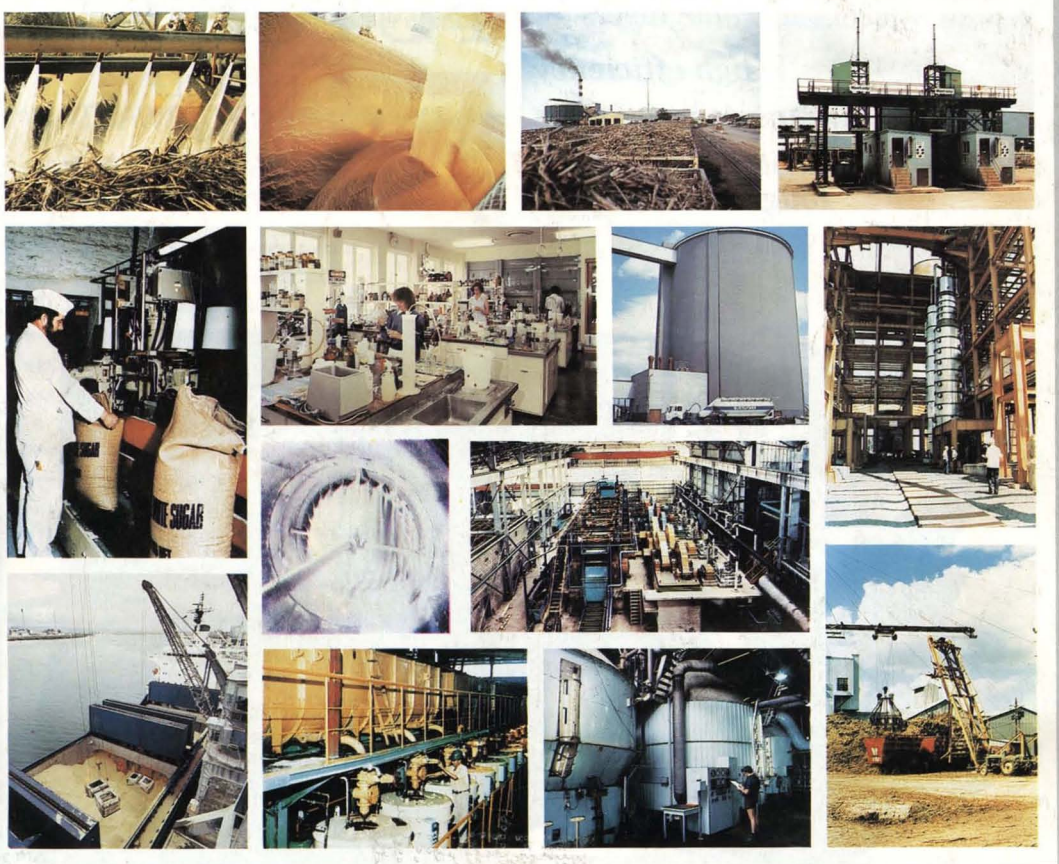
INTERNATIONAL SUGAR JOURNAL



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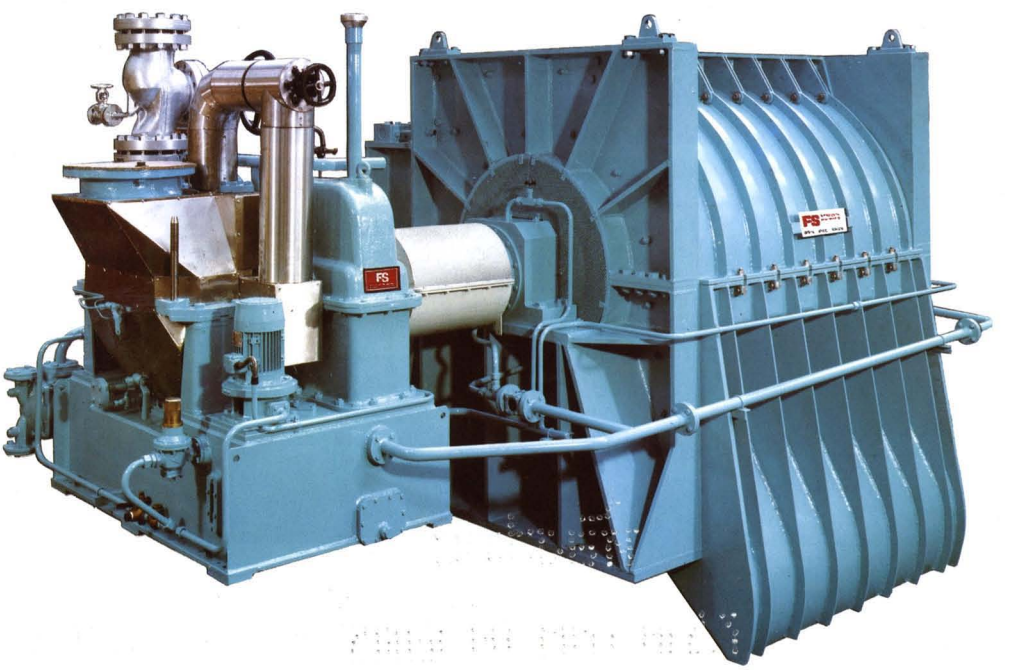

