which means that, as the harvest wound down in one region owing to the lack of ripe cane, workers would be sent into other regions where the harvest continued.

Castro said that the shortfall in certain regions was due to the fact that the heavy mechanical cane harvesters, which were scheduled to account for 60% of the harvest, became bogged down in rain-soaked fields. Officials said individual cane cutters with machetes should be sent into the muddy fields when the mechanical combines could not operate in them. The amount of raw sugar produced during the 1986/87 season has not made public; in past years a daily chart of crushing statistics for the mills in each province has been produced. One official said that a production result similar to last year's disappointing 7.3 million tonnes would now be considered lucky by the sugar industry.

Corrigendum

Calculated total sugar production figures for Europe quoted in our June issue[7] have been corrected by F. O. Licht GmbH; they should be 29,930,000 tonnes for 1987/88, 31,450,000 tonnes for 1986/87 and 30,864,000 tonnes for 1985/86.

5 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 191.
6 F. O. Licht, *Int. Sugar Rpt.*, 1986, **119**, 224.
7 *I.S.J.*, 1987, **89**, 101.

Pol analysis — Collaborative tests

By Murray R. Player
(ICUMSA Referee for Subject 11, Polarization of raw sugars)

Introduction

At the 18th Session of ICUMSA in 1982, the author, in his Referee's Report for Subject 11, "Polarization of raw sugars", discussed the desirability of narrowing the range of basicities of the basic lead solution used for clarifying solutions for pol determination[1]. This followed work reported by Baird & Player[2] who had found differences in pol of up to 0.06°S for a four-unit difference in basicity. The current specification[3,4] for wet lead used in the pol method allows a range of eight units.

Other matters which had been raised at recent ICUMSA sessions in connexion with the clarification of solutions before pol measurement include:

1. The appropriate volume of wet lead to clarify very high pol sugars satisfactorily.
2. The preferred basicity of wet lead to achieve efficient clarification.
3. The reproducibility of the polarimetric method.

Collaborative test program

In order to examine more data on the role of wet lead basicity in pol measurement the Referee decided to conduct a collaborative test program.

Ten laboratories (named in Appendix 1) participated in the program, which called for analysis of five sugars comprising two beet raws and three cane raws. The nominal pol values of the beet raws were 96.5 and 99.4°S while those of the cane raws were 99.5, 98.9 and 97.9°S. In the results which follow these are designated as raws 1 to 5, respectively. Sugars were analysed for pol[4,5] by two analysts at each laboratory and altogether thirty pairs of results were submitted by each laboratory. Wet lead was supplied at three basicities, nominally 38, 41 and 44% (lead 1 to 3 respectively), and each sugar was analysed using two different volumes of these three wet lead solutions. The volumes of wet lead were chosen from 0.5, 1.0 and 1.5 cm^3 according to the pol of the sugar. The sugars above 98.5 pol were analysed at 0.5 and 1.0 cm^3 while the sugars below were analysed at 1.0 and 1.5 cm^3. In order to assess the

M. R. Player

effectiveness of each lead clarification, the colour and turbidity of the filtrate used for pol determination were measured. A portion of the filtered solution for pol determination was read directly in a spectrophotometer at 420 nm and 720 nm without any additional filtration, pH adjustment or degassing. The results for colour and turbidity were recorded and calculated as set out in the ICUMSA method for determination of colour in solution[6]. Upon receipt of the sugar samples collaborators determined moisture using the loss on drying method as specified by Plews[7].

Treatment of results

The Referee prepared work sheets and summary sheet for each laboratory's report of results. All data were checked for clerical errors and pol data were tested for outliers using Dixon's method[8] and two results were subsequently treated as outliers with those data being replaced with values calculated as missing values. When the method used by the laboratory did not conform strictly with the ICUMSA methods specified, the data from that laboratory was excluded from analysis. No data were entered for one laboratory in respect of raw sugar 1.

Analysis of variance

Analysis of variance was carried out separately on the data for each of the raw sugars, giving a total of 15 separate analyses, five each for pol, colour and turbidity. Within each block, data were analysed for the effect of: volume of wet lead, basicity of wet lead, differences between laboratories, and differences between analysts (within laboratories) as well as the interactions between these effects. The statistical program used was 'GENSTAT' (Numerical Algorithms Group Ltd., Oxford, England), on a VAX 11/780 computer.

Results and discussion

POL DATA

The analysis of variance for pol data did not show any significance for the effects of basicity of lead, or volume of lead, or for interactions. There were highly significant difference between laboratories, and between analysts within laboratories. Computed variance ratios are shown below in Table I.

Laboratory effects

It was not surprising that the effect of laboratories should be a significant source of variance since it was one of the objectives of this test program to obtain some quantitative assessment of the magnitude of these difference. The standard deviation of the average of the results of each laboratory was found to be 0.07, while the standard deviation of the difference between analysts within a laboratory was 0.04. The residual error

1 *Proc. 18th Session ICUMSA*, 1982, 172 - 173.
2 *I.S.J.*, 1980, **82**, 263 - 268.
3 *Proc. 18th Session ICUMSA*, 1982, 190.
4 *Proc. 17th Session ICUMSA*, 1978, 156 - 160.
5 *Proc. 18th Session ICUMSA*, 1982, 175 - 180.
6 *Proc. 17th Session ICUMSA*, 1978, 343 - 344.
7 "Analytical methods used in sugar refining", (Elsevier, Amsterdam), 1970, 41.
8 *Ann. Math.-Stat.*, 1951, **22**, 68 - 78.

Table I. Analysis of variance for pol

Effect	F Ratios Raw 1	Raw 2	Raw 3	Raw 4	Raw 5
Laboratory	35***	35***	34***	37***	37***
Analyst (within lab.)	6***	5***	7***	5***	4***
Lead volume	1	3	3	1	3
Lead basicity	1	1	1	1	1
Residual S.D.	0.046	0.043	0.044	0.041	0.041

Note: *** indicates a 99.9% level of confidence while ** and * indicate 99% and 95% respectively; no * indicates lack of significance at the 95% level.

was 0.043. This latter figure underestimates slightly the residual since individual sugars were analysed in batches, so the residual is rather the residual within one batch on one day.

Effect of volume of lead

The analysis revealed that the use of different volumes of wet lead did not give statistically different pol results. For this analysis the ten laboratories' duplicate results for each sugar at three basicities and for each volume of wet lead were averaged (60 results) and compared with the similar average obtained for the other volume of wet lead used for that sugar. The data used in this comparison are given in Table II. (Each result is the average of 60 determinations.)

Table II Average pol values for different volumes of wet lead used

Raw sugar	Mean pol	0.5 cm³	1.0 cm³	1.5 cm³
1	96.507	-	96.508	96.507
2	99.360	99.366	99.354	-
3	99.521	99.514	99.528	-
4	98.863	98.864	98.861	-
5	97.884	-	97.877	97.890

Effect of basicity

The analysis for effect of basicity involved comparison of average pols from the ten laboratories for each sugar with results for different volumes of wet lead included in the average. Each pol result in Table III below is the average of 40 determinations.

Table III. Average pol values for different basicities of wet lead used

Raw sugar	Lead 1	Lead 2	Lead 3
1	96.499	96.510	96.513
2	99.357	99.363	99.361
3	99.520	99.524	99.519
4	98.857	98.874	98.857
5	97.884	97.881	97.886

Effect of volume of lead and basicity interaction

In this analysis the proposition that the combination of volume and basicity or total amount of basic lead used has an effect on the pol results is tested. The data compared are the average pols for the ten laboratories for each sugar and each basicity at the different volumes used. Each average represents twenty determinations and these appear in Table IV. The results of this analysis reveal that no significant pol differences arise out of this interaction.

Table IV. Average pol values for three basicities and two volumes of wet lead

Lead	Volume of lead	Raw 1	Raw 2	Raw 3	Raw 4	Raw 5
	0.5	-	99.361	99.509	98.857	-
1	1.0	96.486	99.353	99.532	98.857	97.870
	1.5	96.512	-	-	-	97.898
	0.5	-	99.371	99.526	98.873	-
2	1.0	96.512	99.356	99.521	98.875	97.876
	1.5	96.507	-	-	-	97.886
	0.5	-	99.369	99.507	98.863	-
3	1.0	96.525	99.352	99.531	98.853	97.849
	1.5	96.502	-	-	-	97.888

SOLUTION COLOUR DATA

The analysis of variance for solution colour was carried out in a manner similar to that for the pol data. There were difficulties with the analysis, particularly for sugars 1 and 2 (the beet raws) as some laboratories reported high colours, possibly owing to turbidity effects. As a result the distribution of the data was far from "normal", and the assumption of the variance ratio test were not met. The computed variance ratios are shown below in Table V.

Laboratory effects

As for pol, there was a highly significant difference in colour results arising out of the laboratories themselves. The cane raws generally clarified well and the agreement between laboratories was quite good. The best case was raw sugar 3 where the relative standard deviation for a single test between laboratories was 10% while the residual relative standard deviation was 9%. By contrast, there was difficulty experienced in clarifying both beet raws and this was reflected in the extent of agreement between laboratories. The relative standard deviation for a single test between laboratories was 39% for raw sugar 2 while the residual relative standard deviation was 7%.

Effect of volume of lead on colour

Table VI below shows mean colour measurements at different volumes of wet lead for each of the raw sugars. Raw sugar 3 showed an increase in colour with increasing volumes of lead; however, with all the other raws, increasing the volume of lead resulted in a fall in the colour of the solution. The fall in colour for raw sugar 2 was small and not statistically significant, but all the other differences were significant including the reverse effect of raw sugar 3. This reverse effect of sugar 3 suggests

Table V. Analysis of variance for solution colour

	F Ratios				
Effect	Raw 1	Raw 2	Raw 3	Raw 4	Raw 5
Laboratory	100***	419***	9***	34***	37***
Analyst (within lab.)	10***	7***	2	2	1
Lead volume	17***	2	97***	708***	539***
Lead basicity	1	4*	<1	44***	55***
Residual S.D.	113	43	39	18	27

Table VI. Colour of solutions with different volumes of added wet lead

Raw sugar	Mean pol	0.5 cm³	1.0 cm³	1.5 cm³	Difference
1	96.51	-	823	734	−89
2	99.36	652	641	-	−11
3	99.52	261	331	-	+70
4	98.86	542	455	-	−87
5	97.88	-	617	502	−115

that the sugar had been "overleaded" when 1.0 cm³ of wet lead was used.

Effect of lead basicity on colour

The statistical analysis revealed that the basicity of the wet lead had a significant effect on the colour of solutions in three out of the five sugars. In Table VII the average colours for each lead basicity, irrespective of volume of lead used, is shown for each sugar tested. Given the error involved in measuring colour, it would appear that, even where the effect of basicity was significant, there would not appear to be compelling reasons for selecting one basicity in preference to another.

Table VII. Colour of solutions with different basicities of wet lead

Raw sugar	Mean	Lead 1	Lead 2	Lead 3	Range
1	779	798	771	766	32
2	646	635	642	662	28
3	296	296	296	297	1
4	498	519	496	481	38
5	559	592	528	528	64

SOLUTION TURBIDITY DATA

The analysis of variance for solution turbidity was carried out in a similar manner to that for pol and solution colour presented above. The results appear in Table VIII.

Table VIII. Analysis of variance for solution turbidity

	F Ratios				
Effect	Raw 1	Raw 2	Raw 3	Raw 4	Raw 5
Laboratory	151***	245***	104***	424***	119***
Analyst (within lab.)	23***	11***	2	2	1
Lead volume	5*	2	28***	1	1
Lead basicity	<1	2	2	1	<1
Residual S.D.	27	10	4	3	6

Laboratory effects

As in the case of pol and solution colour, there was a highly significant difference in turbidity results arising out of the laboratories themselves. Analysts familiar with turbidity measurements would not expect close agreement either within or between laboratories. However, the order of magnitude of the results was important in assessing the relative solution clarity obtained for different sugars and different wet lead quantities.

Effect of volume of lead

Table IX above shows the mean turbidities with different volumes of wet lead for each of the raw sugars. In two out of the five sugars (Nos. 1 and 3), different volumes of lead had a statistical effect on the turbidity of solution. For the low pol beet raw, the extra lead gave a clearer solution, but for the high pol cane raw, the extra lead gave a slightly more turbid solution.

Using the data on pol, colour and turbidity it was possible to examine whether there was any preferred volume of lead to be used in the pol analysis. Since the volumes used produced pol results which were not statistically different from each other, one would be free to choose volumes which have merit for some other technical reason. It would seem that lower colours and turbidities should be preferred for the ease of reading instruments. Looking at Tables VI and X together, one concludes that sugar 1 with a pol of 96.5 benefited significantly from increasing the volume of wet lead from 1.0 cm³ to 1.5 cm³. With average colours in the 700-800 range such solutions would be getting difficult to read in some manual instruments. The slight improvement in turbidity would also be beneficial to reading such solutions.

Table IX. Turbidity of solutions with different volumes of wet lead

Raw sugar	Mean pol	0.5 cm³	1.0 cm³	1.5 cm³	Difference
1	96.51	-	82	70	−12
2	99.36	80	77	-	−3
3	99.52	2	6	-	+4
4	98.86	4	4	-	0
5	97.88	-	7	6	−1

Table X. Turbidity of solutions with different basicities of wet lead

Raw sugar	Lead 1	Lead 2	Lead 3	Range
1	78	74	78	4
2	78	77	81	4
3	3	4	5	2
4	4	4	4	0
5	7	7	6	1

At the 16th Session of ICUMSA it was reported[9] that the South African Associate Referee suggested that their very high pol sugar would be better clarified with a smaller volume of wet lead than the 1.0 cm³ called for in the method. The findings of the present study supported this suggestion. In particular, for raw sugar 3, a volume of 0.5 cm³ gave statistically significantly lower colours and turbidities than was obtained with 1.0 cm³.

Effect of lead basicity on turbidity

The statistical analysis revealed that

9 *Proc. 16th Session ICUMSA*, 1974, 130.

basicity did not have a significant effect on the turbidity of the solution. From a practical point of view there would not seem to be a compelling reason to favour any particular basicity judging from the turbidity of solution produced.

Effect of volume of lead and basicity interaction

The data in Table XI show the average turbidities obtained for each basicity at a particular volume of wet lead used. Only in the case of raw sugar 3 was this interaction statistically significant. It appears that high lead basicity tends to cause turbidity in high pol cane raws, when 1.0 cm³ of lead is used.

Table XI. Average turbidities for three basicities and two volumes of wet lead

Lead	Volume of lead	Raw 1	Raw 2	Raw 3	Raw 4	Raw 5
	0.5	-	79	2.5	4.4	-
1	1.0	83	77	3.4	4.5	7.9
	1.5	72	-	-	-	6.1
	0.5	-	76	1.6	3.4	-
2	1.0	78	77	7.0	4.4	7.8
	1.5	69	-	-	-	5.3
	0.5	-	84	1.8	3.4	-
3	1.0	86	78	8.5	4.4	5.3
	1.5	70	-	-	-	7.4

Loss on drying

Each sample of raw sugar was oven-dried and duplicate measurements made by each analyst of the loss on drying. The between-laboratory standard deviation was found to be 0.015 while the within-laboratory value was 0.016. These standard deviations suggest that both the standard of analysis was very high and that samples did not change moisture as a result of being transported from Sydney, Australia, to the other nine participating laboratories located all around the world.

Conclusions

It was expected the collaborative test program would help the Referee decide whether to recommend reduction of the range of basicities permitted for wet lead and, if so, whether any particular values were preferred. The test results showed that there were no compelling reasons to change the present values in the method. The work of Baird & Player[2] showed that the basicity effect was small with its magnitude varying between sugars. This was supported in work by Braunsteiner[10]. It would seem safest to permit the status quo to prevail.

Concerning volumes of wet lead to be used for sugars of different pol, it seems that 1.0 cm³ is generally satisfactory for all normal raw sugars though sugars with a pol greater than 99.0°S clarified better with 0.5 cm³. It would seem that with the trend towards increasing quantities of raw sugar having higher pols, there would be increasing pressure to have the volume of wet lead reduced for these sugars. Since the collaborative test showed there was no significant difference in pol results between 0.5 and 1.0 cm³ of wet lead for raws 2, 3 and 4 a volume of 0.5 cm³ for pol levels greater than 99.30°S would seem called for. The figure of 99.30°S was chosen because in South Africa such sugars are regarded as very high pol (VHP)[11] and that industry already uses 0.5 cm³ of wet lead because this gives a clear filtrate without question.

In dealing with sugars close to the border-line, they should be analysed with the volume of wet lead which is normally used for sugars of their class. If sugars of their class normally fall below 99.30°S then 1.0 cm³ will be used; if the result is marginally higher than 99.30°S there should not be any need to repeat the analysis using 0.5 cm³ of wet lead. Similarly, for sugars of pol normally in excess of 99.30 and analysed with 0.5 cm³ of wet lead, a result marginally below 99.30 should not necessarily be repeated with 1.0 cm³ of wet lead. Such an management would permit prior agreement among laboratories on what volume of wet lead should be used for a particular class of sugar.

This study established a between-laboratory variance (including between-operator and between-equipment variabilities) of $\sigma_L^2 = (0.078)^2$. The within-laboratory variance was also measured $\sigma^2_W = (0.043)^2$. These results lead to repeatability r of $2.83 \times 0.043 = 0.12$ which compares with values of 0.11 and 0.10 reported previously[12]; and reproducibility R of $2.83(0.078^2 + 0.043^2)^{1/2} = 0.25$.

The statistical terms used in the paragraph above are defined in ISO 5725-1981.

Appendix I

Laboratories participating in the collaborative test program

Mauritius Sugar Syndicate, Mauritius
Institute fur landwirtschaftliche Technologie und Zuckerindustrie, Germany
Pfeifer & Langen, Germany
B.C. Sugar Refining Co. Ltd., Canada
Japan Sugar Refineries' Association, Japan
Amstar Corporation, U.S.A.
Tate & Lyle Refineries, Great Britain
Sugar Milling Research Institute, South Africa
South African Sugar Terminals, South Africa
CSR Limited, Australia

10 Private communication, 1981.
11 Clarke: *Sugar y Azúcar*, 1985, **80**, (9), 34.
12 *Proc. 18th Session ICUMSA*, 1982, 169.

Philippines request for higher US sugar quota[13]

Following market reports that Taiwan will not be able to fulfil its quota, the Philippines is asking the US Department of Agriculture to increase its 1987 sugar quota. The Philippines would protest against any move to award Taiwan's shortfall to the Dominican Republic because that country already has a larger quota. Taiwan's quota is 10,920 short tons, raw value, and according to US import statistics, only 14 tons had been supplied up to March 21.

13 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 165.

Update on dextrans and dextran analysis*

By M. A. Clarke, E. J. Roberts, T. B. T. To and W. S. C. Tsang
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Introduction

Dextran in sugar production and refining continues to be a topic of interest. This paper presents recent results in three areas: dextran effect on pol measurement; the relationship of the two major dextran tests, and the use of dextranase enzymes in analysis. This paper takes the form of a general report on these recent studies, and does not contain descriptions of experimental work.

Effect of dextrans in polarimetry

There has been some discussion in the literature about the effect of dextrans on pol measurements. Dextrans are known to have a high specific rotation of approximately 200° at normal measurement temperatures, and therefore to increase a pol measurement by about three times the value of an equivalent weight of sucrose. This has been clearly shown to be the case by Chou & Wnukowski[1], where dextrans added to sugars (white and raw) were then separated by dialysis and tested for pol. The experimental effect was found to be very close to the theoretical. This is also the case in pol measurements on white sugars.

But to achieve this effect, the dextrans in the sugar must be in the polarimeter tube. If the sugar sample is clarified before the measurement (which white sugars generally are not) then dextran may be removed during that clarification step. This has been observed by Guzman[2] in Tucumán and Legendre *et al.*[3] in Louisiana, working on juices from deteriorated cane, where Herles' reagent (a basic lead nitrate mixture) was used to clarify refractory juices. These juices, from stale or frozen cane, cannot be clarified well enough with lead acetate to allow a polarimeter reading to be taken. Guzman[2] observed that the polarization of juice with and without added dextran or "cane gums" was the same after clarification with Herles' reagent – a surprising result, when increased pol was expected from the dextran and gums. Legendre *et al.*[3] found that polarimetry results on juices from frozen cane clarified with Herles' reagent correlated very well with HPLC analysis for sucrose in these juices.

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The reason for these observations is that the Herles' reagent carries the polysaccharides into the precipitate, whereby they are filtered off, and do not affect the pol of the filtrate. The very basic reagent causes loss of sucrose and should not be used for regular polarimetry.

Clarification with lead acetate presents a similar possibility: are the dextrans in juices and sugars removed in the lead acetate precipitate, or do they remain in the filtrate to affect the pol reading?

Recent work by CSR Ltd.[4] has shown that dextran in raw sugars is removed to a great extent during lead clarification, and that the increase in pol caused by what dextran remains in the leaded filtrate is generally less than one-third of the original. The pol measurement should, therefore, be increased by less than one-third of the theoretical amount e.g. an addition of 900 ppm dextran to a raw sugar caused a pol increase of 0.11 rather than the theoretical prediction of 0.27.

Initial results from studies at S.P.R.I. on removal of dextran from cane juice and raw sugars[5] also indicate that lead acetate clarification (wet or dry lead procedure) removes some or all dextran from the sugar or juice sample.

Results shown in Table I indicate that in cane juice clarification almost all dextran is removed in the lead acetate precipitate, leaving only a few percent to affect juice pol. Dextran in juice will, therefore, affect the pol balance calculations for the factory very little. High dextran juices can, however, go on into the factory undetected, if no analysis other than pol and purity is done on the juice. Juices shown here are normal juices, with dextran added. Very poor juices, from stale or frozen cane, cannot be clarified with lead acetate, as mentioned above[5].

In the case of raw sugar polarimetry, there appears to be less complete removal of dextran by lead acetate clarification than in the case of

* *Paper presented to Sugar Industry Technologists*, 1986.

1 *Proc. Tech. Session Cane Sugar Refining Research*, 1980, 1 - 25.
2 *Proc. 16th Congr. ISSCT*, 1977, 2897 - 2907.
3 *Proc. Sugar Processing Res.*, 1984, In press.
4 Bradbury: *Sugar J.*, 1986, **48**, (8), 11 - 13.
5 Clarke: *S.P.R.I. Ann. Rpt.*, 1985; *Paper presented to Amer. Soc. Sugar Cane Tech.*, 1986.

Table I. Effect of lead acetate clarification on removal of dextran (T-2000) from cane juice (All dextran as ppm on juice, determined by the Roberts method)

Dextran added to juice	Total dextran in juice	Dextran after lead acetate clarification	% Dextran removed in lead clarification
Juice A			
0	27	3	88.9
500	558	6	98.9
1000	1169	0	100.0
1500	1649	16	99.0
Juice B			
0	53	4	92.5
500	622	23	96.3
1000	1142	15	98.7
1500	1701	4	99.8

Table II. Removal of dextran from raw sugars by lead acetate clarification

Raw sugar pol	Initial dextran, ppm	Dextran after lead acetate, ppm	Dextran removed by lead clarification, %
97.27	366	58	84
98.49	450	190	58
98.64	241	47	80
98.68	1670	576	66
98.94	676	48	93

cane juice. There are several possible reasons: the viscosity of juice is usually lower than that of raw sugar pol test solution, and the amount of lead acetate relative to sample volume is higher. Filter aid is used in juice clarification, along with lead acetate. Suspended solids are much higher in juice, and so there is a greater volume of precipitate both per unit volume of sample and per unit weight of sucrose.

Table II shows data on a representative range of raw sugars of various pol values, and the dextran in the sugars, as determined by the Roberts' Dextran Test[6], before and after lead subacetate clarification, that is, the dextran levels in the whole raw sugar and in the leaded filtrate. Results agree with those of Bradbury *et al.*

After adding quantities of dextran of various molecular weights to raw sugars, and clarifing the mixtures, the clarified filtrates were analysed by both Roberts' method[6] (for total dextran) and the haze method[7] (for high molecular weight dextrans). Results are shown in Table III.

Very low molecular weight dextran (T-10) and medium/low molecular weight (T-40) were used. Results indicate that the higher molecular weight dextrans are preferentially removed by lead subacetate, leaving lower molecular weight material in the leaded filtrate to affect the pol reading.

This observation explains, in part, the variation noted in Table II, on removal of dextran by lead acetate. There can be a wide range of molecular weights of dextran in raw sugar, and sugars with a lot of high molecular weight dextran may lose all that dextran in the lead acetate precipitate, while sugars with a greater proportion of lower molecular weight (and probably more soluble) dextrans may show only partial removal by the lead acetate clarification.

Dextrans formed in cane are generally of high molecular weight and, although these can be broken down in process, dextrans in juice may be expected to have an average molecular weight higher than those in raw sugar.

Work is continuing in this area, in a study on removal of dextran by clarifying reagents that do not contain lead, since the days of lead usage seem limited. The effect of dextran in sugars on pol measured by the high wavelength dark solution polarimeter must also be considered.

Table III. Effect of lead acetate clarification on removal of dextrans added to raw sugar

Dextran added before clarifying T-10	T-40	Dextran remaining after clarifying Roberts, ppm	Haze, m.a.u.
Sugar A (containing 241 ppm)			
-	-	47	0
200	-	191	0
-	200	83	0
1000	-	147	0
-	1000	66	0
1500	-	446	0
-	1500	39	10
Sugar B (containing 676 ppm)			
-	-	48	0
200	-	20	0
-	200	88	0
1000	-	576	20
-	1000	65	0
1500	-	477	0
-	1500	69	0

Comparison of results of dextran tests

There are two dextran tests in general use in the industry today: the traditional alcohol haze method[7,8], and the recently developed Roberts' copper method[6,8].

The haze test measures dextran in terms of turbidity in a 50% alcohol solution, and assays for dextran of higher molecular weight. This is variously defined by workers in the field as molecular weight of 10,000 daltons to above 40,000 daltons. The Roberts test measures all dextran after isolating it as a complex of the alkaline copper (II) ion†. The Roberts method will therefore give a higher reading than the haze method in most cases. Sugars with little low molecular weight dextran, or sugars with a high level of protein or ash can give higher readings by the haze method than by the copper method.

Table IV compares results for a wide variety of raw sugars; in the second column are results from the haze method reported as milliabsorbance units or m.a.u. (5 cm cell basis)[7]; in the third, haze results are given as ppm based on a calibration curve[8] made with 40,000 daltons dextran (T-40) while, in the fourth column, results are from the Roberts' method, expressed as ppm.

It should be mentioned that in reporting haze results, the size of the measurement cell should always be quoted as various published versions of the method use cells of 1 cm, 2 cm or 5 cm, and results, if not normalized, can be increased from two to five times.

The sixth column lists the ratio of Roberts' test results in ppm to haze

† This is not Fehling's solution; some authors have incorrectly referred to the copper reagent in the Roberts' test as Fehling's solution, which it is not.

6 *I.S.J.*, 1983, **85**, 10 - 13.
7 "Bulk raw sugar contract, General contract provisions" (Amstar Corp.); July 1, 1984.
8 Meade - Chen: "Cane sugar handbook" 11th Edn. (Wiley, New York), 1985.

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Table IV. Results of dextran tests and total polysaccharides tests on several raw sugars

Sugar	Haze test (H), m.a.u.	Haze test ppm/T-40 calib.	Roberts' test (R), ppm	Total polysaccharides ppm	R/H
A	10	40	484	-	48.4
B	-10	0	978	3610	-
C	15	12	343	-	22.9
D	18	27	615	-	34.2
E	25	92	501	1390	20.0
F	30	225	372	1670	12.4
G	55	111	626	-	114.0
H	55	122	601	-	10.9
I	540	1144	1129	3120	2.1

analysis in m.a.u., and points out the lack of correlation between the two tests, for the reasons explained above.

In any discussion of the molecular weight range of dextrans in sugars, it should be remembered that, before 1982, only the haze test was in use, and therefore only high molecular weight dextran was measured.

The fifth column lists the levels of total polysaccharides found in some of these raw sugars (not all were analysed for total polysaccharides). This analysis shows the total of dextrans, starch, mannans, I.S.P. and soluble cell wall polysaccharides in the sugar. It is shown here to emphasize that polysaccharides can be present in raws at levels higher than the other non-sugars.

Other dextran tests have been published recently[9-12], but have not been studied at S.P.R.I. and so are not discussed here.

Dextranase enzymes and dextran analysis

It is well known that dextranase enzymes will break down the large dextran molecules into smaller molecules, some of which are mono-, di- and trisaccharides and some larger oligosaccharides. The breakdown of the large molecules will decrease viscosity of the sugar syrup that contains them, and thereby facilitate processing of the syrup and increase the yield of sugar. This change in viscosity has been proposed as a basis for some tests for dextran[13].

A study comparing the effects of several dextranase enzymes available in the U.S. compared their effects on dextrans of molecular weights T-2000 and T-70, and B-512 dextran (very high molecular weight) using a level of 0.5% to 1% dextranase at 40°C over various periods of time. Products of the enzyme treatment were analysed by HPLC (BioRad HPX87C column; solvent - deionized water with 10 ppm calcium propionate; R.I. detection). It was observed that, of the dextranases tested (Novo, Miles, Sigma and International), some contained a significant proportion of sugars and dextran.

Results from typical treatments are shown in Table V. Within 30 minutes, in every trial, all large molecules of dextran had disappeared, but very little glucose had appeared. Major products were oligosaccharides of D.P. 8 to 15 (containing 8 to 15 sugar units), isomaltose and trisaccharides. The trisaccharide peak has been identified as a mixture of isomaltotriose and 3²-α-glucosyl-isomaltose[14].

When α-glucosidase enzyme was added along with a dextranase, results predictably showed a greater proportion of glucose in the products; 12 to 15% had formed within 30 minutes treatment, and more than 20% after 1 hour of treatment. Typical results are shown in Table VI.

Results shown here are from runs at low sugar levels. At higher sugar levels (> 5%), the enzyme effect is slowed down; the product contains more oligosaccharides in proportion to mono-, di- and trisaccharides.

These results indicate that, while tests for dextran that rely on the change in viscosity of syrup upon dextranase treatment can have some validity, tests

Continued at foot of next column

9 Goodacre & Martin: *Proc. Sugar Industry Tech.*, 1981, 103 - 128.
10 Li & Mbada: *I.S.J.*, 1982, **84**, 105 - 108.
11 Day & Sarkar: *ibid.*, 1985, **87**, 123 - 126.
12 Curtin *et al.*: *Sugar J.*, 1986, **48**, (9), 5 - 8.
13 Geronimos & Greenfield: *I.S.J.*, 1978, **80**, 227 - 231.
14 Parrish: *Proc. Sugar Process Res.*, 1982, 157 - 166.

Table V. 1% dextran (T-2000) + 1% dextranase om 2% sucrose solution

Time, hours	Oligosaccharides	Trisaccharides	Disaccharides	Glucose	Fructose	Total, %
1.5	27.05	35.99	33.85	2.32	0.61	99.82
2.5	26.77	31.79	35.91	3.41	0.80	98.68
4.5	26.66	26.16	36.26	6.69	1.80	97.57
7.5	26.14	20.30	38.48	11.50	2.81	99.23
24.0	16.80	20.66	22.63	28.08	11.82	99.99

Table VI. 1% dextran (T-2000) + 1% dextranase + 0.1% α-glucosidase

Time, hours	Oligosaccharides	Trisaccharides	Disaccharides	Glucose	Fructose	Total, %
0.5	33.10	28.87	26.81	11.20	-	99.98
1.0	32.45	26.81	24.21	18.44	-	101.91
1.5	32.00	24.91	20.00	23.17	-	99.08
2.0	30.78	22.32	17.62	28.66	-	99.40
3.0	29.82	17.71	15.40	37.19		100.12
4.0	29.82	11.88	14.56	43.74	-	100.00
5.0	29.21	6.53	14.23	49.81	-	99.78

Developments in the drying and cooling of sugar*

By N. R. Twaite and A. J. Randall
(British Sugar plc)

British Sugar currently operates 13 factories, all producing sugar in the category "white" in the EEC grading system. Since 1981, when four factories were closed, daily sugar production has increased from 9,900 to 11,100 tonnes/day in the 1985/86 campaign. At the same time, attempts have been made to maintain and improve sugar quality whilst reducing steam demands at the sugar end in the drive for heat economy. Results for the past four years are shown in Table I.

N. R. Twaite A. J. Randall

The majority of the sugar at factories (except Peterborough) is stored in concrete silos holding from 8,000 to 26,000 tonnes. Silos built up to 1974 had conditioned air blown into the air space at the top and recirculated. Since 1974, conditioned air has been blown through the sugar and recirculated. A program of replacing the over-sugar air systems with the through-sugar systems is being carried out on a planned basis.

Table I. Campaign average white sugar quality as produced

Campaign	Solution colour	Loss on drying, %	Conductivity ash, %	Quality index Domestic	Quality index Industrial
1981/82	203	0.0191	0.0103	59.71	87.58
1982/83	196	0.0190	0.0100	58.96	89.07
1983/84	188	0.0158*	0.0107	61.78	91.86
1984/85	175	0.0144*	0.0098	65.74	93.13

* Change of method reduced by approx 0.006%

The increase in quantity of sugar produced and improvement in quality was achieved with very little major capital expenditure on new sugar end plant. One result of this has been that the sugar drying and cooling plant was put under ever-increasing load and this has resulted in much warmer sugar going to bulk storage.

The increase in sugar temperatature going to the silos has put additional demands on the air conditioning systems, particularly the refrigeration coolers on the earlier systems and indirect cooling towers on the later underflow plants. There were also the dangers of sugar caking with the migration of heat and residual moisture; this made withdrawal more difficult and increased the dangers of colour build-up during storage. It was decided to investigate the present position around the company and look into the best method of reducing the sugar temperature to storage to around 25°C.

Figures from past records and a check of temperatures on October 22, 1983 are recorded in Table II.

A survey of all the sugar drying and cooling equipment was carried out during the 1982/83 campaign to determine the actual performance aginst design. British Sugar has normally used rotary cascade dryers for this duty. Buell tray dryers were tried at one or two locations but have been replaced with rotary units. Two standard sizes have been used: 6 ft diameter – retained from the past – and 8 ft diameter – a standard design used in all the major rebuilding projects over the last 10 - 20 years. The cascade drums were designed with an air flow of 2.4 ft/sec (0.73 m/sec) which gave 4500 cfm (7650 m^3/hr) for the 6 ft and 7500 cfm (12,750 m^3/hr) for the 8 ft. Measurements obtained during the survey are recorded in Tables III and IV.

A study of the results revealed that the design air flow was not being achieved on a good proportion of the units, particularly the sugar coolers, and that in some cases the sugar curtain was not covering the whole drum area.

* *Paper presented to the 28th Tech. Conf., British Sugar plc, 1986.*

Table II. Campaign average and spot temperatures (°C) of sugar to silos

Factory	1980/81 Campaign	1981/82 Campaign	1982/83 Campaign	October 1983
A	39	-	33	33
B	26	24	27	29
C	45	46	41	41
D	37	33	30	32
E	-	37	37	41
F	30	39	36	32
G	42	41	42	40
H	49	-	46	38
J	37	37	39	41
K	40	-	37	41
L	29	-	32	32
M	24	22	25	24
N	40	-	39	37

Continued from previous page

that assume that the product of enzyme treatment is glucose (even with a combination of enzymes) may require further examination.

Summary

This paper has presented some recent observations on three topics concerning dextrans in sugar manufacture and dextran analysis. The effect of dextran on polarization measurements, when lead acetate is used for sample clarification, has been shown to be less than theoretical. Results from the two dextran tests in common use have been compared and shown to have no obvious relation to one another. A survey of the effects of dextranase enzymes on various dextrans has shown that the major products are di- and trisaccharides, and oligosaccharides containing eight to fifteen sugar units.