INTERNATIONAL SUGAR JOURNAL

UK ISSN 0020-8841

Volume 90

Issue No. 1075

July 1988

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Published by

International Media Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.
Telephone: +44-639-887498 *Telex:* 21972 REF 869 *Telefax:* +44-639-899830
US Office: 2790 Foster Avenue, Corning, CA 96021

Annual Subscription:
£55.00 pst free

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By Air: £25.00 extra

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News and views

EEC sugar exports, 1987[1]

In spite of the depressed state of the world sugar market in the Community marketing year July 1986/June 1987, the EEC managed to raise its exports by no less than 12%. Most of the EEC export surplus goes to countries in Africa and Asia; while exports to Asia declined in 1986/87 African importers took significantly more EEC white sugar than in the previous year. Algeria alone took 182,000 tonnes more while Egypt increased its purchases by 54,000 tonnes and Kenya, plagued by domestic production problems, imported nearly 60,000 tonnes more than in 1985/86. Somalia increased its purchases by nearly 25,000 tonnes while the Sudan imported nearly 30,000 tonnes more than in the previous year. Morocco took 41,000 tonnes less but this was much more than compensated by gains elsewhere on the continent.

Total exports to Asia amounted to hardly 2 million tonnes, however, which compares with nearly 2.2 million tonnes in 1985/86; the main reason was the decline in Indian import requirements. The trend is likely to continue in 1987/88 as India expects a 3.9% rise in production in spite of the drought experienced this season. Iran also took significantly less EEC white sugar, viz. 128,000 tonnes against 425,000 tonnes the previous year. This is apparently not due to an overall decline in import requirements as significantly more was imported from Brazil and Turkey. The decline in these two countries was partly offset by higher demand from Bangladesh, Israel, Kuwait, Oman, Pakistan, Saudi Arabia and South Yemen. Nevertheless, the overall trend is clearly negative.

Exports to East Europe declined further to 122,000 tonnes; to put this in context it should be noted that, as recently as 1984/85, no less than 830,000 tonnes was exported to this region. This poses a significant problem for the EEC sugar industry as in the past the East European countries, and in particular the USSR, provided a welcome outlet for EEC white sugar. Given the apparent improvements in the Soviet sugar industry, this market may be lost for good, which augurs ill for EEC sugar exporters.

In view of the increase in exports for two years in a row, the question arises as to how much of the increase is sustainable. Future export performance will largely depend on Asian import demand as no improvement can be expected in Eastern Europe. India is likely to import less and higher Chinese demand is of little consolation as that country imports mainly raw sugar which is only offered in limited quantities by the EEC. On the other hand, competition may be less severe; Brazil expects another poor crop in 1987/88 and this could be reinforced by a disappointing crop in Cuba, another major white sugar exporter. Hence, the outlook for 1987/88 is mixed; although it cannot be excluded that the export level can be maintained, no significant rise can be foreseen at present.

Details of the export figures appear below:

	1986/87	1985/86
	tonnes	
Raw sugar		
W. Europe	7,193	16,675
E. Europe	8,025	14,018
Africa	71,044	77,805
America	78	213
Asia	20,143	27,079
Oceania	120	84
Unspecified	497	373
Total	107,100	136,247
White sugar		
W. Europe	482,725	319,844
E. Europe	3,481	1,325
Africa	1,571,820	1,165,196
America	152,838	34,873
Asia	1,984,411	2,147,511
Oceania	12,984	8,772
Unspecified	41,071	96,325
Total	4,249,330	3,773846
Grand total, raw value	4,725,937	4,238,254

Dumping of sugar on the world market

The increase in EEC sugar exports is likely to be seen as a means to castigate the Community for dumping its surplus sugar on the world market. But if dumping is considered to be the sale of a commodity at below cost price, with the aid of government or other subsidy, this applies to virtually every supplier to the world market. Most exporting countries deliver less than 40% of their production to the world market and their sales on that market, at below cost price in almost all cases, are possible only because of profitable domestic or preferential sales or by direct government intervention in order to obtain hard currency. Whether the EEC should have expanded production some years ago is a different question entirely and is complicated by the fact that there was then and still remains a growing market for white sugar which is not met by the raw sugar producers who are the most vociferous against EEC exports.

F. O. Licht GmbH notes[2] that, "contrary to the generally held view in the US, exports are not being subsidized directly even though the EEC at its weekly tenders pays what is called an export restitution. These export restitutions are granted only on exports of A and B quota sugar in excess of domestic consumption. These refunds are financed by means of a production levy paid by beet growers and sugar producers. Only 1.4 million tonnes, raw value, of sugar – equivalent to imports from ACP countries – are financed by the EEC's agricultural guarantee fund ... this is because the Community does not consider that its sugar producers should bear sole responsibility for the cost of such imports which were negotiated when the UK joined the EEC. ... Because of the low level of world prices, producers have had to pay levies of 2% of the intervention price on A quota sugar and 39.5% on B quota sugar, which is hardly an incentive to expand export production. Even this was insufficient to bridge the entire gap between internal and depressed external prices and a super levy is now imposed to ensure that the full costs of the export restitutions are recovered. ... Sugar production above the maximum quota (A plus B) must be sold on the world market without any benefit from export refunds. ... The higher exports in

1 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 193 - 204.
2 *Int. Sugar Rpt.*, 1988, **120**, 193.