ISJ Abstracts

Cane sugar manufacture

Factory research in South Africa

Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1985/86, 3 - 8, 10 - 11.

Post-harvest deterioration of whole stalk cane: Investigation of the effect of cane deterioration on the sucrose content of burnt and trashed NCo 376 cane showed that temperature had an important effect on the rate of purity drop, which increased by a factor of 3 - 4 per 10° rise. Since deterioration led to the production of ethanol and lactic acid, the cut-to-crush delay could be estimated by measuring the ethanol content in a cane extract, with allowance for the average ambient temperature. Deterioration had little or no effect on the colouring matter concentration in clean, healthy cane, while amino-N increased considerably in diseased cane as deterioration progressed.

A recovery parameter independent of juice quality: A Corrected Reduced Boiling House Recovery (CRB) factor has been developed and shown to be independent of mixed juice purity. The basic principle involved is calculation of a target molasses purity based on mixed juice rather than final molasses analysis, the target purity then being used with standard sugar and juice purity to calculate recovery from the s-j-m formula; the recovery is further corrected by factors relating to actual factory performance (undetermined and filter cake losses and molasses target purity difference) to give the CRB. The formula, which was tested on monthly factory data from two seasons, has been derived for true sucrose purities, and the use of pol values would lower its accuracy.

Inversion losses during evaporation: Sucrose losses in evaporation are most often due to poor pH control of limed juice, low juice flow rates or to excessively hot heating surfaces. Inversion can sometimes be detected by monitoring the glucose:Brix ratio across the evaporator. Hourly samples of clear juice and of juices from the heater, two Kestner effects, a separator and the 2nd, 3rd, 4th and 5th effects at a sugar factory were taken over a 4-day period and composited; the composites were analysed for Brix, glucose and sucrose and showed a steady rise in the glucose:Brix ratio throughout the evaporator up to the 4th effect, clearly indicating the occurrence of inversion. In investigation of undetermined losses at another factory, the temperature, pH, Brix and residence time in each evaporator effect were measured and thermal sucrose degradation calculated from the results. It was found that an appreciable proportion of the undetermined losses probably occurred in evaporation, especially in the first two effects. Consideration of undetermined losses throughout the South African industry suggested that the loss at each factory might be largely determined by the size of the first two effects relative to the entire evaporator; a significant correlation ($r = 0.87$) was found between undetermined loss based on pol measurement and the percentage of the total evaporator heating surface that is located in the first two effects (HS%): undetermined loss = 0.082 HS% - 3.9. Laboratory experiments failed to reduce the losses by readjusting the pH of juice immediately after the Kestner vessels; the adjustment caused precipitation in the juice and increased sucrose loss on subsequent heating.

Crystal size distribution in B-*massecuite and its effect on molasses purity rise*: A survey conducted at randomly selected factories showed that the width of *B*-massecuite crystals ranged from 115 to 176 μm with a length:width ratio of 1.6 - 2.0. The effect of the percentage of small crystals on the purity of *B*-molasses was determined and shown in graph form. Some of the factories used 0.06 mm centrifugal screens and some 0.09 mm screens, and equations have been derived for calculation of the effect of slot width on molasses losses.

Comparison of single and double curing of C-*massecuite*: In seven comparative weekly runs with single and double curing of *C*-massecuite, no significant difference was found in exhaustion of *A*-massecuite, while a slightly better exhaustion of *B*-massecuite was obtained with double curing. There was a 1.1 difference in target purity difference and a 0.34 difference in pol lost in molasses % pol in mixed juice in favour of single curing, but undetermined losses were higher at 1.53 than with double curing (1.41) as was sugar colour (570 compared with 480 ICUMSA units). The results appear to contradict the observation of factory staff that it was easier to meet raw sugar quality specification with double curing, and may have been affected by processing difficulties during the tests at the factory in question and by the fact that up to 60% of the factory sucrose intake was being diverted to high-test molasses, which affected the accuracy of the data based on mass balances.

Crystal size dispersion in massecuites: The relationship between crystal width (W_c) of *C*-massecuite and its standard deviation (∂), calculated from data accumulated during monthly surveys of crystal size in South African factories during 1984 and 1985, may be expressed by $\partial = 0.63\ W_c - 25$ ($r = 0.86$), showing that ∂ increased with crystal size. Investigations of changes in crystal size distribution during boiling at two factories reporting good final molasses exhaustion while showing very different crystal size characteristics (with one factory having large crystals and a wide distribution, and the reverse being true for the other factory) indicated that the difference started in the very early stages of crystal growth.

Crystallization and crystal deformation: Although a batch of crystals grown under a given set of conditions in a standardized laboratory procedure show a distribution of shapes (expressed as y/z), the repeatability of the mean value of y/z for about 15 batches is good for both normal and elongated crystals and crystal shape is independent of size. The technique has demonstrated that elongation increases with the impurities concentration, which is analogous to the increase in elongation as boiling progresses in a factory pan. Since the crystals are grown under identical laboratory conditions in the technique, it is concluded that chemical effects are more important than physical parameters

in crystal shape modification. It apppears that refinery products have five times the elongating power per unit mass of impurities than factory products, possibly indicating some form of selective inclusion of the more potent elongators in the raw sugar crystal, leading to a substantial concentration of these impurities in the refinery where extensive elongation takes place even at relatively high purities. Refinery and factory molasses fractions containing predominantly components of high or low molecular weight were added to sucrose solutions in proportion to the yields at levels equivalent to non-sucrose:water ratios of 0.1 for refinery products and 0.5 for factory products, i.e. purities of approx. 97 and 86, respectively; at all South African refineries crystal elongation is significant at this impurity level. In all cases, the polysaccharides constituted about 7 - 10% of the non-sucrose and played little part in elongation, practically all of which was caused by alcohol-soluble components of low M.W.; the oligosaccharides in this fraction comprised some 10% of the total non-sucrose. These same low M.W. components are also the major contributors to crystal elongation in the factory, and oligosaccharide concentrations were similar for both factory and refinery products in a laboratory crystallizer. However, polysaccharides also make a significant contribution to crystal shape at the higher levels encountered in the factory, and their role could well predominate should these levels increase dramatically. An oligosaccharide fraction separated from sucrose and monosaccharides by carbon-celite chromatography was found to contain the bulk of the crystal elongating and rate-retarding constituents. No single component was found to be responsible for *c*-axis elongation.

Maidstone diffuser dewatering mill: The turbine-driven dewatering mill is equipped with a two-roller pressure feeder and has hydraulics on both top and discharge rollers. Measured values are tabulated for torque and power on the feeder and rollers and of roller lift at three turbine speeds (2516, 2912 and 3310 rpm). Lift on the pintle side was very much greater than on the gear side in the case of both rollers, and alteration in the hydraulic pressure had hardly any effect on this. While bagasse moisture content was about the same at approx. 57% at the two highest turbine speeds, at 2516 rpm there was a significant drop to about 53%.

Umzimkulu milling performance: Continuous measurement of the torque on No. 2 and No. 4 mills showed very low power inputs despite a high hydraulic loading, reduction in which caused no decrease in torque. A speed reduction caused increase in torque and a slight increase in power.

Operating performance of the mechanical vapour recompressor at Noodsberg: While tests indicated that a better steam balance with less frequent blow-off was achieved by operating the compressor between vapour 2 (at 110 kPa abs) and vapour 1 (170 kPa) than when it was operated between vapour 2 and exhaust steam at 210 kPa, under the new arrangement the compressor has excess capacity so that its efficiency is low.

Vacuum pan design data: Investigations of the effect of steam injection on the evaporation rate of *C*-massecuite as a function of tube length and vacuum in a pilot pan showed that the increase in evaporation as a result of the injection was greater with tubes 1.8 m long than with 0.6 m tubes and that the increase was greater at high vacuum (10 kPa abs) than at low vacuum (15 kPa).

Diffuser chain survey: Unacceptable corrosion of chain pins and bushes in a particular type of diffuser was considered to be due to a basic design fault, and the manufacturer has since improved the pin specification. It was found that stainless steel pins did not corrode in the diffuser environment, showed very little wear and rotated freely in their bushes.

Factory research in Australia

Anon. *Ann. Rev. Sugar Research Inst.*, 1985/86, 7 - 16.

Fibre determination apparatus: A prototype unit for determining the fibre content in 500g samples of cane was tested to check that it performed satisfactorily by removing all sugar, losing no fibre from the sample and minimizing the processing time; it has now been re-engineered to provide a unit satisfactory for factory use. Once all the dissolved solids in the sample have been washed out, the sample container is moved across to the drying unit; this separation of the washing and drying operations ensures that no wash water accidentally enters the sample at the end of the drying cycle. Operation is controlled by a single programmable logic controller, so that the operator has only to load, transfer and unload the sample.

Maintenance studies: As a start to an investigation of corrosion-resistant alloys , a range of stainless steels were selected for evaluation in boiler flue gas ducts downstream of wet scrubber systems. Problems concerning the failure of stainless steel tubing, particularly in juice heaters and evaporators, were also examined, leading to further examination of the pitting resistance of lower chromium austenitic steels and the components of factory process streams that effect the pitting. Studies of protection against rust and of long-term coatings for structural steels, etc. were also begun. The main problem encountered in an investigation of the possible use of plastics in sugar factories concerned the specification of the type of material used, since plastics are generally sold under a brand name without reference to composition; examination of technical literature has failed to provide a solution.

Corrosion pitting in stainless steel: High concentrations of chloride have been suspected in cases of severe pitting corrosion in juice heater and evaporator tubes made of 304 stainless steel; other factors possibly involved include scale-induced crevices, low levels of residual oxygen and other corrosion products at the metal surface when cleaning or rinsing solutions are in contact with the plant for a time. The fact that molasses acts as a corrosion inhibitor may explain why corrosion of 304 steel is not widespread.

Milling studies: Much emphasis is

being placed on investigations to offer guidance for the design of unconventional mill configurations, e.g. with ratios of roller length to diameter other than 2 or mills with fewer than five or six rollers arranged in different configurations. Theoretical work continues on computer simulation of flow in the nip region of a pair of rollers; as a precursor to this work, a study was undertaken to produce an improved empirical model for the prediction of reabsorption at a No. 1 mill and the effect of differing cane preparation on No. 1 mill performance. The model also helped to explain some of the peculiarities found during milling trials conducted several years ago in a study of the effect of cane variety on mill performance. Existing extraction and feeding theory was used to assess the performance of mill design other than the standard 5- or 6-roller configurations. The data used include the results of a re-examination of all available measurements of milling torques and loads over the last 10 years.

Diffusion studies: A small-scale shredding and milling unit was used to investigate the permeability of bagasse produced by different shredding treatments, and the information used to comment on suitable strategies for diffusion of cane of vastly differing characteristics; the same equipment was also employed in a study of the change in milling behaviour caused by heat treatment of bagasse. Measurement of the acetate levels in juice in regard to the effect of lime addition in diffusers showed that when pockets of high pH are caused by uneven distribution of lime, there is a 10-fold increase in juice acetate, even at pH 5.6, so that care in dosing can minimize lime consumption, reduce the extraction of impurities and improve molasses exhaustion.

Large gear metrology: The large, low-speed gears used in the final drives of cane mills are costly to manufacture; once they have been made there is no adequate means of ensuring acceptability of the overall tooth form (especially when the gear is to match with an existing one) until mating tests can be carried out, and if the results are unsatisfactory there is no way of measuring the extent to which the tooth form deviates from the ideal. A scheme set up by the SRI in conjunction with other organizations aims to produce two items of portable gear measuring equipment. The first to be made was an axial pitch instrument which can also measure the gear's helix angle; a final working prototype and working drawings have been produced, and a company to manufacture two instruments of this type was being sought. The other item is a profile or flank form-tracing instrument which exists as a preliminary prototype.

Automatic bin identification: While three factories have already adopted the reflective bar code/solid state camera system of automatic cane bin number identification to assist in cane reception automation, a commercial system based on a small transponder attached to each bin was also to be evaluated by the SRI; the transponder is activated and read by aerials mounted near the line of bins. However, while the read station is cheaper than with the bar code system, the transponders are more expensive, so that the system is more suitable for relatively small bin fleets and may be applicable to control of sugar bin deliveries.

Cane preparation using a ball mill: Examination of the possibility of using a ball mill to prepare billeted cane in place of a shredder showed that at a cane rate of about 400 tonnes/hr the power requirement would be about the same as for a heavy-duty shredder while the equipment would be much larger; the problem of how to remove the prepared cane from the ball mill was not investigated.

Bagasse moisture measurement: As part of a project aimed at finding a method for measuring bagasse moisture rapidly and developing the appropriate instrumentation, experiments showed that at radio frequencies the dielectric constant of a compressed bagasse sample is closely related to the amount of water in it; however, the effect of factors such as cane variety, Brix and pol, compaction and temperature need to be explored more fully. An under-belt moisture meter developed for the coal industry is also being examined; the system uses capacitance at radio frequency to measure the water content of the material on the belt and gamma-radiation to measure its density.

Spontaneous combustion of bagasse: Investigations into spontaneous combustion of stored moist bagasse have shown that the initial temperature in the bagasse pile should be below 84°C; spontaneous combustion is imminent once the temperature exceeds 94°C. While it has been generally thought that microbial activity is responsible for self-heating of organic matter to about 65°C, with further heating apparently resulting from other aqueous phase chemical reactions, field and laboratory tests involving various biocides showed that microbial heating had no significant effect on bagasse pile heating.

Cooling crystallizer model: Factory trials using pilot crystallizers during 1983/84 were intended to verify results of laboratory-scale experiments on low-grade massecuite cooling. All the parameters influencing crystallization have been incorporated in a mathematical model which has been found to give an accurate simulation of the process and is to be used to evaluate alternative modes of crystallizer operation and to assess alternative crystallizer designs.

Swirl burner development: An experimental furnace and pilot burner system have been built to evaluate the use of swirl burners designed to burn bagasse more efficiently. Extensive testing of the burner has identified two specific burner nozzle geometries which develop stable bagasse flames; the stability limits of the flames have been established in relation to swirl level, primary and secondary nozzle velocities, combustion air distribution and bagasse moisture content. The upper limit was reached at 32% bagasse moisture, and a significant improvement in stability was achieved by including a diverging conical insert at the exit of the burner primary fuel nozzle. Both attached and detached stability limits have been established and flame temperature and gas composition contours measured for burner configur-

ation that develop stable flames. A half-scale prototype burner suitable for use with unsieved bagasse has been designed. The combustion facility in the experimental system has been modified to include bagasse drying using simulated furnace exit flue gas; the characteristics of the drying circuit have been measured for variations in gas inlet temperature, residence time and bagasse inlet moisture content, and sufficient performance data have been obtained to permit the design of a full-scale drying system.

Ultrafiltration: Results obtained with a pilot ultrafiltration plant comprising four 2.6 m^2 modules in series, each fed by separate pump from a common manifold, confirmed earlier findings that the process can effectively remove starch, dextran and other polysaccharides from clarified juice; however, both rejection and flux were governed by concentration polarization of the membrane surfaces rather than by the membranes themselves, so that juice fluxes were very much lower than expected. Membrane cleaning was also difficult, best results being obtained using 0.25% NaOH solutions at 70°C. While it was estimated that sugar losses could be reduced to about 0.5% and that a membrane life of 3 - 4 seasons might be possible, the effect of the concentration polarization was such that the process would not be economically viable unless the effect could be reduced by relatively minor process modifications.

Pan stage technology: The continuous low-grade pan at Tully is considered to incorporate the best of continuous pan design concepts and has consistently produced well exhausted massecuites of high concentration despite lower evaporation rates than in batch pans which, however, have resulted in quite low specific steam consumption per unit production. Circulation is good, operation of the pan is simple and supervision requirements are minimal. Modification of incondensable gas venting pipes on one of the three calandrias intended to allow full-depth venting failed to cause any significant changes in the evaporation rates, which are thought to be associated with the heavy boiling conditions, relatively low vacuum and the absence of any added circulation steam.

Pan overstirrer developments: While beneficial effects were obtained by installing a large axial-flow impeller above the top tube plate of a floating calandria pan, the results were not as good as expected; however, a revised design fitted to a *B*-pan almost doubled the input power:pan volume ratio, increased the swept area by about 50% and halved the gap at the leading edge of the blade. The heat transfer coefficient was raised by up to 20%.

Boiler water treatment problems: Deposits in boiler water systems at a number of factories have consisted mainly of iron and copper corrosion products scavenged during phosphate precipitation of Ca^{++} and Mg^{++} ions; the concentrations of these products in condensates are maximum during the first few hours after the weekly start-up, and the condensates can be used for imbibition during this period provided there is adequate feedwater available. A few cases of pitting corrosion in boiler steam drums may have been caused by interaction of the corrosion products with the magnetite surface, although residual oxygen is also suspected in some instances.

Survey of mill shut-down/start-up procedures: A survey of techniques and equipment used by factories during shut-down after the weekly crush and for the start-up and pre-start-up periods showed a significant variation in the methods used for initial replacement of juice in the evaporator effects with water and for subsequent boiling out with NaOH and rinsing. It was found desirable to have a storage volume of NaOH at least sufficient to cover the calandrias; the time involved in transferring NaOH to and from storage was often excessive and could be significantly reduced by using larger pumps and lines. Appreciable cuts in the time spent in shutting-down the pan station were achieved by leaving high-grade massecuites in the pans or receiving troughs.

Evaporator circulation studies: The typical Australian evaporator has a calandria which is only 2 - 3 m tall, with no special provision for returning juice from above the top tube plate. Inclusion of 44 downtakes, 150 mm in diameter, evenly distributed across the calandria of a new 5100 m^2 evaporator at Fairymead improved the heat transfer coefficients by 7%. A juice level control scheme based on the head of juice collecting above the top tube plate rather than on the static juice level in the tubes has been demonstrated.

Crystal initiation pan development: A 100-litre prototype pan has been constructed for graining. It combines intensive mixing of the graining blend with the ability to optimize the purity of the blend and tight fully automatic control of the important crystallization variables; a sequence controller and conductivity and level sensing instrumentation are incorporated. Connected to the graining pan at a factory, the unit was to be used to establish crystal seed particles and grow them from 5 to 30 μm for transfer to the factory pan.

Sugar drying and cooling: The electrical resistance between two electrodes on a raw sugar belt is used to provide an estimation of the Dilution Indicator of the sugar and to activate additions of water if it is too dry. Because of accumulation of sugar on the electrodes, causing mis-readings, a contactless conductivity electrode was tested. Results showed a close relationship between sugar moisture and the dielectric loss of a tuned circuit in which a sample cell containing the sugar acted as capacitor. The prototype electrode gave results similar to those given by clean direct conductivity probes and was not greatly affected by a coating of sugar.

Dextran — plans for the 1986 crop

J. A. Polack. *Sugar Bull.*, 1986, **65**, (1), 8.

A survey is presented of measures to determine and control dextran and to establish where, between the cane in the field and raw sugar, dextran was likely to be generated.

Beet sugar manufacture

Treatment of first carbonatation mud by centrifuge

C. A. Accorsi and F. Zama. *Ind. Alim. Agric.*, **103,** 639 - 647 *(French).*

The theory of solid-solid separation is explained and the possible use of scroll-type centrifuges for mud treatment discussed. The components and operation of a centrifuge are briefly explained, and details then given of tests conducted in 1983/85, first using separate types in 1983 and 1984, and using two of the same type in series in 1985. Mud from filter-thickeners was treated in the first machine and the underflow from this diluted to 15 - 20°Bé with some of the juice from the 2nd centrifuge; sweetening-off water at 25% on thickened mud was added in the 2nd machine, juice from which not used for mud dilution was utilized for lime slaking. At an hourly throughput of 16 - 25 m^3 containing 0.22 - 0.29 tonnes of dry solids per m^3, the final mud dry solids content was raised to 63 - 65% at a pol loss of 0.5 - 0.6%. While addition of polyelectrolyte at 100 - 233 ppm reduced the amount of mud in suspension, it also caused a fall in final mud dry solids and an increase in sugar losses. While use of centrifuges increases electricity consumption, there are the advantages of drier muds, elimination of the need for filter aid or other auxiliaries, regular operation unaffected by juice quality, simplicity of installation and less encumbrance.

Clear progress in the treatment of sugar factory effluent: the anaerobic filter

C. Camilleri and I. Bourgeois. *Ind. Alim. Agric.*, 1986, **103,** 651 - 653 *(French).*

Descriptions are given of SGN anaerobic systems at two French sugar factories. Common to both is the use of thin corrugated plastic rings as support for the falling stream of effluent. At Thumeries, throughput of beet wash water is 125 m^3/hr at a daily COD rate of 16 tonnes; 90% of the COD is eliminated and a nominal 5000 m^3 of methane produced per day. At Aulnois-sous-Laon, throughput of a mixture of beet wash water and distillery waste is 135 m^3/hr, and approx. 90% of the 28 tonnes of COD per day is eliminated; methane production is 8750 m^3/day.

Coal energy in the sugar industry

J. P. Faussereau. *Ind. Alim. Agric.*, **103,** 655 - 658 *(French).*

The advantages of coal as fuel for sugar factory boilers are discussed, particularly the economics by comparison with oil, and the merits of the pulverized coal boiler with mechanical thrower, eleven of which have been introduced in the French sugar industry for outputs in the range 35 - 125 MW, are indicated. Seventeen French sugar factories now burn coal.

Energy cost and beet pulp pressing. Optimization

M. Demaux. *Ind. Alim. Agric.*, 1986, **103,** 661 - 667 *(French).*

A simple mathematical model of the technico-economic aspects of pulp pressing and drying, on which was based a study reported in 1978, is used in a new investigation for which the values of the various parameters incorporated in it have been updated. The basis of the study is to determine the economically optimum dry solids content of pressed pulp at which the total costs of pressing and drying are minimum. It is shown that the conclusions arrived at in the earlier study remain valid for the later investigation. While the technical costs and arrangement of a pressing/drying station can be appraised with good approximation, a compromise factor must also be incorporated in the model to allow for the fact that the upper limit of pressing is the major governing factor and required level of dry solids may be difficult to obtain to satisfy the economic constraints of the drying process.

The computer systems of the design office at the service of the sugar industry

C. Oudart and A. Belotti. *Ind. Alim. Agric.*, 1986, **103,** 677 - 682 *(French).*

The authors describe the application of CADAM software and IBM hardware to the planning and design of sugar factory process stations and equipment at Soc. Fives-Cail Babcock, and give details of a program of calculation for a quintuple-effect evaporator.

New computer techniques in the sugar industry

J. P. Faidherbe. *Ind. Alim. Agric.*, 1986, **103,** 685 - 688 *(French).*

The components of the Philips computerized system for logging beet reception data and beet sample weight and pol are described.

Degradation of reducing matter during main liming

E. Sarka, K. Vrskova and L. Fortova. *Listy Cukr.*, 1986, **102,** 207 - 211 *(Czech).*

Methods for calculation of reducing sugars and sucrose degradation kinetics under ideal mixing and plug flow conditions are presented, and values of the invert sugar degradation constant calculated using the various equations are compared for varying pH and temperature. Experimental studies at Nymburk sugar factory (where 1st carbonatation mud is recycled to preliming) are reported in which variants of liming involved two or three vessels, the first of which in all but one variant was provided with a stirrer. Values of the ratio between the juice reducing sugars content after liming and the value theoretically obtainable with perfect mixing were determined in each case as well as the extent of degradation (negligible sucrose degradation being assumed). Results obtained at another two sugar factories are also reported. A number of recommendations are made on the basis of the experiments, including the desirability of liming in a number of small vessels in series or, if a single vessel is used, adoption of the type employed at Hrochev Tynec which has a lateral feed pipe with 90° elbow allowing the juice to flow down the central

section housing the vertical stirrer so that immediate mixing takes place towards the bottom of the tank. Hot liming at 82°C gave higher degrees of invert sugar degradation than cold limng at 62°C and was more effective with extended residence time.

Incrustations above the liquid level in sucrose crystallizers

S. K. Heffels, A. Pot, L. H. de Nie and E. J. de Jong. *Zuckerind.*, 1986, **111**, 845 - 850 *(English, German).*

In investigations of incrustation formation in crystallizers (equivalent to factory vacuum pans) used in the experimental system at Delft Technical University, it was found that crystals, particularly small ones, played an essential role. Droplets of suspension splashed on the walls of the vessels and trapped crystals; the droplets had a critical size below which they did not move and a critical speed of flow above which they formed a tail, i.e. a thin liquid film. Crystals remained attached to the wall either in the static droplet or in the tail. No material was found that would completely prevent incrustation, although hydrophobic material such as Teflon (polytetrafluoroethylene) was better than hydrophilic material such as glasss or steel in delaying incrustation formation (the stagnating droplet being much smaller than on the other materials). Incrustation was noticeably affected by the crystal residence time at the wall, by the crystal surface area per unit volume of adhering droplets and by the evaporation rate. One practical method for prevention of incrustation is suggested in which undersaturated syrup or water is sprayed onto the walls to form a film; the amount of water would have a major effect on the heat economy of the vessel, so that an optimum amount would have to be determined; 1 - 2 g/m² was found to be adequate for a large degree of prevention.

Dust separation from (pulp) drying vapours by means of a belt filter at Düren sugar factory

K. H. Weschke, K. Biedermann and A. Vonplon. *Zuckerind.*, 1986, **111**, 851 - 854 *(German).*

Two drum dryers are used to raise the dry solids content of 93 - 94% of the molassed pressed pulp from 27% to 90%, suitable for pelleting, while the remaining 6 - 7% of the pulp is dried (also to 90% dry solids) on a special belt filter of 80m² surface area, Boiler flue gas is fed to the two drum dryers, the vapours from which are combined and passed through the layer of pulp on the belt filter; since the velocity (1 m/sec) at which the vapour passes through the bed is very low relative to the filter surface area, fine particles of dust are retained on the pulp. The dust-free vapour below the filter is removed by a fan and fed to the atmosphere. The dust and SO_2 contents of the air from the pulp drying plant are below the upper limits set by West German regulations for atmospheric emission.

Monitoring bulk materials

O. Parisek. *Zuckerind.*, 1986, **111**, 854 - 856, 858 *(German).*

The Endress + Hauser deflecting plate flow meter for bulk material is described and its application to monitoring pressed pulp feed to dryers and to steadying white sugar centrifugal work (by monitoring the amount of sugar passing from the granulator to the screens) at Waghäusel factory discussed. As the material falls, e.g. from the end of a conveyor, it strikes the deflector with a force that pushes a vertical lever on it against a measuring spring. Although the force is composed of a vertical and a horizontal component, equal and opposite vertical forces act on the patented vertical bearings of the rotary axis, so that only the horizontal component is measured. The travel, directly proportional to the force of impact, is measured by an inductive system and converted to an electrical signal. An account is also given of the Granuflow microwave flow detector based on the Doppler effect which is used to indicate flow/non-flow; the three pulp dryers are provided with the instrument so as to prevent overheating and possible outbreak of fire in the event of feed stoppage.

Automatic recycling and continuous centrifugals for the sugar industry

B. Koros. *Czechoslovak Heavy Ind.*, 1986, (10), 15 - 20.

Detailed descriptions are given of the Czechoslovakian ARO 80 series of fully automatic centrifugals (available in two sizes for affination, *A*-, *B*- and *C*-massecuites and refined sugar) and of the OKK 1400 M continuous machine suitable for *B*- and *C*-massecuites.

The disperse composition of dust formed during white sugar drying

V. V. Varvarov and V. A. Golybin. *Sakhar. Prom.*, 1986, (9), 17 - 18 *(Russian).*

Ultrafiltration and microscopy of sugar dust samples taken from different spots about the granulator showed that the largest particles occurred in a sample taken at the granulator discharge point (approx. 40% of the particles exceeding 100 μm), while 85% by weight of the air after the dust separator contained particles measuring <10 μm).

Single pass biological ponds with tall aquatic plants in a recirculation water supply scheme for sugar factories

V. V. Kravets, E. A. Pervaya and N. V. Rogozovskaya. *Sakhar. Prom.*, 1986, (9), 21 - 23 *(Russian).*

Experimental treatment is reported of Class III sugar factory waste water (including beet flume/washer mud, overflow from filter-cake settling, water from gas scrubbers and filter cloth laundering and domestic sewage) in a settling pond followed by a series of four biological ponds planted with reeds of the *Scirpus* and *Typha* species, flags, sedges, etc. Results depended on the time of year but tabulated data for a campaign indicate reductions of 95.7%, 97.2% , 80.3% and 72.4% in BOD_5, COD ,

nitrogen and phosphates, respectively.

Trials of an Al-PSS centrifugal liquid separator for thick juice clarification

A. A. Mukhin *et al. Sakhar. Prom.*, 1986, (9), 26 - 28 *(Russian)*.

A conical disc centrifuge with hydraulically activated sequential opening of the mud and juice discharge ports was tested on sulphitation thick juice of 50 - 60 Brix. Microprocessor control of juice feed was based on viscosity, impurities level (as established by laboratory analysis) and centrifuge speed. The performance of the machine was evaluated in terms of a clarification coefficient (relating to turbidity). Mass production of the centrifuge, which has advantages over disc filters, is recommended once further trials have been conducted on 70°Bx juices.

The new Al-PD2-S30 diffuser

A. P. Parkhod'ko and D. I. Smetana. *Sakhar. Prom.*, 1986, (9), 28 - 30 *(Russian)*.

The development of the Al-PD2-S30 inclined scroll diffuser is described from the first experimental model to commissioning trials of a modified version. The diffuser, of 3000 tonnes/day nominal throughput, has an angle of slope of 10°30' from the horizontal and is provided with two upper and two lower scrolls rotating at 0.93 rpm and driven by one motor per pair; the lower scrolls are longer than the upper ones by three rows of blades, but the loads on the motors are equalized by supplementary supply of feed water in the discharge section of the lower part. In tests conducted in 1984 with beets of which 24% were frozen and 59% were of normal processing quality, losses were 0.38% on beet at a draft of 137.7%. A number of design improvements have been recommended.

Factory trials on a spray-type pressure carbonatation vessel

V. B. Vyskrebtsov, V. V. Ponomarenko and V. I. Bochkin. *Sakhar. Prom.*, 1986, (9), 30 - 32 *(Russian)*.

Spray absorbers 800 and 1400 mm in diameter are mounted on opposite sides of a continuous carbonatation vessel. Juice is pumped up through a nozzle at 2 and 4 bar pressure into each absorber while gas is pumped down into the upper section; the gas/juice mixture then flows down a pipe into the carbonatation vessel below the level of juice already there; it is this level that governs the juice feed pressure in the absorbers. In trials, the new system provided up to 1 unit higher purity than in a conventional system as well as greater CO_2 utilization, lower lime salts and improved mud settling.

Experience in operation of the pulp drying section at Aleksandriiskii sugar factory

A. F. Zaborsisn, V. D. Orlov and V. P. Mulenko. *Sakhar. Prom.*, 1986, (9), 32 - 34 *(Russian)*.

The advantages of two cylindrical furnaces in place of chamber furnaces for the pulp dryers at Aleksandriiskii are discussed. Remote control of pulp feed on the basis of the temperature of the exhaust heating medium ensures maximum possible heat load, and fuel consumption is lower than with the previous furnaces. Replacement of brass screens with stainless steel ones on one of the pulp presses, after a number of the former type had been damaged, increased pressing efficiency. Other items discussed include the temperature conditions in the pulp dryers, problems with the fireclay bricks used to line the furnaces and the means used to monitor fuel oil consumption.

Some mechanisms of the scale formation process in long-tube evaporator channels

N. A. Pryadko *et al. Sakhar Prom.*, 1986, (9), 38 - 41 *(Russian)*.

The dynamics of scale formation in an experimental long-tube evaporator system, operated for up to 54 days in parallel with normal evaporator effects, were investigated and the effect of scale on heat transfer determined. The system comprised four units in each of which a pair of evaporators differed in their tube length:diameter ratios; the juice was fed from one of the normal evaporator effects to which it was recycled after treatment in the long-tube unit. Comparison of the heat transfer coefficients as a function of heat flux between the two types of evaporator showed close agreement only when heat exchange surfaces were clean; the fall in the heat transfer coefficient caused by scale formation was smaller in the long-tube evaporators than in the short-tube units. The experimental data have been incorporated in formulae for calculation of heat transfer and heat surface utilization as a function of time for a required Brix rise.

Some thoughts on the classical method of juice purification

H. Schiweck. *Cukoripar*, 1986, **39**, 95 - 99 *(Hungarian)*.

See *I.S.J.*, 1986, **88**, 15A.

Microbiological evaluation of beet sugar

L. Kerekes. *Cukoripar*, 1986, **39**, 105 - 111 *(Hungarian)*.

After a brief summary of the classes of micro-organism found in sugar and the conditions under which they develop, descriptions are given of sampling and culturing methods, whereby it is shown that there is no significant difference in the results given by culture in Petri dishes, dilution culture and membrane filtration. The establishment of microbiological standards for sugar is discussed with the aid of statistical analysis of tabulated data for Hungarian sugar and reproduction of characteristic curves. The Bartlett test for estimation of variance is shown, by application to levels of the different classes of microbe in sugar as determined in 1980, to be invalid despite the exclusion of several scattered values. It is suggested that, for routine purposes, two representative samples and one limit based on the

average values for each type of micro-organism should be applied. Comparison of 1980 and 3-year average values with the ICUMSA norms on this basis showed that the values for yeasts, moulds and spore- and acid-forming aerobic thermophiles were below the limits, only the value for aerobic mesophiles being above the norm. Application of systems of standards such as the ICUMSA or US systems is appropriate provided allowance is made for Hungarian conditions. Use of the proposed system of estimation is demonstrated.

Beet reception and accounting using a Proper 16 W professional personal computer at Petohazi sugar factory

M. Tömördi. *Cukoripar*, 1986, **39**, 112 - 114 *(Hungarian)*.

Details are given of the hard- and software incorporated in the computerized system for beet reception and accounting at Petohazi, including data logging from the Venema beet analysis system. The scheme is centred on a 256-kilobyte IBM-compatible Proper 16 W/A unit.

Sugar syrup decolorization with an inorganic sorbent

V. M. Sukhanova and V. V. Zueva. *Mater. 2-oi Nauch.-Prakt. Konf. Mol. Uchenykh i Spets. Voronezh. Tekhnol. Inst. po Aktual. Probl.*, 1986, 116 - 118; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (19), Abs. 19 R443.

The use of alumina gel for sugar solution treatment gives a high (70%) decolorizing efficiency and a good degree of purification (80.3%); the purity rises to 99.3 and lime salts are completely removed. The decolorizing capacity of alumina gel under dynamic conditions was evaluated in chromatography columns heated with water at 80°C; column diameter was 10 mm and the sorbent bed layer depth 160 mm. When the initial volumes of syrup were passed through the column, the decolorizing efficiency was 82 - 83%, purification efficiency was 52 - 59%, up to 30% lime salts were removed and the pH fell from 7.8 to 7.0. Treatment of the alumina gel with H_2SO_4 caused carbonization and swelling. Positive results were obtained by regeneration with 1M NaOH solution.

Intensification of the white sugar drying process

G. I. Liberman. *Mat. 2-oi Nauch.-Prakt. Konf. Mol. Uchenykh i Spets. Voronezh. Tekhnol. Inst. po Aktual. Probl.*, 1986, 66 - 68; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (19), Abs. 19 R445.

Reasons are given for the choice of white sugar drying method in a vibro-fluidized bed with combined conduction-convective heat feed, and the arrangement of the working element (thermal gas distributor) is described. A table is presented of comparative analysis of the unit developed and of a convective vibro-dryer for white sugar employed at Liepaja sugar factory.