1986/87 are therefore not a result of higher subsidies but entirely a result of increased demand for white sugar."

International Sugar Agreement

The second session of the new ISA was held in London in May. Brazil has joined and so all "Big Four" exporters are now members, an essential condition for any hope of progress to an Agreement with economic provisions. There were welcome calls for a working party to look into possible bases for such an Agreement; however, some felt that action on sugar should only be taken as part of an agricultural package to be negotiated within the context of the GATT Uruguay round, and the hope was expressed that members might be prepared at the mid-term session in December to agree on steps to reduce protectionist measures[3].

Several papers were circulated at a session of the Market Evaluation, Consumption and Statistics Committee including one which illustrated the relationship between surplus stocks and world market prices; this showed, furthermore, how surplus stocks have fallen in the four years since the end of 1983.

F. O. Licht GmbH deplores[4] the lack of a sense of urgency shown by delegates over the question of a new Agreement which could halt or even iron out the fluctuations of the recurrent trade cycle in sugar. They point out that the signs are at present that we are now well on the way to a repetition of the classic boom and bust market situation and, while structural changes – particularly the decline in imports by the developed countries and the rise in the more price-sensitive developing countries – may act as a brake on excessive price rises, it would have been expected that enlightened self-interest would have stimulated delegates to seek a consensus for negotiation. "The history of commodity agreements would appear to indicate that real progress never takes place until the last possible moment. In the case of the Uruguay Round that would be mid-1991. One has to wonder whether the sugar industry, if it is to survive in its present form, can wait so long for international action."

World sugar prices

The London Daily Price of raw sugar stayed very stable during most of April. Starting the month at $224.60, it fluctuated only between $222.40 and $228.80 up to April 26 when it rose to $234.20, only to fall back rapidly to close the month at $230.60. A sharp drop to $220 then occurred on May 3 followed by a steady climb to $243.60 on May 16, and a fluctuating level between $238.80 and $246.20 during the rest of the month, closing at $246 on May 31.

The corresponding price of white sugar followed a similar pattern but with a stronger rise in April, from $234.50 to $246 on April 26, a drop to $234 on May 3 and a peak of $257.50 on May 23. The LDP(W) was weaker than the LDP towards the end of May, however and finished the month at $254.

Strength was provided to the market during this time by Chinese purchases, particularly when prices had fallen, while rumours of Soviet interest in April were a cause of the fall late in the month when the reports came to nothing. Another cause was the cancellation of plans by Pakistan to buy sugar after domestic output showed an improvement.

The rise in the first half of May followed more rumours of purchasing interest by the USSR and by India, while the subsequent weakness of the LDP(W) came when it was realised that requirements were smaller than anticipated.

Tate & Lyle success in Staley bid

Om May 30 it was announced that a revised offer of $36.50 per share for Staley Continental Inc. had been recommended for acceptance by the Staley board[5]. The vehicle for the acquisition will be RP Acquisition Corporation, an indirect subsidiary of Tate & Lyle. The latter will be the biggest supplier of sweeteners to the US market with a 15% share from its combination of beet sugar, refined cane sugar and now corn-based sweeteners. Almost half the cost of $1480 million was recouped very soon afterwards when Tate & Lyle sold the Staley food services subsidiary, CFS Continental, for $700 million, more than had been expected. The Staley headquarters is to return to Decatur, Illinois, where it has a 400-acre corn processing facility.

European beet area, 1988[6]

F. O. Licht's second estimate of the areas sown to beet in 1988, publish-ed at the end of April, showed only few changes from the first estimate made at the beginning of March[7]. The total for the EEC is now set at 1,839,000 hectares against 1,852,000 ha earlier and a 1987 area of 1,841,000 ha (increased from the previous figure of 1,828,000 ha). The decrease arises from reductions in the forecasts for Belgium, Greece, Ireland and, especially, Italy, offset by a small increase for Spain. Instead of an increase from 1987 in Turkey, there is now expected to be a reduction, which means that that country will have no sugar for export whereas 110,000 tonnes are estimated to have been exported from the 1987 campaign.

The estimate for Eastern Europe is more or less unchanged with an increase in Hungary almost matching a reduction in East Germany. The total is now set at 7,132,000 ha against 7,200,000 ha earlier, and a revised 1987 figure of 7,225,000 ha. It is not expected that last year's excellent performance is likely to be repeated, although initial conditions seem to be fairly good; even if the USSR should repeat its excellent results of 1987/88, overall European sugar production can be expected to decline. By how much will depend on weather up to the end of the campaign but Licht considers an overall output of 30.5 million tonnes in 1988/89 to be a good working hypothesis; this compares with an outturn of 31,863,000 tonnes in 1987/88.

3 *Czarnikow Sugar Review*, 1988, (1773), 71 - 72.
4 *Int. Sugar Rpt.*, 1988, **120**, 277 - 278.
5 See *I.S.J.*, 1988, **90**, 97.
6 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 219 - 222.
7 *I.S.J.*, 1988, **90**, 78.

Louisiana mill extractions in context

By R. M. J. Withers
(Audubon Sugar Institute, Louisiana State University, Baton Rouge, Louisiana, USA)

Introduction

The sugar factories in Louisiana operate their mills at speeds which are high relative to practices in many parts of the world. The factory managements have chosen to operate in this way so as to achieve a high average throughput for the size of mill tandem. This high throughput is felt to be necessary on acount of a wish to shorten the operating season so as to avoid the risk of premature closure owing to freezing weather conditions. It is possible that such freezing weather may be sufficiently severe to make the cane crop unsuitable for the extraction of sugar in the factories.

It is also the case that factory extraction capability in Louisiana has often been limited by an inability to evaporate the water which could otherwise be added as imbibition to to the mills. The consequential low imbibition which often results in the Louisiana factories, relative to that in other parts of the world, results in a further unfavourable comparison in so far as extraction is concerned. It has also been reported that large amounts of imbibition, whilst leaching out more sugar, can cause feeding problems with three-roller mills when working at high speed and so reduce their capacity. The relatively short operating season, combined with relatively high interest rates, has inhibited the expenditure of capital to remedy these problems although some progress is being made in some factories.

The purpose of this paper is to examine relevant performance data of some sets of Louisiana mills to see whether they are substantially in accord with that one might expect from a general understanding of mill performance and then to compare this performance with current expectations of other ways of mill operation in vogue around the world.

Background

The fundamental concept of the horizontal three-roller mill used in Louisiana goes back many years. The first such design in ironware was due to

R. M. J. Withers

Smeaton in 1754[1], but his layout was not very different to the wooden mills established by the Moors many centuries before. Nevertheless, predicting the performance of such a mill in numerical terms to give its throughput and sugar extraction has only become an openly understood and accepted practice in relatively modern times. Thus, in the 1945 edition of their authoritative handbook, Spencer & Meade[2] merely refer to the classic work of Noel Deerr[3] in the 1930's and state that no performance formula based on the mechanical layout has wide spread acceptance.

Manufacturers and sellers of mills are nevertheless expected to provide a guarantee of performance and have, over the years, devised empirical formulae of their own for this purpose. Together with their various codes for manufacture and assembly, such formulae or performance curves have often been enshrined in the closely guarded manuals of the more reputable and long standing manufacturers and not made generally available even to their own employees.

The first openly published formula which reflected a general understanding is probably that of P. H. Parr[4] who wrote a number of papers on the subject over the years 1921 to 1935 in the *International Sugar Journal*. His 1921 formula was based on a mill roller surface speed of 20 feet per minute and with cane of fibre content equal to 12%.

Tons of cane per hour
$= K \times D^2 \times L \times N^{0.5}$
where K is an empirical factor (1/6600), D = roller diameter in inches, L = roller length in inches and N = number of rollers in the tandem.

The Fletcher & Co. manual of the time suggests that this formula gave a conservative result by perhaps as much as 25%, but the authors were probably happy enough to base a performance guarantee upon it. This was because of the influence of so many other non-quantifiable factors, over which the manufacturer had little or no control, not least the quality of the cane and the personnel responsible for the adjustment, operation, and supervision of the plant. By 1938 the empirical constant in this formula had been changed by a factor of 50%, however, in recognition of the general increase in the mill speeds up to 30 f.p.m and the provision of suitable grooving in the roller surface. Nevertheless the Fletcher manual continued to recommend a significant margin between what might thought a realistic performance figure and the guarantee figure. Obviously such a margin will still be thought prudent today, although it is much reduced because of the wider understandings and the increased competitive pressures between manufacturers in an international market.

The handbook which has perhaps achieved the widest international recognition amongst mill engineers is that of the French sugar technologist Emile Hugot[5]. It was first published in 1948 and the latest edition appeared in 1986. In it he provides an updated version of the Parr formula so as to take acount of the speed of the rollers, the fibre content of the cane, and the cane preparation and the variation of the coefficient of friction between bagasse and metal with the peripheral speed of the mill, as shown by Bullock[6].

This formula (which is broadly similar to that used in the Fletcher manual but with a different empirical constant) is :–

tonnes of cane per hour =
$Kcn(1 - 0.018nD)D^2LN^{0.5}/f$
where K = empirical constant (0.0255), c = coefficient for cane preparation, n = speed of rollers in revolutions per minute, f = percentage of fibre in cane, D = roller diameter in feet, L = roller

1 Withers: *Interdisc. Sci. Rev.*, 1983, **8**, 132.
2 "Cane Sugar Handbook", (Wiley, New York), 1945.
3 "Cane Sugar", (Norman Rodger, London), 1921; *I.S.J.*, 1928, **30**, 247 - 259.
4 *I.S.J.*, 1921, **23**, 562; 1935, **37**, 355.
5 "Handbook of Cane Sugar Engineering", (Elsevier, Amsterdam), 1986, pp 188 - 191.
6 *Ph.D. Thesis* (Univ. Queensland), 1957.

length in feet, and N = number of rollers in the tandem.