Sugar cooling: the NEU solution

Anon. *Sucr. Franç.*, 1986, **127**, 285 - 286 *(French)*.

Advantages of fluidized bed cooling of sugar over the use of rotary drums are discussed by a representative of NEU, a company that manufactures the former type.

Affination of low-grade yellow sugar with heated dilute molasses in centrifugals

G. F. Tyazhelova. *Sakhar. Prom.*, 1986, (10), 18 - 20 *(Russian)*.

Affination with molasses at 82°C and 77.2°Bx raised the purity of low-grade sugar from 94.1 to 97.3 and reduced its colour from 58.4 to 29.8 units without any major change in the molasses parameters.

Results of factory trials on PG-1 foam depressant

T. S. Taranenko *et al. Sakhar. Prom.*, 1986, (10), 25 - 28 *(Russian)*.

Trials are reported on foam prevention in diffusion using PG-1, a solid parafffin-type mixture of two food-standard surfactants which has a melting point of 45 - 55°C. At 0.005 - 0.008% on beet, an aqueous suspension of 8 - 10% concentration increased diffuser throughput with reduced juice draft even when the beet were somewhat sub-standard.

Utilization of energy resources at the "Fiftieth Anniversary of the USSR" sugar factory at Erken-Shakhar

N. K. Polishchuk. *Sakhar. Prom.*, 1986, (10), 39 - 40 *(Russian)*.

Introduction of a number of steps to save heat energy led to a reduction in fuel and limestone and a drop in molasses sugar despite an increase in the beet slice. The measures adopted are described.

Effect of beet scalping on increase in the quality of raw juice

V. S. Shterman, A. R. Sapronov, E. V. Ivchenko, M. S. Zhigalov and L. P. Popova. *Sakhar. Prom.*, 1986, (10), 41 - 43 *(Russian)*.

Since the layers adjoining the outer surface (periderm) of a beet contain the least sugar and the most non-sugars, it has been suggested that removing them would have a positive effect on raw juice quality. Laboratory tests confirmed that scalping to remove 5% of the beet raised purity by 4% compared with juice from control beets. A mathematical model was developed of the diffusion process for determination of the degree of scalping at which the effective sugar yield (sugar obtained from a given quantity of beet plus that in final molasses, the total being a function of the wholesale price of sugar) is maximum. There is an optimum point above which it is inadvisable to remove any more layers because of increased sugar losses in the peelings. Other positive effects of scalping are mentioned; the peelings should be dried together with beet pulp to provide animal fodder of higher nutritive value.

Laboratory studies

The effect of sugars on saponin determination in waste water

V. V. Sakhnenko, V. M. Zaitseva, L. S. Makhataya and I. A. Zabulonskii. *Sakhar. Prom.*, 1986, (8), 28 - 29 *(Russian).*

To detemine the effect of sugar on saponin determination by the method described earlier[1], sugar solutions of 0 - 50% concentration w/v were adjusted to pH 1 with HCl, boiled for 20 minutes, cooled to room temperature and passed through a Schott filter with kieselguhr. The filter and contents were dried for 1 hr at 105°C followed by extraction with 10 ml hot acetic acid; the extract was mixed with 10 ml HCl and placed for 3 hr on a boiling water bath for hydrolysis. Measurement of the optical density showed that sugar exerted a marked influence on saponin determination by reacting with the HCl to form colour. Subsequent tests showed that the problem can be overcome by washing with 10 - 25 ml distilled water (depending on the sugar concentration) adjusted to pH 1 - 2.

Methods and techniques for predicting the potential crystal sugar yield as a function of the chemical composition of processed beet

M. Z. Khelemskii and A. L. Shoikhet. *Sakhar. Prom.*, 1986, (8), 41 - 42 *(Russian).*

Prediction of sugar yield on the basis of beet analysis is discussed, and the contributions made by various authors indicated. The formula of Reinefeld *et al.* for molasses sugar and that of IRIS for the alkalinity coefficient are reproduced. The desirability of laboratory processing of beet to the molasses stage as a complement to beet analysis is examined, and references made to development of laboratories for beet analysis, particularly the IRIS system.

Evaluation of sugar beet quality in terms of the corrected sugar content, particularly evaluation of the importance of the classes of substance involved

E. Reinefeld, A. Emmerich, M. Burba and M. Possiel. *Zuckerind.*, 1986, **111**, 730 - 738 *(German).*

Quality evaluation on the basis of the corrected sugar content, in which a deduction is made from the pol reading to allow for K, Na and N (as the blue number), was applied to beet samples of extreme composition and shown to be valid even in such cases. Evaluation of the relative melassigenic importance of the nitrogenous fraction and salts fraction (comparing mostly alkali salts) in beet showed the latter to be clearly the dominant contributor to molasses formation. However, the method for beet evaluation developed by Devillers *et al.*[2] attaches greater importance to the N content, and the Dedek factor based on a 1:1 ratio of sucrose:(K + Na) is highly dependent on the blue number:alkali ratio according to their formula, whereas this effect is much smaller in the case of the formula developed by the authors of this article. Hence, the formula of Devillers *et al.* is not considered generally applicable. Use of the beet evaluation method of Akyar *et al.*[3] (incorporating invert sugar, which is especially important under Turkish conditions for which the formula was developed) for 88 beet samples of widely differing (K + Na) and blue number values confirmed the validity of the corrected sugar content concept; even though Turkish beet deviate markedly from normal beet standards, a correlation coefficient of 0.97 was obtained between the two formulae for molasses sugar.

Use of Lane & Eynon's sugar table for titration with a small amount of Fehling's solution

H. Iwamoto. *Rpts. Central Customs Lab.* (Japan), 1985, (25), 83 - 86; through *S.I.A.*, 1986, **48**, Abs. 86-1070.

In the determination of reducing sugars by the Lane & Eynon method, the possibility was investigated of using smaller volumes of Fehling's solution in order to make the method applicable to dilute solutions of reducing sugars which are outside the range of the standard Lane & Eynon tables. The volume of Fehling's solution chosen was 4 ml instead of the standard 10 ml. Titrations were carried out on solutions containing known concentrations of glucose, fructose, lactose, maltose or sucrose; recoveries, calculated as values from the Lane & Eynon table × 0.4, were low (91 - 98%), but application of a correction factor (constant for any one sugar) resulted in recoveries very close to 100%.

Effect of ultrasound and gas blowing on the kinetics of calcium carbonate and sucrose crystallization

A. T. Bogorosh. *Izv. Vuzov, Pishch. Tekh.*, 1986, (2), 57 - 61 *(Russian).*

Electron microscopy and high-speed cine photomicrography were used in investigations of calcium carbonate and sucrose crystallization under the effect of ultrasonic vibrations at 22 kHz and an intensity of 2×10^5 W/m² on the magnetostriction transducer; in the case of $CaCO_3$ (in the form of aragonite and calcite) the effect of injecting a mixture of air and CO_2 was also studied. Six stages of nucleation were established in supersaturated solutions of both carbonate and sucrose: (1) spontaneous formation of sub-microcrystals consisting of two molecules or pairs of ions, (2) parallel movement of these, leading to formation of twin crystals with a common face, (3) formation of double active centres, (4) commencement of growth of the faces, (5) uniting of a number of sub-microcrystals to form microcrystals, and (6) growing together of microcrystals to form macrocrystals outwardly identical to monocrystals which continue to grow together to form conglomerates, these in turn joining to form particles 0.6×10^{-3}m in diameter. Differences in the behaviour of the two forms of carbonate are noted. The increase in crystallization rate resulting from ultrasonic treatment was enhanced

1 Skirdov *et al.*: *I.S.J.*, 1984, **86**, 155.
2 *Sucr. Franç.*, 1976, **117**, 437.
3 *Zuckerind.*, 1980, **105**, 457.

by injecting a 70:30 air:CO_2 mixture in the form of fine pulsating bubbles. When 2nd carbonatation was preceded by ultrasonic treatment, purification was markedly accelerated and the mud formed approached monodispersion, with consequent benefit for filtration. Ultrasonic treatment for 30 min at 20°, 40° and 55°C of sucrose solutions of 1.05, 1.1, 1.15 and 1.2 supersaturation demonstrated that the increase in crystallization rate was a function of temperature and supersaturation. However, the increase in growth rate reached a maximum at an intensity of 18.56 kW/m² after which the faces of the single crystals started to disappear in the region of visible cavitation; continuous ultrasonic treatment of carbonate also led to disintegration of the crystal faces. The rate of mass crystallization in a limed aqueous sucrose solution under the effect of ultrasonic radiation at 22 kHz and 22×10^4 W/m² intensity was many times greater than when powdered seed was injected. This effect on sucrose crystallization was confirmed in continuous boiling tests.

Effect of the method of heat supply on the recrystallization intensity of massecuites

V. K. Kudrik, V. O. Shtangeev and I. S. Gulyi. *Izv. Vuzov, Pishch. Tekh.*, 1986, (2), 88 - 91 *(Russian)*.

Fluctuations in mother liquor temperature and concentration during boiling cause recrystallization and are a function of the method used to supply heat to the system. Laboratory studies were conducted in which pre-heated artificial massecuite samples were boiled for 1 hr in a flask on a sand bath heated by an electrical muffle furnace or in a flask placed in a UHF heater. Identical evaporation rates were maintained by varying the voltage on both types of heater. After boiling, the massecuites were centrifuged at constant temperature, the crystals washed with sucrose-saturated ethanol and specific activity of the crystals and of the mother liquor determined as well as Brix. Results showed that redistribution of the crystals took place in association with recrystallization whereby some crystals were dissolved while others grew, leading to movement of sucrose molecules across the phase interface and marked exchange of material between the crystals and mother liquor. However, less temperature fluctuation and local overheating in the UHF heater reduced recrystallization by 5 - 10% compared with the other form of heating.

Chemiluminescence flow-injection analysis determination of sucrose using enzyme conversion and a microporous membrane flow cell

C. A. Koerner and T. A. Nieman. *Anal. Chem.*, 1986, **58,** (1), 116 - 119; through *Anal. Abs.*, 1986, **48,** Abs. 9D200.

Sucrose is initially converted into glucose by β-fructofuranosidase and aldose-1-epimerase (immobilized on controlled-porosity glass) in 0.1M phthalate buffer (pH 5.65). The solution is then mixed with a stream containing luminol, haemin and horse-radish peroxidase in 0.1M Tris (pH 10.5) and passes finally into a flow cell where it mixes with glucose oxidase in 0.1M acetate buffer (pH 5). The hydrogen peroxide formed reacts with the luminol to produce chemiluminescence. The working range is 5μM to 1mM and analysis time is 2 min.

Gas chromatographic analysis of carbohydrates in liquid food products where glucose crystallization takes place

I. P. Chepurnoi, S. M. Kunizhev and N. A. Katunkin. *Izv. Vuzov, Pishch. Tekh.*, 1986, (3), 30 - 32 *(Russian)*.

The Brobst & Lott GLC method involving trimethylsilylation[1] is described and results are reported of its application to determination of sugars in various products, including a glucose-fructose syrup.

Beet quality analytical line

P. Devillers, M. Loilier and B. Noe. *Ind. Alim. Agric.*, 1986, **103,** 619 - 626 *(French)*.

Details are given of the TDF-IRIS microprocessor-based automatic analytical line for determination of sucrose, glucose, (K + Na) and alpha-N in beet; tests on molasses analysis have shown that the line could be used for most sugar factory products after appropriate sample dilution. In normal use, reproducibility is 0.5% for glucose, sucrose and alpha-N and 0.6% for (K + Na). The system can also be adapted for measurement of nitric and ammoniacal N in soil. Sucrose and glucose are determined enzymatically, (K + Na) by flame photometry and alpha-N by the Moore & Stein method. A microcomputer is used to carry out all the calculations, to provide a print-out and store the data. Operation of the line is described and information given on the reagents used.

Solubility of calcium and magnesium silicates in water and aqueous sugar solutions

N. M. Podgornova, V. M. Perelygin and I. F. Bugaenko. *Sakhar. Prom.*, 1986, (10), 20 - 22 *(Russian)*.

Calcium silicate solubility increases with temperature while that of magnesium silicate falls, but both increase with higher sucrose concentration in aqueous solutions at constant temperature. Tabulated values are given and equations presented for solubility as a function of temperature and sucrose concentration. At constant temperature, calculated values were within ± 1.8% of the experimental data.

Chromatographic and spectrophotometric investigation of molasses composition

N. G. Gulyuk. *Sakhar. Prom.*, 1986, (10), 23 - 25 *(Russian)*.

Biogel R-2, of high selectivity, was used for chromatographic fractionation of dilute beet molasses, and the optical densities of the fractions then measured spectrophotometrically at 200 - 800 nm. The spectra for eight fractions are reproduced and discussed.

1 *Cereal Chem.*, 1966, **43,** (1), 35.

By-products

Large intestine digestion of pigs fed molasses. V. VFA production

J. Ly. *Cuban J. Agric. Sci.*, 1986, **20**, 41 - 53.

In determination of the rate of volatile fatty acid production in the caecum and flexura coli of 12 pigs fed on maize, high-test molasses or final molasses as the sole energy source, the rate was higher with the high-test molasses but no effect of site in the large intestine was encountered. The rate of VFA production depended mainly on the retention time of fresh digesta in the caecum and flexura coli. The contribution of VFA to the energy metabolism of the pigs was greater with high-test molasses than with maize, while it was practically negligible with final molasses.

Studies on the fermentative production of L-lysine. Identification of L-lysine accumulating bacteria

Y. T. Liu and S. L. Sang. *Taiwan Sugar*, 1986, **33**, (3), 24 - 29.

See *I.S.J.*, 1986, **88**, 120A.

Hydrolysis of bagasse

Anon. *Ann. Rpt. Sugar Milling Research Inst.*, 1985/86, 11 - 12.

After extraction of the hemicellulose component by acid prehydrolysis, the residual bagasse was ground to a fine slurry in a stirred bead mill of 10 tonnes/hr (dry basis) capacity; optimum performance was achieved with a slurry solids content of 8 - 9% for which the energy requirement was 0.1 kWh/kg dry bagasse, although the mill was able to handle solids contents of 15% but with reduced throughput and increased energy consumption. Best enzymatic hydrolysis of a slurry and fermentation of the resulting sugars were obtained with a system involving partial saccharification at 50°C followed by simultaneous saccharification and fermentation at 37°C. Applying this scheme to steam-exploded bagasse from a furfural plant made it possible to start with 20% solids and convert 90% of the cellulose to ethanol, giving a final alcohol concentration of 5% with the enzyme loading of only 5 filter paper units per g of bagasse. Results for milled bagasse were less promising than for the steam-exploded bagasse, mainly because of the 15% limit to the starting solids concentration and the lower amenability of the cellulose to enzymatic digestion. The overall reaction time could be reduced by at least 40% by coupling the saccharification vessels to a tower fermenter.

Planning and operational control of alcohol production

S. E. Ferrari. *GEPLACEA Bull.*, 1986, **3**, (08), 5 pp.

The procedures involved in operational planning and process control in distilleries are discussed and details given of the principal control parameters. An operational schedule for a distillery producing 120,000 litres of alcohol per day and an individual fermentation bulletin are reproduced as examples.

Studies on biogas formation from pressed beet pulp

K. Buchholz, H. J. Arntz, A. Pellegrini and E. Stoppok. *Zuckerind.*, 1986, **111**, 837 - 845 *(German)*.

Investigations are reported on batch and continuous anaerobic treatment of pressed pulp. In the batch tests, as expected, the rates of decomposition during hydrolysis varied according to the component in question; hydrolysis of pectin and araban was relatively rapid while that of cellulose was slower, so that a two-stage system would be required in which the pectin and araban were hydrolysed in stage 1 and the greater part of the cellulose in the methane tank acting as stage 2, mud being recycled to increase the cellulose residence time. The effects of solids load and residence time on biogas yield were examined in an experimental two-stage continuous unit. At a daily solids load of 5 - 15 g/litre consisting of pulp of 21 - 23% dry solids content, a liquid residence time of 10 - 30 hr, a pH of 5.8 - 6.8 and 2 - 6 days retention in the methane tank, methane yield was 82 - 91% on feed dry solids.

A solid phase fermentation process for the production of ethanol

K. D. Kirby and C. J. Mardon. *Res. Rev. CSIRO, Div. Chem. & Technol.*, 1985, 27 - 40; through *Ref. Zhurn. AN SSSR (Khim.)*, 1986, (18), Abs. 18 R435.

A proposed economical method for alcoholic solid-phase fermentation is based on use of yeasts to ferment juice on the surface of beet or cane fragments of a definite thickness. Under laboratory conditions, beet fragments of 2 - 4 mm were steeped in a small volume of concentrated yeast suspension at pH 4.5 and the mixture fermented under anaerobic conditions at 25 - 35°C. After 10 - 16 hr (depending on concentration of the seed suspension) the fermented mass was pressed, washed with a small quantity of water and the press liquor centrifuged; the liquid, of approx. 10% alcohol concentration, was distilled and the yeast recycled to fresh substrate. Alcohol yield was approx. 93% of theoretical and >99% of the sugar was fermented. The thickness of the fragments should be 3 - 4 mm at which the sugar gradually diffuses to the surface and the fragments absorb the alcohol formed while there is no inhibiting effect of higher concentrations of sugar and alcohol on the yeasts and energy consumption in distillation is reduced. With increase in the yeast suspension concentration the fermentation period is cut from 15 hr at 2 g yeast per kg to 9 hr at 9 g/kg. A temperature rise from 25 - 30° to 35°C causes a fall from 74% to 36% in the production of live cells in the recycled yeasts. With the proposed method there is no risk of infection because of the relatively high concentration of the seed yeasts and the absence of juice on the outside of the beet tissue. The method can be carried out continuously using other forms of raw material. Experimental laboratory and pilot plant schemes are given with the equipment and costs of the method, and coefficients of alcohol yield and recycled yeast activity are given as a function of the factors tested.