The value given by Hugot to the empirical constant was much influenced by working experience in Java and there have been a number of improvements in the mill technology affecting capacity since then, notably the introduction of arcing. However the value of the empirical constant depends also upon the extraction performance that is required since, as Hugot points out, if the same thickness of bagasse blanket is maintained, by increasing the feed as the speed of rotation increases, the extraction will decrease as the throughput goes up. During the recent grinding season one of the factories in Louisiana removed the crown pinions driving the back rollers of all except the first mill in its 18-roller tandem. There was no apparent change in the capacity of the tandem and no obvious change in the power requirement, but the back rollers turned at nearly half their previous speed; whilst the dry substance of the final bagasse and the overall extraction improved significantly.

Hugot suggests that the value given to c, the coefficient for cane preparation, may lie betwen 1.1 and 1.22, but this assumes that preparation with two effective high-speed heavy-duty knife sets is enough. This is a reasonable assumption when working with conventional three-roller mills but with the four- and five-roller combinations now coming into service in other parts of the world, very much better extraction results are obtained with massive shredding of the cane such as is obtained with the Tongaat shredder.

The optimum preparation of the roller surface is a matter of some debate, and a balance has to be struck between the requirement of the primary task of squeezing and the task of traction and providing channels for the expressed juice. The juice has to escape against the direction of the roller movement so high roller speeds tends to make the drainage more difficult. For high speed milling with relatively small mills the necessarily deep grooves need to be heavily notched to obtain the traction whereas, with more generously-sized, slower

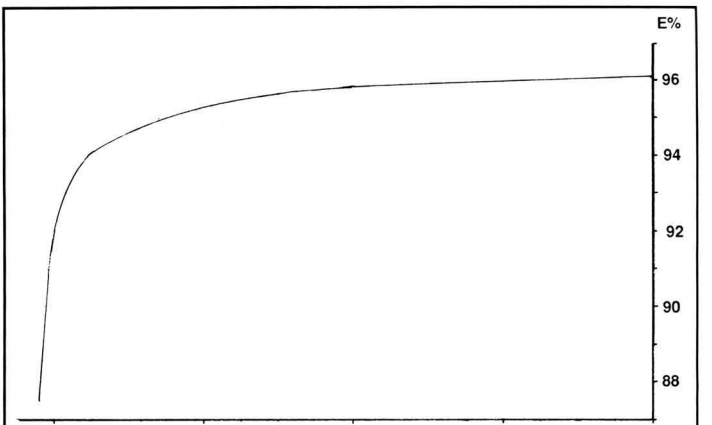

Fig. 1. Reduced extraction (E, %) *vs.* imbibition (I, % on fibre) at 35 fpm speed in a 6 × 3-roller tandem

milling, less notching is needed and the surfaces are less deeply grooved to obtain the maximum extraction performance. In the Australian school of extraction emphasis has been given to the separation of the functions by the use of a positive feed to the mill to push the bagasse through leaving the mill rollers with the clear primary task of squeezing at a relatively slow speed. Thus the grooves have a minimum of notching and are merely roughened by the continuous use of arc welding. There is a brief mention of pressure feeding in Hugot.

Dry milling (i.e. without imbibition) results in the expression of juice until the fibre content reaches around 50%. In consequence the quantity of juice extracted in the successive mills in a dry tandem falls rapidly to zero and the cumulative extraction will never exceed 90%, although it should exceed 86% in a well managed apparatus. The practice of using a counter current flow of imbibition water and juice passing over multiple mill stands, has combined the process of pressing with that of leaching to give overall extractions in the region of 96% in modern milling systems. Much of the original conceptual thought on imbibition systems is due to Parr and Deerr but Hugot provides a comprehensive review and a number of curves showing the way in which the effectiveness of the various imbibition systems is affected by the various factors such as the number of rollers.

Figure 1 illustrates the dramatic effect of increasing the imbibition over the range of 0 - 100% on fibre for an 18-roller tandem. The slope is of course less and the ultimate extraction lower if there are fewer rollers. For only nine rollers the corresponding extraction at 100% imbibition would be approximately 90%. It also makes clear the sensitivity of predictions of mill performance to uncertaintities in the imbibition quantity in the 0 - 100% range.

Hugot also provides a simple formula whereby different tandems working with different imbibition can be compared. The use of imbibition adversely affects the capacity of the tandem, since it is more difficult to feed the mills especially when hot water is used. To mitigate this problem a variety of techniques are available, all requiring extra capital equipment. (The advantages of a positive feeding device such as the Australian pressure feeder becomes much more marked when finely prepared cane is milled with hot imbibition.) The extra imbibition water has to be boiled off in the subsequent unit processes but, although this also needs extra equip-

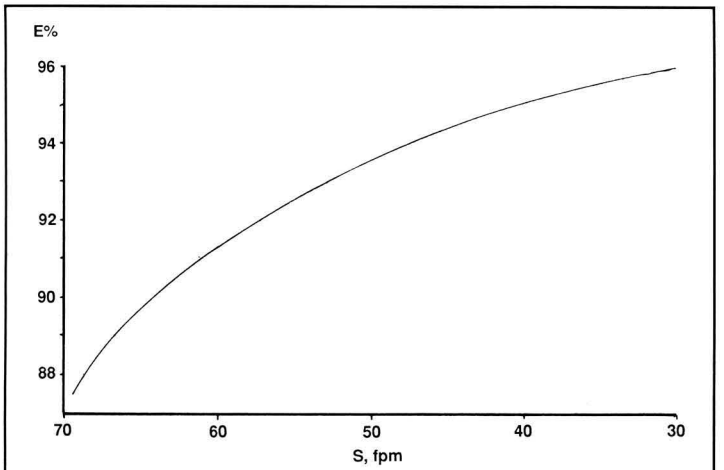

Fig. 2. Reduced extraction (E, %) *vs.* mill speed, (S, fpm) at 250% imbibition in a 6 × 3-roller tandem

ment, there should not be any requirement for extra fuel on this account in a properly constructed factory as sufficient energy is normally contained in the bagasse. However, there is a noticeable drop in purity between the juice expressed at the first mill and that leached out subsequently by the imbibition water. It does not necessarily follow that the extra sugar leached out by the imbibition will end up in a bag.

The effect upon the extraction of turning the rollers at different speeds is nothing like so easy to determine under practical conditions in a working factory as is the case with imbibition. It is not surprising that there is little quantitative information in the literature. It is generally agreed, however, that the effect is not dramatic as is the case for imbibition, although the loss in performance becomes appreciable with peripheral speeds in excess of 50 fpm. To what extent this is simply a matter of speed and to what extent it is due to the differing surface preparation that is necessary for high speed milling is a matter for conjecture, but Figure 2 illustrates the general relationship. One definite advantage of high speed milling is the significantly lower torques at the shafting and gears. This leads to the possibility of relatively low capital cost of installation compared with slow speed milling. But to obtain comparable extraction performance there have to be more rollers in the system and high imbibition. On this account it may not be so clear where the balance of advantages lies in respect of capital cost.

Whilst for a particular mill an empirical factor can usually be obtained from practical observations which will allow the given formula to be used to predict the consequences of changes in imbibition, roller speed etc., some caution needs to be exercised when comparing different mill combinations in differing working environments. No one simple empirical factor is likely to be satisfactory. Hugot admits at one point in his book that the formulae cannot pretend to show more than general trend of a relationship.

There are two further difficulties in making practical comparisons between real installations and theoretical expectations. The first is that in a real factory a working tandem will often consist of a collection of mills with differing roller diameters, widths and speeds. The second is the difficulty of obtaining meaningful samples and analyses from a factory system which is only running superficially in a steady state. There is a fair amount of tedious arithmetic in compiling an extraction balance for a complete tandem, whatever formulae are used, but this aspect has become less onerous with the advent of personal computing. In this context however it is important not to let the computation give an impression of a precision which can never be realised in the practical working environment.

Predicted and actual results for a group of Louisiana factories

In Table I data are presented for seven Louisiana tandems working in the autumn of 1985. The data is derived from two sources in Louisiana and worked up using the relationships previously described but making use of empirical constants based upon the working experience of the author. The purpose of this exercise is not to compare one Louisiana factory with another or to some theoretical norm, but rather to see whether the results for the group as a whole are in line with what

Table I

Tandem	Rate, tcd	System, N × D × L	Speed, fpm	Imbibition, % fibre	EP1, %	EP2, %	EN, %
1	4700	18 × 38 × 66	46	92	94	89	90
2a	5600	18 × 39 × 74	49	221	94	91	86
2b	5600	18 × 39 × 74	48	221	94	91	91
3a	5000	17 × 37 × 72	50	120	93	89	88
3b	5000	17 × 37 × 72	50	172	93	91	88
4	5000	20 × 36 × 48	70	25	88	80	88
5a	3500	18 × 32 × 52	49	37	94	90	89
5b	3500	18 × 32 × 53	56	37	92	86	88
6	4250	12 × 38 × 84	48	57	94	89	88
7	5200	18 × 37 × 66	54	114	93	89	94
Averages	4735		51	110	93.0	88.5	88.9

N = No. of rollers; D = roller diameter (in); L = roller length (in)

one might reasonably expect from a wide background of experience. A comparison may then be made with other ways of operating mills in other countries, and consideration given to the implications these might have in respect of capital investment requirements.

The two sources of data are first a comprehensive set of test results at five factories obtained by staff of the Audubon Research Institute at Louisiana State University and second the 1986 edition of the Gilmore Sugar Manual. The individual factories are not identified here by name, and in calculating theoretical performance data simplifying assumptions have been made to the dimensions of the rollers so as to give a uniform equivalent set throughout each tandem. Only this simplified equivalent is detailed in the table. Only in one or two cases were the imbibition quantities and the roller speed given as directly measured quantities from the rest of the available data. As has already been mentioned there is scope here for a considerable margin of error. Furthermore, in the case of the Audubon test data a number of test runs were logged and there is noticeable variation in some of the parameters between test runs. The mean results derived must therefore be seen as indicative and representative rather than a true average. In the table three sets of extraction data are given. The first is theoretical figure for the tandem at 250% imbibition, the second the theoretical figure at the assumed imbibition and the third is the extraction as measured from the test data at the actual factory. There is some variation between the predictions and the actuals, but this is to be expected and the overall agreement is satisfactory.