Table III. Spot balances for 6ft diameter drum dryer/coolers

Factory	Temperature, °C Sugar in	Sugar out	Air in	Air out	Heat in use	Sugar moisture, %	Sugar flow, tph	Air flow, cfm	Curtain width, %
Design					No		10.0	4500	100
Dryers									
F1	55.5	37.5	19.0	38.0	Yes	0.5	15.0	3440	90 - 100
F2	55.5	37.5	19.0	44.0	Yes	0.5	15.0	3410	90 - 100
H1	72.0	47.0	33.0	39.3	Yes	1.02	12.5	5350	80
H2	72.0	55.0	45.0	37.0	Yes	1.02	12.5	4810	-
K1	59.0	40.0	39.6	38.0	Yes	0.76	12.5	3500	80 - 90
K2	59.0	39.0	39.7	37.0	Yes	0.76	12.5	2640	80 - 90
L1	58.0	34.0	19.0	38.3	No	0.71	12.5	5000	100
L2	58.0	33.0	19.0	37.1	No	0.71	12.5	5230	100
M1	60.3	29.5	19.5	36.8	No	1.0	9.6	4300	80 - 90
M2	60.3	28.8	18.0	37.3	No	1.0	9.6	4400	80 - 90
Coolers									
F1	45.0	36.0	16.3	43.5		0.18	30.0	4000	100
L	33.0	30.5	11.5	31.4		-	25.0	1950	100

measured on Burlec

Table IV. Spot balances for 8ft diameter drum dryer/coolers

Factory	Temperature, °C Sugar in	Sugar out	Air in	Air out	Heat in use	Sugar moisture %	Sugar flow, tph	Air flow, cfm	Curtain width, %
Design					No		18.0	7500	100
Dryers									
A1	64.0	38.8	27.5	39.0	No	0.90	17.5	6980	80
A2	64.0	40.6	26.9	37.5	No	0.90	17.5	7600	80
B	61.2	38.8	17.8	36.0	No	0.78	30.8	9400	80
C	64.0	37.0	34.0	39.0	Yes	0.85	27.5	3340	80 - 90
D1	62.0	37.0	24.9	35.0	No	0.92	23.4	7880	90
D2	57.0	37.9	25.0	36.7	No	0.92	23.4	8510	90
E1	61.3	47.4	39.0	35.0	Yes	0.51	16.0	2730†	90
E2	61.3	48.6	36.0	36.0	Yes	0.51	16.0	2430†	90
G1	66.8	43.2	47.1	42.0	Yes	1.25	26.0	8000	90
G2	66.8	43.4	51.7	41.0	Yes	1.25	26.0	5450	90
J1	61.0	47.4	43.0	43.8	Yes	0.56	19.0	9700	80 - 90
J2	61.0	48.8	45.8	39.5	Yes	0.56	19.0	5900	80 - 90
N	59.0	39.0	24.5	38.0	No	0.42	21.2	2600	100
Coolers									
A	39.7	37.8	24.0	32.7		-	35.0	5240	80
B	38.8	35.3	19.0	33.0		-	30.8	6360	80
C	37.0	32.5	14.5	37.0		-	27.5	5900	100
D	37.5	35.3	21.5	31.0		-	45.8	1650	50
E	46.8	43.4	12.0	19.5		-	32.0	-	80
F2	36.0	33.0	16.6	34.5		-	30.0	3300	100
G	43.3	41.8	16.5	32.0		-	52.0	2900	80
H	48.0	45.0	19.0	34.0		-	25.0	2500	80
J	43.5	42.2	20.0	25.0		-	38.0	1800	50 - 60
M	28.8	24.5	17.4	20.3		-	19.2	3940	80

† Calculated

A two-year program was instituted to modify the drum internals to get a better distribution of sugar where this was necessary. The air flows were also examined and equipment altered and renewed where necessary to bring the flows back to design. At some factories even this would not achieve the desired sugar temperatures so it was decided to

see whether the drums would take an additional air flow rate without serious carry-over of the product.

Perry[1] gives the values of the terminal velocity of spherical particles of different densities settling in air under the action of gravity (this is reproduced as Figure 1). Taking the British Sugar design of 0.73 m/sec (2.4 ft/sec), this has the same forward velocity as particles of about 170 microns have in falling velocity. Thus the particles of this size would fall at about an angle of 45°.

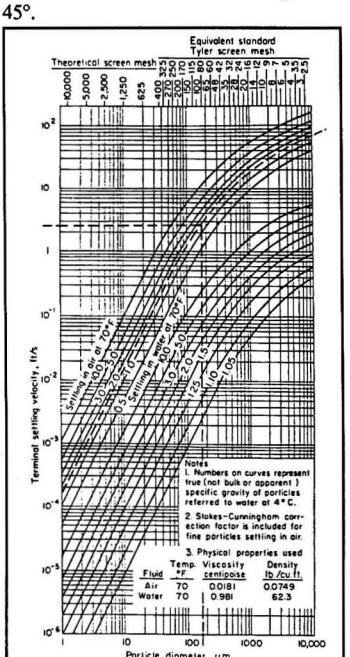

Fig. 1. Terminal velocities of spherical particles of different densities settling in air and water at 70°F under the action of gravity. To convert feet per second to metres per second, multiply by 0.3048. (*From Lapple et al.*: "Fluid and Particle Mechanics" (University of Delaware, Newark), 1951, p. 292.) Note: sugar crystal s.g. = 1.58

Cantley factory modified the 8 ft diameter cooler by doubling the air flow rate and putting in a set of spirals to convey the sugar 1.8 m into the drum before the first lifters cascaded the sugar through the air. From Figure 1, doubling the velocity to 1.46 m/sec increases the particle size to around 260 microns at the 45° fall angle. Tests were carried out at Cantley during the 1984/85 campaign and confirmed that particle sizes up to this value were being blown out of the drum. Checking the size distribution graph (Figure 2) would indicate that up to 6% of the sugar lies within this size range but in fact only around 1% of the production was being collected from the end of the drum. The reason for this could be two-fold:–

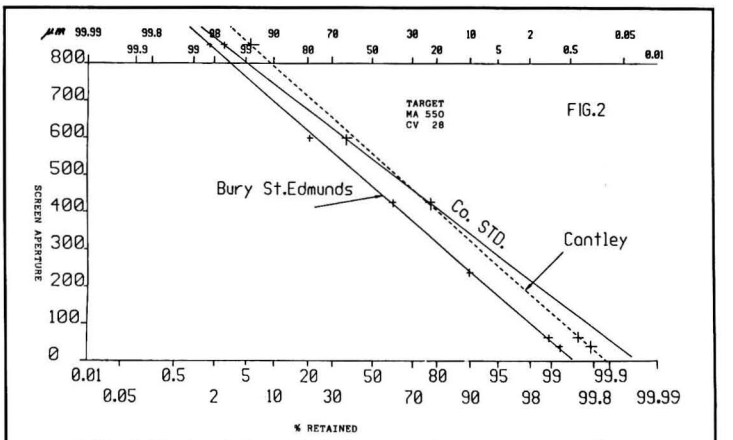

Fig. 2. Size distribution of Bury and Cantley production sugars compared with company standard

(1) the mass of falling sugar would trap some of the fines and prevent them being conveyed out of the drum, and

(2) not all the sugar is discharged at top dead centre - the proportion falling earlier or later has a shorter distance to fall and hence the approx. 45° angle could be exceeded.

A further set of tests was conducted during the 1985/86 campaign. The results indicated that nearly 90% of the sugar carried out by the air was below 250 microns in size and that the total quantity was under 1% of the throughput compared with a possible maximum of 5%.

Provisional calculations on the air flows needed at Bury factory revealed that, even with the larger flows as at Cantley, an additional two standard 8 ft drums or one much larger unit would be required to achieve the necessary cooling. The same applied to the other large factory, Wissington. As space in the area was tight it was decided to investigate whether a fluid bed cooler would be a better proposition.

A literature search revealed that a fluid bed dryer had been used at Smith Sugar's Gledhow sugar factory in South Africa from the 1977/78 campaign[2]. Although problems were reported, the installation was considered a success. The other main area of activity was in the East European countries, particularly in Russia and Poland. One interesting dryer/cooler at Buryn factory has been reported[3]. The main details are shown in Figure 3. Both these reports concluded that the fluidization operation did not cause any measurable damage to sucrose crystals.

British Sugar, therefore, decided to hire a 1 tonne/hr pilot plant unit for trials at Bury St. Edmunds during the 1983/84 campaign. A report[4] on the trials concluded that a fluidizing velocity of 0.8 m/sec at the bed is needed, with the air space widening out above the bed to bring the carrying velocity to 0.5 - 0.6 m/sec. This compared well with our standard design (qv). It was also found, even with air flows double the chosen velocity, no measurable damage to the sugar crystals occurred.

1 "Chemical Engineers' Handbook", 6th Edn., Page 5 - 67, Fig. 5 - 80.
2 Fitzgerald *et al.*: *Proc. 54th Congr. S. African Sugar Tech. Assoc.*, 1980, 52 - 55.
3 Temper *et al.*: *Sakhar. Prom.*, 1979, (6), 31 - 34.
4 Randall & Bell: *Internal Rpt. British Sugar plc*, 1984.

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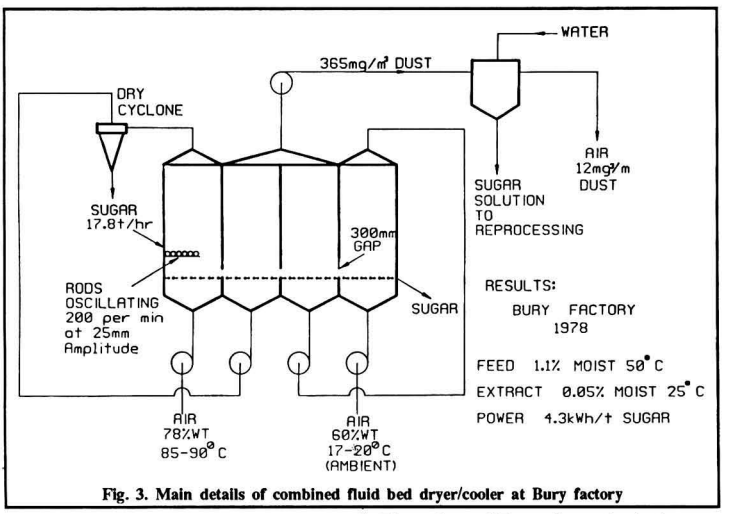


Fig. 3. Main details of combined fluid bed dryer/cooler at Bury factory

Dr. John Ashworth, of Drying Research Ltd., was engaged to give guidance on the design and test work on fluid bed coolers for white sugar. An internal report[5] assesses the handling properties of the sugar and process design of the cooler. Based on particle size distribution measured by British Sugar and the plant manufacturer, the minimum velocity required for complete fluidization was in the range 0.5 to 0.6 m/sec.

At such a velocity some of the finer sugar would be carried away, so a tapered bed was recommended to restrict the free-board velocity to 0.4 m/sec.

Dr. Ashworth also derived an equation for a model of the fluid bed cooler[5]. From this he defined the effectiveness E

$$= \frac{(Temp_{air\ out} - Temp_{air\ in})}{(Temp_{air\ max} - Temp_{air\ in})}$$

and $Temp_{air\ max} =$

$$(Temp_{sugar\ in} + Temp_{sugar\ out})/2$$

The values of E are shown in the last column of Table V. Two of the values are shown as over 100%. Such a result is impossible and may arise through small errors in temperature measurements. However, in practice, the effectiveness may be promoted by two factors which are not taken into account by the model: (1) heat losses from the walls of the cooler, and (2) some evaporative cooling owing to loss of moisture. Whilst these results are very good it would not be safe to design above an effectiveness factor of 0.9.

Tenders for a full size plant were obtained and the equipment was installed at Bury for the 1984/85 campaign. The design duty was:–

Feed: 60 tonnes/hr sugar at 40°C

Air: Filtered ambient at 10°C; 57,000 m³/hr requiring 62 kW of power.

The plant generally ran well – there were problems with the irrigated cyclone on the dust/air separation and this unit had to be replaced with a wet box. The inlet air filter also malfunctioned at times and once the bed glazed over. It was thought on this occasion that some very wet sugar had found its way onto the bed. Three tests were carried out and the results are logged in Table V below.

At Frasnes-Lez-Buissenal factory in Belgium during the 1984/85 campaign it was observed that a Comessa fluid bed cooler on white sugar was in use. Mr. J. P. Lemaire kindly sent details of his installation and the main details are shown for comparison in Table V.

A dry cyclone in the air exit ductwork was used to collect the larger fraction of dust coming over with the air. The quantity was just under 0.1% of the feed rate and size fraction 0.6% on a 425 micron screen, 1.0% on a 212 micron screen, 55.9% on a 150 micron screen, 33.7% on a 125 micron screen and 8.9% through the 125 micron screen.

Obviously, the efficiency of the cyclone dropped off significantly with the smaller fraction but the results tend to confirm that the maximum size removed is in line with the predictions from Perry[1]. However, reference to Figure 2 would indicate that at the 100 micron size up to 2% of the feed could be removed, not the 0.1% that is actually removed. It was, therefore, decided to remove the dry cyclone and send the outlet air stream directly to a water scrubbing wet collector.

With the good results obtained from the Bury plant it was decided to fit a further four factories for the 1985/86 campaign, namely Brigg, Ipswich, Wissington and York. Specifications were issued and tenders from two potential suppliers (1 and 2) were obtained. The main design figures are

5 Ashworth: "Guidance on equipment sizing and design for fluid-bed cooling of white granulated sugar" (Drying Research Ltd.), March 1985.

Table V. Test results on Bury fluid bed cooler - design *vs.* operation

Test	Sugar rate, tonnes/hr	Sugar temperature, °C In	Sugar temperature, °C Out	Air temperature, °C In	Air temperature, °C Out	Air flow, m³/hr	Effectiveness E
Design	60.0	40.0	25.0	10.0	29.0	57,000	0.844
T1	54.2	48.0	34.7	18.2	38.4	45,700	0.873
T2	52.1	39.0	29.3	17.5	35.0	37,400	1.104
T3	52.0	40.3	24.4	5.2	32.6	35,300	1.009
Belgium	35.0	58.0	32.0	10.0	43.0	68,000	0.943

Table VI. Comparison of design for four fluid bed coolers

Design Factory/supplier	Sugar rate, tonnes/hr	Sugar temperature, °C In	Sugar temperature, °C Out	Air temperature, °C In	Air temperature, °C Out	Air flow, m^3/hr	Effectiveness E
D/1	60	40	25	10	28	62,600	0.800
D/2	60	40	25	10	31	52,190	0.933
G/1	35	40	25	10	27	42,000	0.756
G/2	35	40	25	10	31	31,100	0.933
H/1	45	40	25	10	27	54,000	0.756
H/2	45	40	25	10	31	39,720	0.933
N/1	30	40	25	10	27	36,000	0.756

shown in Table VI.

It is evident from the table that supplier 1 was proposing an overdesign based on the effectiveness factor. A requote was arranged, based on an agreed factor in the region of 0.9. This was done and orders were placed, two with each manufacurer. The results obtained during the 1985/86 campaign are shown in Table VII.

The above test results based on spot balances would indicate that the results are in line with those predicted at the design stage and that the use of 90% as a working efficiency is being achieved in the majority of cases. Thus, the use of fluid bed sugar coolers is achieving the objectives set at the start the excercise.

Use of a fluid bed on brown sugar

British Sugar did not produce the whole range of special sugars until Britain joined the EEC. The marketing division then gradually increased the range of sugars coming onto the market in the late 1970's.

Demerara sugar was manufactured by mixing a screened white sugar of around 750 μm size with about 3% of cane molasses. Experiments in the drying of this product was made in both rotary cascades and fluid bed designs of dryers. With the rotary dryer, the material would not cascade without a large percentage back-mix of the dried product. Tests were carried out on two different designs of fluid bed dryer but in each case the product came out mixed with some friable lumps of the material being dried. After consideration of the costs and technical difficulties, the project was shelved. The use of 3% molasses resulted in the moisture content of the crystals being in the region of 0.6% which was too high for the packeting requirements so a higher coloured molasses was used. Thus the amount of molasses added could be reduced for the same colour of product and at the same time the moisture content was reduced to around 0.3%. At this level the product was acceptable for both packaging and use.

Towards the end of 1984, the marketing division requested that further work be undertaken to find a Demerara-type product suitable for drying for use in sachets and packets. British Sugar Research Laboratories carried out tests on commercially available Demerara sugars and the results are shown in

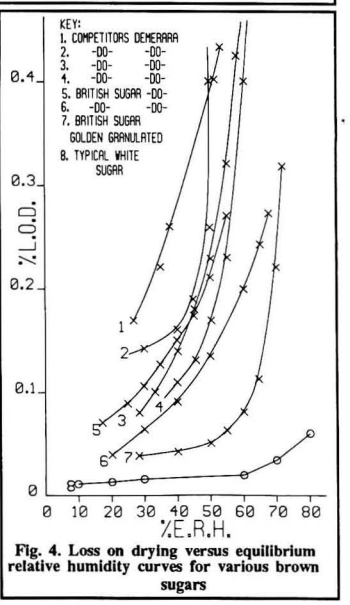


Fig. 4. Loss on drying versus equilibrium relative humidity curves for various brown sugars

Figure 4. To achieve a practical dried sugar which kept in reasonable condition during storage and use it is necessary to work as near as the bottom right hand corner of the graph as possible. Dr.

Table VII. Comparison of fluid bed coolers (1985/86 campaign)

Factory	Sugar rate, tonnes/hr	Sugar temperature, °C In	Sugar temperature, °C Out	Air temperature, °C In	Air temperature, °C Out	Air flow, m^3/hr	Effectiveness E
D	50	44.5	30.0	14.0	33.5	42960	0.82
	40	44.0	28.0	18.0	34.0	46300	0.89
G	58	45.3	33.0	19.0	34.0	54390	0.74
	54	44.8	27.2	11.2	36.0	44700	1.00
H	33	40.8	26.3	17.5	32.0	37900	0.90
K	34	46.0	30.8	16.8	38.2	28380	0.99
	35	45.3	28.0	8.0	34.0	26950	0.91
N	25	42.8	26.0	9.0	34.5	19093	1.00
	25	40.0	28.0	19.0	33.0	24650	0.93
	25	40.5	27.5	16.0	30.0	26520	0.78

Ashworth[6] determined the material characteristics of the Newark production to determine the best type of dryer to use. A vibrating fluid bed unit was one of the main contenders. A trial was arranged on a pilot plant unit at our Bury factory of a Sulzer Escher Wyss design, having a bed 2.0 m × 0.3 m sized for use on fine white sugar.

The distributor plate was partly blanked off to provide a higher fluidizing air velocity for the coarse brown sugar. Two trials were carried out and the moisture content was reduced from approximately 0.250% to 0.095% d.s. Examination of the sugar after drying revealed negligible crystal damage and only a small colour loss due to attrition. Overall, the tests established the suitability of the vibrating fluid bed technique and produced dry sugar crystals of attractive "sparkly" appearance.

Summary

Increased rates of production of white sugar at most factories have resulted in higher temperature of sugar to bulk storage. A survey of the drying and cooling equipment showed that design figures were being exceeded in many instances. A two-year program was instituted to either modify the existing equipment, or to fit additional systems to reduce sugar storage temperatures. The development in the use of fluid bed coolers at five factory sites is described. Finally, details of trials of a fluid bed dryer/cooler on brown sugar are given.

6 Idem: "Feasibility study of economics of drying Demerara brown sugar at Newark factory" (Drying Research Ltd.), April 1985.

ENGINEERING

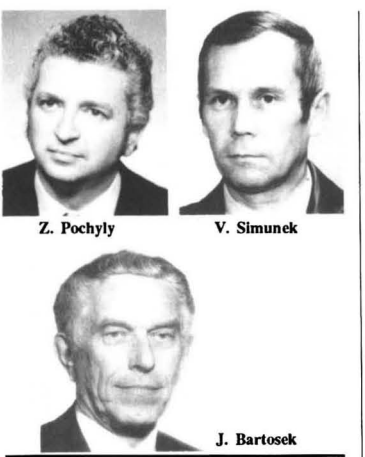
The Shabac sugar factory

By Zdenek Pochyly, Vaclav Simunek and Jaroslav Bartosek

The Shabac beet sugar factory, of capacity 4000 tonnes/day, one of the two latest sugar factories of Yugoslavia, had its first full season during the 1985 beet campaign. A complicated guarantee test was carried out successfully during that season and we believe it may be interesting to make known its results as well as to give some more information about the factory.

The Czechoslovak sugar machinery suppliers and sugar technologists, right from the beginning of the last century, have had close and cordial relations with the Yugoslav sugar industry, which have continued to this day. After the Second World War the Yugoslav sugar industry and associated engineering industries both developed rapidly. Much has been done in the country which was dependent to a great extent on foreign technical design. New complete factories were bought and installed by West European suppliers.

It was interesting to confront the old and new conditions while building the two new sugar factories recently. The conditions of the guarantee test were an example of high requirements, which had been growing with each new installation. Prior to the final contract negotiations the suppliers were obliged to accept, in connexion with the guarantee test, 14 operational data to be achieved under penalty. These are listed below along with the results of the actual test performed in 1985. A run-in sugar factory with stabilized conditions and staff may well be required to work with such results but it is evident that, apart from rare exceptions, different conditions prevail just after commissioning, at the time the guarantee operation is carried out. The gap which is usually rather wide creates a situation both difficult and delicate.



Z. Pochyly V. Simunek

J. Bartosek

The length of the guarantee test was unusual as well, namely 10 days, during which the working capacity of 4000 tonnes of beet had to be reached each day; an average over the testing period was not acceptable. There was no tolerance on the working capacity, the other data had a tolerance of – 2%.

The following were the contract requirements and the corresponding achievements of the test which started on September 30th, 1985, i.e. the 15th day of operation of the factory:

1. Working capacity 4000 tonnes of beet per day; fulfilment:

Day	Slice, tonnes	Percentage
1	4321	108.0
2	4233	105.8
3	4217	105.4
4	4157	103.9
5	4187	104.7
6	4267	106.7

7	4268	106.7
8	4095	102.4
9	4232	105.8
10	4288	107.2

Total for 10 days was 42,265 tonnes of beet.

2. Steam entering the evaporator: maximum 39% on beet; fulfilment: 38.9%

3. Limestone consumption: maximum 4.93% on beet; fulfilment: 4.22%

4. Consumption of lime as CaO: maximum 2.28% on beet; fulfilment 2.03%

5. Dry coke consumption: maximum 0.4% on beet; fulfilment: 0.31%

6. Liquid SO_2 consumption:maximum 0.02% on beet Fulfilment: 0.014%

7. Kieselguhr (Hyflo or similar): maximum 0.01% on beet; fulfilment: no kieselguhr consumed

8. Heat consumption of the pulp drying plant: maximum 3780 kJ per kg of evaporated water; fulfilment: 3130 kJ/kg

9. Capacity of the beet unloading section: 550 tonnes/hr of beet; fulfilment: 580 tonnes per hour

10. Overall sugar losses: maximum 0.708 % on beet; fulfilment: 0.721%, i.e. within the 2% tolerance, the reason being the coordination with the diffusion plant

11. Sugar in final molasses: maximum 2.2% on beet; fulfilment: 2.01%

12. Quality of sugar produced: EEC 2, i.e. max. 22 points; fulfilment: 17.2 points

13. Moisture content of dried sugar: maximum 0.03%; fulfilment: 0.03%

14. Electrical energy consumption: maximum 4.92 kWh per 100 kg of beet; fulfilment: 4.31 kWh

The Shabac sugar factory is owned by AIK Shabac (Agricultural and Industrial Complex of Shabac). The equipment was imported from Czechoslovakia through Technoexport Prague and Generalexport Belgrade. The general supplier as well as the Engineer of the Project was the Hradec Kralove

Fig. 1. General view of the factory

Engineering Works of CHEPOS, Brno (originally a part of Skoda, Czechoslovakia), the Yugoslav part of the equipment was supplied by the Djuro Djakovic Engineering Works at Slavonski Brod, civil engineering design was done by Mashinoprojekt Belgrade and the civil engineering firm was Izgradnja Shabac; the erection was carried out by Djuro Djakovic under the supervision of CHEPOS and a working team of sugar technologists from the Czech sugar industry, Prague, led the guarantee test along with a team of engineers from CHEPOS.

The sugar equipment was Czechoslovak, as were the electrical installation, the instrumentation for automatic control and the steel structure for the factory buildings. The boilers, turbo-generator, lime kiln and pulp drying station were manufactured in Yugoslavia, as were the vacuum pans and crystallizers. Certain individual items were from other countries, mainly the Belgian De Smet diffuser (partly manufactured in Czechoslovakia), Putsch beet slicing machines from West Germany, a Venema beet laboratory and six other items. Waste water purification plant was outside the contract.

The daily capacity of 4000 tonnes of beet means the possibility of slicing yearly up to 400,000 tonnes. The sugar produced is white crystal of EEC-2 quality, boiled from a pressure-filtered standard liquor made up of thick juice, in which is dissolved *B*-sugar and double-cured *C*-sugar. Sugar is stored in silos and packed in bags of 1, 2 and 50 kg. The by-products are pelleted dried pulp and final molasses.

Local coal is used to fire the boilers and the pulp drying plant. Wells are the source of water for operation and for drinking. There are two closed water circuits, i.e. the flume water and the barometric water circuit, with particular care for economy. All storage capacities are on the high side by special request. All materials may be received or despatched by either road or rail transport.

The beet unloading section has a working capacity of 550 tonnes per hour and a storing capacity of 40,000 tonnes of beet in ventilated silos, the maximum height of the pile being 7 metres. Sampling and analysis are carried out in the Venema beet laboratory including determination of potassium, sodium and amide nitrogen. Beet is unloaded by four water jets from the transport vehicles, carried by hydraulic transport through

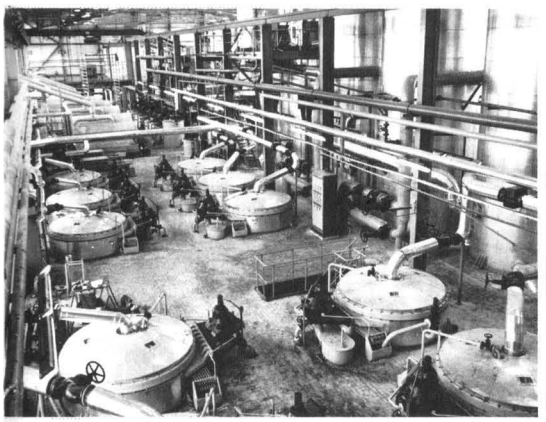


Fig. 2. Continuous thickening filters

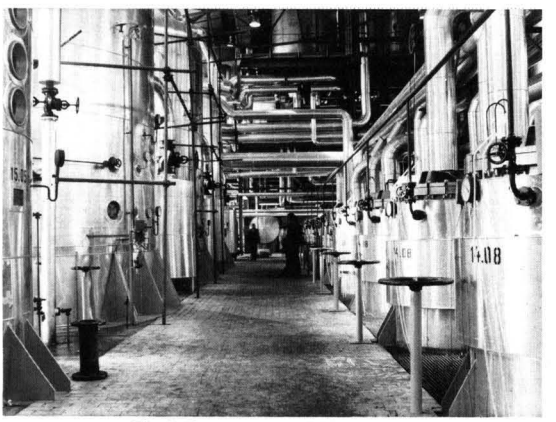


Fig. 3. Evaporator and juice heaters

different separators and pass via a vibrating screen jet washer to the mechanical piler. Water jets start further transport with dirt separation to the beet pump with a second unit installed as 100% spare. A trough-type beet washing machine is followed by an additional pressure water sprayer and water separator. Efforts have been made to cope with the problem of the dirt coming to the factory along with the mechanically harvested and loaded beet. A particular feature at Shabac is the high adhesivity of soil to the beet roots.

The beet slicing station has three vertical disc-type Putsch slicing machines with all accessories. The width of the De Smet diffuser is 6500 mm and the diffusion zone is 27 metres long, comprising 18 sections with double helix juice circulation. Overall length is 45 metres. Cossettes scalding takes place in the diffuser which works with cold juice outlet. Nominal capacity is 4000 tonnes/day but the manufacturers have guaranteed that it will work up to 4400 tonnes/day.

The beet tails are treated in a separate station to extract additional sucrose and the resulting juice is fed into the diffuser. Beet pulp is pressed to 20% dry substance in 5 three-spindle pulp presses, of which two work with variable speed and one is a spare unit. Two pulp drying units made in Yugoslavia cover the full capacity of the factory. All dry pulp is pelleted and put in a store of 24,000 tonnes capacity.

The pressure-type lime kiln, of 250 m^3 capacity, has been manufactured in Yugoslavia under licence from Eberhardt of West Germany. The CO_2 compressors, like the vacuum pumps, are of the water-ring type.

The juice clarification station works with the latest Czechoslovak process using cold pre-liming or, alternatively, hot pre-liming when beet quality is poor. The main liming dose enters the piping at the head of the carbonatation vessel, in which CO_2 flow provides the desired circulation. Simultaneous carbonatation may also be applied. There are two pre-liming vessels, especially to regulate timing. This is used mainly with juices of thermal lability. There is a single body for second carbonatation and equipment for possible thin juice sulphitation. In spite of all the possible alternatives for operation the equipment is relatively simple.

The filters in the clarification section have surplus capacity as a special requirement of the buyers, so as to permit working with beet of inferior quality. There are seven thickening filters of 120 m^2 each after first carbonatation, followed by four vacuum filters of 40m^2 each and five thickening filters for the second carbonatation. The final filtration of thin juice is in four pressure disc filters of 70 m^2 each. Both the thickening and the pressure filters are of a new Czechoslovak design.

The evaporator is of a standard quintuple-effect design, all in single bodies and with a total heating surface of 9800 m^2. The central condenser station has two sections: one for the evaporator and crystal sugar pans and the second for the *B*- plus *C*-sugar pans. A three-unit cooling tower is equipped with 3 fans, each of 8 m diameter. Water for the machinery cooling circuits is cooled in micro-towers.

The sugar boiling station has equipment of Yugoslav make with 11 vertical vacuum pans, each holding 60 tonnes of massecuite and having 300 m^2 heating surface in vertical tubes. Four of them for *C*-boiling have mechanical circulators. Crystallizers are of the horizontal type, the *C*-massecuite crystallizers being in two continuous lines, each having 2 receiving and 5 cooling units. The standard liquor for *A*-sugar boiling is filtered by six pressure disc filters of 70m^2 each.

In accordance with Czechoslovak practice, all massecuites are cured in recycling sugar centrifugals; these are fully automatic type ARO 80-1250 T machines having a charge of 1250 kg massecuite. The speed of the *A*- and *B*-machines is 1200 rpm and that for *C*-sugar is 1500 rpm. The *A*-sugar machines operate at 24 cycles per hour. All centrifugals have equipment for dividing the run-off (with the *C*-foreworkers this is used during steaming to avoid diluting final molasses) as well

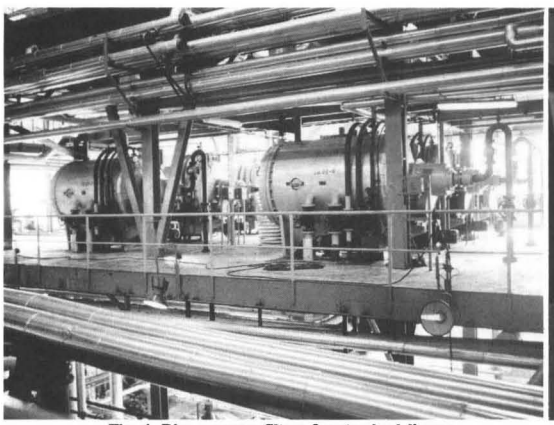


Fig. 4. Disc pressure filters for standard liquor

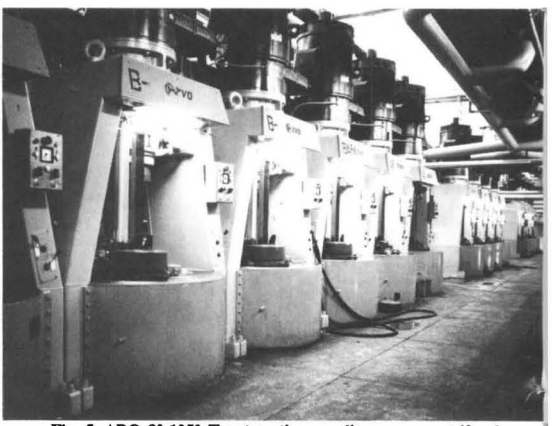


Fig. 5. ARO 80-1250 T automatic re-cycling sugar centrifugals

as equipment for sugar washing by means of two media. This centrifugal as well as its drive, control instruments and other accessories is of Czechoslovak design and make and is fully up-to-date. The direct current electric motor has thyristor rectifiers and full regeneration while the controls are on easily exchangeable printed circuits. Altogether 14 machines have been installed, of which five are used for *A*-sugar, three for *B*-, two for *C*-affination and four for *C*-curing. There are spare units everywhere and the *B*-plus *C*-affination centrifugals have a common spare. All molasses are brought to standard Brix and temperature.

The final product is dried in two fluid-bed type sugar dryers, each giving 16 tonnes of sugar per hour with dust and lump sugar separation, apart from which there is no further size classification. There are two concrete sugar silos, each of a capacity of 20,000 tonnes of sugar.

The bagging station has two Libra automatic bagging machines of pneumatic type for flap-type bags of 50 kg, a Hesser automatic packing machine for 1 or 2 kg packets, and parcelling and palletizing equipment. The storage capacity for packed sugar is 8000 tonnes.

The boiler house has been equipped with 2 boilers generating 55 tonnes per hour each of steam at a pressure of 4.5 MPa and a temperature of 430°C. An auxilliary boiler of 15 tonnes/hr is used for the off-season and starting. Yugoslav coal, i.e. a dried lignite of 17,000 - 20,000 kJ/kg, is used. One 8.5 MW turbo-generator is backed up by the possibility of using power from the mains. The boiler and power house equipment is made in Yugoslavia and of local design.

The waste water purification station is under construction outside the sugar factory contract and includes biological cleaning; the cycle will be two years and water will be released to the Sava river.

The sugar factory automatic control is basically divided in accordance with individual stations or their combinations, for example a common panel for the juice clarification and the evaporator. There is no automatic control of sugar boiling at present, but it is to be incorporated at a later date. Every automatic control may be switched to manual control from the respective panel. All control instruments, except for those of the diffuser, are of Czechoslovak make.

The general lay-out of the factory and particularly the lay-out of the main building have combined space economy with easy orientation which, to our mind, is of importance. The Shabac beet sugar factory sets a good up-to-date standard. Following Czechoslovak traditions, the best possible combination has been sought of the available design possibilities and the financing methods to reach the most suitable solution for conditions under which the investment may be exploited.

Operational results of the 1985 campaign, i.e. the second campaign at Shabac may be compared with the second campaign of five other new sugar factories in the same region of Vojvodina, installed recently and working in comparable conditions:

Average daily working capacity of the total duration of the campaign, including all stoppages: Shabac 88.6% nominal capacity; Others 52.8-67% of the same.

Overall recovery during the campaign: Shabac 79.3% on beet; Others 74.7-78.3% on beet.

Altogether 198,374 tonnes of beet were sliced, i.e. all the beet planted for 1985, and 24,500 tonnes of sugar were produced, the duration of the campaign being 56 days.