Comparison with other milling systems

Table II provides some calculated model data which illustrate the extraction performance of the individual mills within various tandem systems together with the measured performance data obtained by the Audubon Institute for three of the cases given in Table I, namely 1, 3a and 6. The calculated models use the same empirical constants used in Table I as these seem to have given a reasonably realistic comparison with Louisiana conditions. The data are all based on mills with 42 × 84 in rollers except for Model A which has 42 × 53 in rollers. It will be seen that extractions as high as 96% are only obtained with the lower speeds, and that, while increasing the number of mills in the tandem or increasing the imbibition can go some way towards mitigating the effect of high speeds, neither of these can compensate for the relatively low extraction inevitably associated with a first mill operating at high speed. Numbers greater than 250% imbibition and six mills in a tandem have not been considered, but significantly better performance of the systems with Donnelly chutes with feeder rollers, and with pressure feeders are illustrated.

The last column shows the moisture content of the bagasse leaving the final mill. With conventional three-roller mills it is not to be expected that this will be less than 50% but experience with pressure feeders has shown that significantly lower moisture contents may be obtained. Spikey toothed positive pressure feeders were originally installed in Australian tandems at the final mill where feeding difficulties with finely prepared cane and hot imbibition were most marked and where the immediate improvement in the exhausted bagasse dry substance gave much benefit because of the inherently lower fibre contents of the Queensland cane and the need to obtain the maximum fuel economy. Subsequently this type of continuous pressure feeder was applied to the first mill where it was found to increase the tonnage throughput, permit lower speeds and closer settings and a minimum of notching. These feeders have since been fitted in a few instances to all the mills in a tandem. At Babinda mill in Queensland two Fletcher 35 × 66 in units installed some 50 years ago to handle 100 tonnes of cane an hour have recently been grinding over 300 tonnes an hour after being fitted with pressure feeders. Fletcher & Stewart commissioned the first spikey toothed pressure feeder outside Australia in Barbados in 1982.

The idea of providing a positive feed to a mill is not new and in the Caribbean area tall feed chutes before the mill are a long established practice. Donnelly has described[7] their further development in Queensland. For some years Fletcher & Stewart have provided as an option to their three-roller mill an arrangement whereby a 4th or feeder roller is mounted on the mill headstock and combined with a Donnelly chute to give a forced feed to the mill. Such mills are in widespread use and as indicated in Table II give a performance intermediate between the standard three-roller mill and the pressure-fed five-roller mill.

7 *Proc. Queensland Soc. Sugar Cane Tech.*, 1958, 25, 83.

Table II

System	Rate, tcd	Imbibition, %	Speed, fpm	N1	N2	N3	N4	N5	N6	W, %
6 3-roller mills										
Actual 1	4700	92	46	51	74	78	81	87	90	55
Model A	5500	100	50	63	74	80	84	87	88	52
Model B	6025	250	35	66	79	87	91	96	50	
5 3-roller mills										
Actual 3b	5000	172	50	59	70	76	83	88		54
Model C	5500	250	35	66	80	89	93	96		50
4 3-roller mills										
Actual 6	4250	57	40	58	70	78	88			53
Model D	4919	250	35	66	81	90	95			50
Donnelly chutes										
4 4-roller mills	5500	250	35	68	84	92	96			49
Pressure feeders										
3 5-roller mills	5500	250	32	80	92	96				48

Whilst the separation of the functions that pressure feeding makes possible gives much more efficient use of energy and so saves horse power, the associated cane preparation needs to be very thorough if the pressure feeder is to work properly. This requires an energy-intensive heavy-duty cane shredder and it is usually found that, for the system as a whole, there is much the same horse-power consumed per tonne of fibre as in any milling system. However, in recent years, pressure-fed mills have been built with frictionless bearings and this certainly has led to both power and maintenance economies[8].

Capital cost comparisons

Mill headstocks usually have a very long operating life and it may well be that an existing tandem can be modified so as to incorporate some system of pressure feeding. However this may be done, it is often the case that a much wider spacing between the millstands and a greater amount of headroom is needed than is readily available in the existing mill house. This aspect and a number of other factors need to be taken in account when making cost comparions.

It has already been remarked that the spikey-tooth pressure feeder requires excellently well prepared cane and that the necessary heavy-duty shredder is a large energy user. It is also expensive to buy and install, particularly when the cost of the associated prime mover and steam supply is taken into account.

The four-roller mill fitted with Donnelly chutes is not so demanding in this respect, but its overall performance is correspondingly lower. Nevertheless, the cane preparation required to give optimum performance from a four-roller mill is certainly higher than that needed to feed three-roller mills and needs to be taken into account when comparisons are made. Experience suggests that preparation by two sets of well-maintained heavy-duty high speed knives may be sufficient for a four-roller mill whereas the five-roller mill definitely needs the heavy-duty shredder previously mentioned, preceded by a set of knives.