"Sugar in Europe" conference

The Club de Bruxelles organized on June 25, 1987, a conference in Brussels on the theme "Is there a future for sugar in Europe?". Representatives from the sugar and chemical industries, European institutions and professional circles discussed the future of sugar in the context of CAP reform, new outlets in the chemical industry, the "sweeteners war" and the strategy employed by sugar concerns. The Club de Bruxelles was founded in 1985 by a number of press and information agencies specializing in the activities of the European Community; it is managed by a private concern which has no connexions with any national or sectoral interest group. Information on the Club and its conference may be obtained from Club de Bruxelles, 12 rue du Collège Saint-Michel, B-1150 Brussels, Belgium.

Facts and figures

British Society of Sugar Cane Technologists

The Annual General Meeting and Spring Technical Meeting of the B.S.S.C.T. was held on April 7 at the Royal Commonwealth Society in London. Presentations included an assessment of the sugar market by Ted Paul of Tate & Lyle International and an audio-visual description "Improving cane productivity in Cuba" by Michael Chambers of ICI Plant Protection Division. A paper "The efficient use of energy in industry" was given by Fred Nash of N.E.I. - A.P.E., and another on "Some recent experience of soil compaction" by David Weeks of Booker Agriculture International Ltd. Dr. R. A. Yates was elected President of the Society for the next two years and Mr. Simon J. F. Winn, Vice President. Mr. A. W. MacGillivray and Dr. Michael J. Bennett were elected Trustees, while Mr. J. E. Morton continues as Secretary-Treasurer of the Society.

Cane milling extraction record

In our February issue we reported a high extraction figure of 98.25% achieved in South Africa[1] and invited readers to advise us if this had been exceeded over a complete season by a sugar factory elsewhere. We are indebted to Dr. John H. Payne who has sent us copies of extracts from the HSPA Annual Reports of the 1920's and 1930's which show that a number of Hawaiian factories achieved extractions above this level. The Hawaiian record was 99.07% set by Hawaiian Commercial & Sugar Company in 1921, while Maui Agricultural achieved 99.05% in 1919 and 1920. The HC&S record is attributed to the development of the shredder by Searby at that factory in 1914. With the advent of mechanical harvesting in 1936 extraction dropped rapidly and did not reach the 98 level again until the first diffuser started operation at Pioneer Mill Co. in 1964.

Australian drought broken[2]

The dry areas of the Australian sugar cane belt along the Queensland coast have received enough rain to sustain the 1987 crop but this is likely to be below the level of 1986. Rainfall has been below normal but good soaking rains have fallen in the Mackay region following a long dry spell. In the far north and south of the state and in New South Wales the crop is looking good after heavy falls.

Haiti sugar factory closures[3]

Three of the sugar factories in Haiti closed in April because of mounting debts and increasing competition from cheap imports. The closure will affect more than 250,000 workers and farmers and cane crops will be left unharvested in the fields. The sugar companies blame the country's interim government for the state of the industry, saying that the imposition of a $3 per bag tax and the importation of cheaper sugar had undermined their viability. They also say the government is doing too little to end the illegal importation of sugar from the neighbouring Dominican Republic. Sales of domestic sugar have fallen significantly and stocks have mounted.

Colombia sugar exports, 1986[4]

	1986	1985
	tonnes, raw value	
Chile	4,261	0
Japan	0	24,000
Korea, South	12,000	12,000
Morocco	28,000	26,000
Peru	2,665	0
Surinam	2,630	0
Trinidad	5,000	0
Tunisia	12,000	0
USA	145,155	185,684
Venezuela	0	47,250
Other countries	104	0
	211,815	294,934

New Indonesian sugar factories[5]

The Indonesian Minister of Agriculture recently stated that four new sugar factories are to be built in Indonesia, with operations projected to begin in 1989. The cost is set at $350 million and they will be located at Bataraja, South Sumatra; Ladongi, South Sulawesi; Los Palos, East Timor; and Pagayaman, North Sulawesi. It is believed that these factories were part of the large expansion program shelved by the government in 1983 owing to lack of funds. Private investors were not interested in taking over the projects then and it is unlikely that they will be undertaking these projects now. Additionally, the Minister of Agriculture indicated that four government sugar estates (one on and three off Java) will invest 1000 million rupiahs ($600 million) in expansion programs. The Cot Girek sugar factory in Aceh, North Sumatra, closed in June 1986; this factory, which was opened in 1970 with a capacity of 2000 t.c.d., could not obtain sufficient cane to operate efficiently. The cane land is to be given over to oil palms while the factory site will be utilized for an oil extraction facility.

Japan HFS manufacture[6]

Mitsui Sugar Co. Ltd., a major Japanese sugar refiner, has joined with five other firms including Takeda Chemical Industries Ltd. and Mitsui & Co. Ltd. to form a new venture called Sai-ei Sucrochemical Co. Ltd., in Nagoya, to produce HFS, animal feed and other products. Production of HFS started in late January and sales in the first year are predicted at 11,250 million yen.

Canada beet sugar production, 1986/87[7]

The 1986/87 Canadian beet sugar campaign ended with a sugar output of 112,135 tonnes, white value, against 50,000 tonnes in 1985/86 when the Taber factory was closed, no beets having been planted in Alberta.

Taiwan not to export sugar in 1987[8]

For the first time in 40 years, Taiwan will not export any sugar this year. Production, reduced by a typhoon that damaged 6000 hectares of cane fields, will total about 480,000 tonnes in the 1986/87 season, sufficient to cover domestic consumption. Output in 1985/86 was 570,000 tonnes, and exports in 1986 reached 149,755 tonnes.

Mauritius sugar industry contraction progress[9]

At a sugar and energy aid coordination meeting in February, rationalization was discussed with the government agreeing to close unviable sugar factories. The 1985/90 sugar action plan forecast closure of the St. Antoine, Rose Belle and St. Felix factories, while Reufac and Solitude have already closed. However, observers expect no major moves until after elections expected between August and October next and the unveiling of a series of industry efficiency studies which should be completed soon after.

New Cuban sugar factory[10]

A new sugar factory, the seventh to be built since 1959, has gone into production in the province of Las Tunas. It has a capacity of 7000 t.c.d. and should produce some 100,000 tonnes of raw sugar per season. Two-thirds of the machinery and equipment for the plant was produced within Cuba.

Mali sugar factory expansion[11]

Mali and China recently signed contracts whereby the two sugar factories at Seribala and Dougabougou in the south of Mali will be extended to a combined capacity of around 2000 t.c.d.

Austria sugar production, 1986[12]

Sugar production in Austria from the 1986 campaign totalled 307,148 tonnes, raw value, against 468,184 tonnes in the 1985 campaign.

Bangladesh sugar production, 1986/87[13]

Bangladesh sugar production in the 1986/87 season totalled 140,000 tonnes, white value, up nearly 60,000 tonnes from the previous season. As a result the country will be able to cut imports to 150,000 tonnes; in 1985/86 imports totalled 224,000 tonnes, of which 100,000 tonnes are still in stock.

1 *I.S.J.*, 1987, **89**, 40.
2 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 166, 194 - 195.
3 *Financial Times*, April 15; April 22, 1987.
4 *I.S.O. Stat Bull.*, 1987, **46**, (3), 11.
5 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 182.
6 *Public Ledger*, March 11, 1987.
7 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 116.
8 *GEPLACEA Sugar Letter*, 1987, (25).
9 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 132.
10 *Zuckerind.*, 1987, **112**, 253.
11 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 147.
12 *I. S. O. Stat. Bull.*, 1987, **46**, (2), 3.
13 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 117.

West Indies Sugar Technologists Conference, 1988

The 23rd Conference of West Indies Sugar Technologists will be held at the Dover Convention Centre, Barbados, from April 17 to 22 inclusive and will be hosted by Barbados Sugar Industry Ltd. The theme of the Conference will be "Diversification within sugar" and anyone wishing to present a paper or attend the Conference is invited to write to the Organizing Secretary, Mr. L. S. Wellington, c/o Barbados Sugar Industry Ltd., P.O. Box 719C, Bridgetown, Barbados, West Indies, as early as possible.

Brazil/Latin American & Caribbean sugar congress

A joint Congress is to be held during November 8 - 13 of STAB, the Brazilian Sugar Technologists Association, annd ACTALAC, the Civil Association of Sugar Technologists of Latin America and the Caribbean. It will be the 4th STAB Congress and the 7th ACTALAC Convention. The official languages of the congress will be Spanish and Portuguese and information on presentation of papers and attendance may be obtained from the Secretariat at Caixa Postal 532, Piracicaba, SP, Brazil 13400.

Guyana sugar exports, 1986[14]

	1986	1985
	tonnes, raw value	
Canada	20,896	9,271
EEC	160,591	185,930
Portugal	0	11,481
USA	4,989	22,721
USSR	27,866	0
Other countries	4,898	983
	219,240	230,386

New Chinese sugar factories[15]

In recent years twelve new sugar factories have been set up throughout the island of Hainan and the 27 existing small factories have been expanded or renovated. The island's cane crushing capacity has been increased from 11,000 to 26,000 tonnes a day.

Yugoslavia sugar expansion[16]

Yugoslavia intends to produce one million tonnes of sugar this year from a beet area of 170,000 hectares; this compares with 900,000 tonnes of sugar produced in 1986 from 6 million tonnes of beet grown on 140,000 ha. With higher production, exports are expected to rise from 127,200 tonnes in 1986 to 150,000 tonnes in the last quarter of 1987.

USSR beet sugar targets for 1987[17]

The 1987 Soviet production targets include a beet crop of 83 million tonnes, an average yield of 27 tonnes of beet per hectare, 12% average sugar extraction and 9.3 million tonnes of beet white sugar. Processing capacities are to be raised by 9800 tonnes of beet per day by means of technological innovations and reconstructions. Capacity utilization is to be increased to 90.5% and the campaign duration is to be reduced to 104 days. More than half of the beet area had been sown by May 6, according to official sources; last year, sowings were complete by May 12.

Peru sugar outlook[18]

The long-term outlook for sugar cane production in Peru is that output is likely to increase next year following adequate rains in the mountain areas which will lead to an increase in irrigation water. For this year, however, the crop will for the most part continue to reflect the effects of last season's drought. Consumption, meanwhile, continues to rise and, according to latest figures, imports of 180/200,000 tonnes will be needed to bridge the gap between domestic production and requirements this year.

Uruguay sugar deficit[19]

Floods experienced in the main production areas at the begining of the crop year reduced average yields and cane quality; the target planting area was not reached and 1986/87 production has been reduced to an estimated 285,000 tonnes. In order to make up the shortfall and to be able to meet its US supply quota Uruguay will import 20,000 tonnes of refined sugar from Central America.

Iran beet and sugar production[20]

In an interview on Iranian television the Minister of Agriculture stated that sugar beet production in the Iranian year 1365 (the twelve months to March 20, 1986) had increased to more than 4.9 million tonnes from 3.9 million tonnes in 1364. The Iranian sugar industry authority has reported that white sugar production from beet in 1985/86 amounted to 486,000 tonnes, which indicates a much lower yield of sugar from beet than was generally obtained some years ago.

Costa Rica sugar industry contraction forecast[21]

The Costa Rican government has not yet made a decision concerning the cane sugar industry in that country. A USDA Attache report said it is forecast that a few small and inefficient factories that operate in the central valley will close down in the near future. However, there is protection for small cane growers in the country, where all mills are obliged to buy up to 5000 tonnes of cane per grower, and the Sugar League sets the price per tonne at the end of the harvest season. On the other hand, the sugar factories are not covered by any type of guarantee when forced to close.

CSR raises bid for Pioneer Sugar[22]

The CSR bid for Pioneer Sugar Mills, reported earlier[23], has been improved by raising its cash offer from $A 2.20 to $A 2.50 per share and by offering as an alternative one CSR ordinary share plus $A 1.20 cash for every two Pioneer shares. This values Pioneer shares at 39% more than the market price of $A 1.80 prevailing before the first offer on March 31.

Norway sugar imports, 1986[24]

	1986	1985
	tonnes, white value	
Denmark	84,162	90,943
Finland	3,227	4,482
Germany, West	21,931	34,306
Sweden	6,282	865
UK	36,963	33,794
Other countries	1,136	719
Total	153,701	165,109
Total, raw value	167,066	179,466

Uruguay membership of GEPLACEA[25]

Uruguay was formally admitted to membership of the Group of Latin American and Caribbean Sugar Exporters at a ceremony in Mexico City on April 3. This brings the membership to 22 countries, representing about a third of world sugar production and half of world exports.

El Salvador alcohol production capacity increase[26]

Given the current international situation, El Salvador's National Sugar Institute is planning to increase its alcohol production capacity, starting with the operation of two new plants which together will produce 130,000 litres of alcohol per day. In addition it will double the production of the plant already operating, from 60,000 to 120,000 litres per day.

Raw sugar conveyor fire at Thames refinery[27]

A fire destroyed the raw sugar conveyor at Tate & Lyle's Thames Refinery in London in April. The conveyor housing collapsed on the raw sugar jetty but the remains have been removed and preparation for replacement are under way. In the meantime, raw sugar is being unloaded from ships by grab crane and transferred to lorries, with the balance of the melt requirements being shipped through Gravesend and Tilbury docks.

14 *I.S.O. Stat Bull.*, 1987, **46**, (3), 25 - 26.
15 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 163.
16 *Reuters Sugar Rpt.*, February 19, 1987.
17 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 222 - 223.
18 *Czarnikow Sugar Review*, 1987, (1760), 61.
19 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 209 - 210.
20 *Czarnikow Sugar Review*, 1987, (1760), 61.
21 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 224.
22 *Financial Times*, May 9, 1987.
23 *I.S.J.*, 1987, **89**, 83.
24 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, S164.
25 *GEPLACEA Bull.*, 1987, **4**, (5), Inst. Inf. 1.
26 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 225.
27 *Tate & Lyle News*, May 1987, 3.

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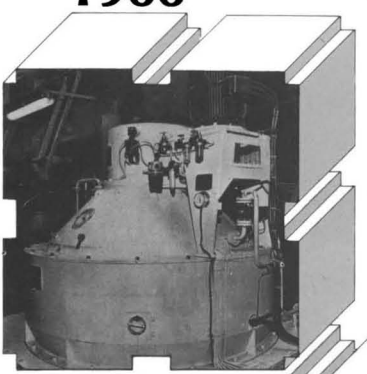

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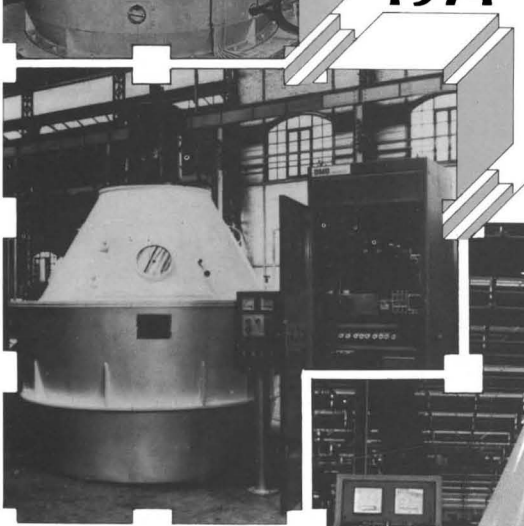

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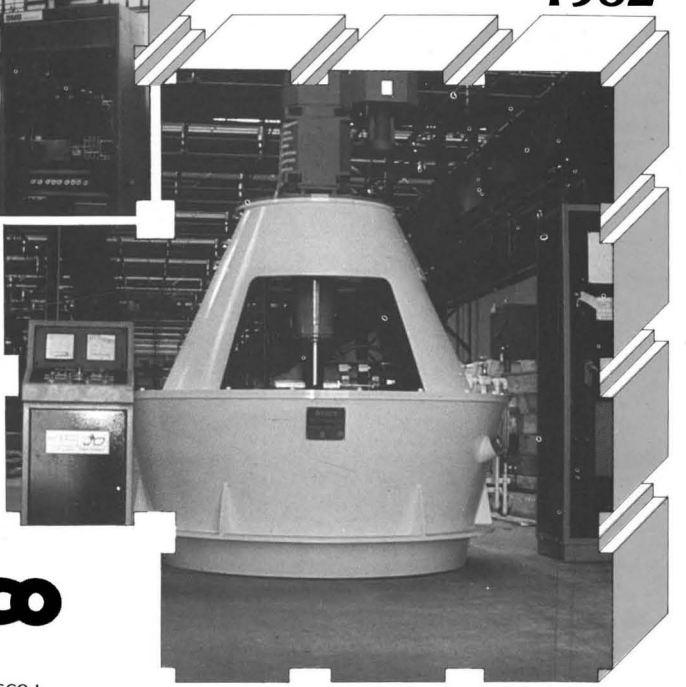

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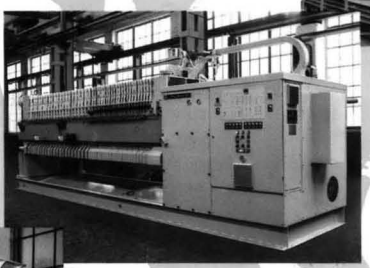

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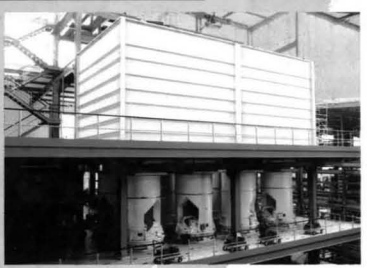

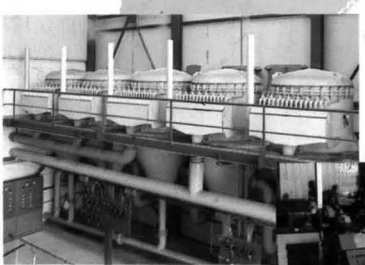

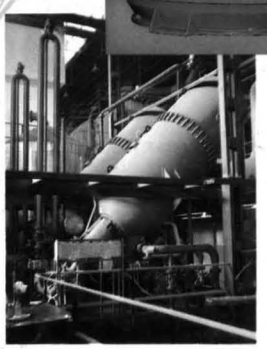

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