Three-roller mill tandems, when working at the speeds practised in Louisiana, clearly require at least six sets of mills if the performance is to be in any way comparable with that obtainable from the pressure-fed systems. If rollers are worked at speeds of around 35 fpm to give an optimum balance between extraction and throughput for the most economical capital expenditure, a five-mill tandem is indicated. The relatively low torques at the final shafting and gears with high-speed milling allows a significant reduction to be made in the capital cost, although it seems to be the case that the high-speed installations have arrived at their current positions more as a result of the progressive need for more throughput from existing plant over a number of years than from an initial conception. For a totally new factory, capital cost estimates, taking everything into acount, suggest that the cheapest solution lies with a pressure-fed system and, in spite of the extra cost of the shredder, there is not much difference in cost between the four- and five-roller combinations.

However, when it comes to modifying an existing factory it will often be found that the best use of existing equipment and of capital will be obtained by upgrading initially the last mill and then those preceding it. This is often most simply effected with the four-roller arrangement.

Whatever is decided, the highest extraction can only be obtained with high imbibition and this demands efficient use of steam. It should also be borne in mind that the spikey-tooth pressure feeder does make it feasible to feed the cane with hot imbibition as high as 350% on fibre, making it possible to achieve levels of extraction that approach those obtained with diffusion systems. However, to obtain real benefit from such an extraction level, facilities throughput the factory have to be of a high standard.

In conclusion, some mention needs to be made of maintenance costs. In a raw cane sugar factory, mill house operating and maintenance may well acount for over 50% of total factory operating and maintenance costs, but the money spent and how it is accounted depends on very much on local attitudes. Of overwhelming importance is the interest charge on capital, as modern sugar factories tend to be capital-intensive rather than labour-intensive; internationally the most modern factories are always to be found where money has been cheap. There is a balance to be struck between the money and effort given to maintenance and capital renewal and there is a limit to how far lost opportunities for sugar extraction can be directly attributed to mill deficiencies and failures. However it is often the case that mill maintenance costs exceed the charge rate for capital improvement and anything in the design which substantially reduce maintenance costs must merit careful consideration.

8 McGinn & Mason: *Proc. Australian Soc. Sugar Cane Tech.*, 1982, 213.

Facts and figures

New alcohol fermentation process[9]

Agua Limpia distillery at Monte Aprazivel in São Paulo state, Brazil, is using a new continuous cane juice fermentation process which, with the aid of an agitator to achieve a more homogeneous fermentation, affords an increase of 4% in productivity. A similar process is under test by the Zanini company at Usina Santa Elisa.

Possibility of no new sugar export contracts for Brazil[10]

Brazil may not sign any new sugar export contracts this year because of a production shortfall, according to the head of the Sugar and Alcohol Institute, who emphasized, however, that Brazil would honour all existing contracts. The institute has said that drought has cost the north-east of the country between 13 and 15% of its cane harvest but São Paulo traders suggest that the loss may be as high as 30%.

Locust threat to Australian cane[11]

Cane crops in the Bundaberg district of Queensland, particularly the western Bingera area, could face serious threats from plague locusts this season, according to the Bureau of Sugar Experiment Stations. Hot, dry weather during December provided favourable conditions for new nymphs to hatch and the BSES warned cane growers to inspect their crops and spray insecticides to protect against the adult locust.

9 *Sugar y Azúcar*, 1988, **83**, (3), 8 - 9.
10 *Financial Times*, March 9, 1988.
11 *Australian Canegrower*, 1988, **10**, (2), 5.

ENGINEERING

A review of methods to calculate mill discharge opening

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Most sugar factories have more than three commercial varieties grown in their areas, with different fibre contents, milling characteristics and seasonal variations. Once the crushing rate and mill operating speeds have been established, the Mill Engineer has to make a decision at the beginning of the crop, based on previous experience, regarding the discharge work opening of the mills for optimum performance under varying conditions. There is really no secret by which the proper discharge work openings for mills in the tandem, necessary for efficient milling performance and survival given the present narrow margin of factory operating profit, are calculated.

As we know, cane milling is basically a volumetric process; we have to calculate the volume of cane or bagasse from the predetermined crushing rate. To determine the volume of cane or bagasse in cubic feet from its weight in tonnes per unit time, it becomes necessary to divide this weight by its density or specific weight. The specific weight of bagasse gradually increases as it passes through the milling train, owing to the progressive compaction of the cane fibre. These density figures are replaced in cane milling by the fibre index, compression ratio, fibre filling ratio or fibre ratings, which are used to estimate the volume of bagasse from each mill at the discharge work opening.

When the volume of bagasse passes through the mill without any slip, in unit time, it is equal to the roller speed × the roller width × the roller work opening. When the mill operating speed and roller width are known, the work opening for the discharge side of the mill can be calculated from these. Methods for calculating the volume of the bagasse are as numerous as there are theories on the subject. The end results, however, cannot be too different from one method to another if desired milling results are to be obtained.

Many years ago Noël Deerr made his classic experiments on the compressibility of cane and bagasse and found that a point was soon reached, in compressing bagasse, at which very

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little reduction in volume occurred despite increasing pressure, under static conditions. A similar experiment to determine the pressure/volume relationship under static conditions, in which some sort of imbibition was also incorporated, was repeated by Pole[1], in South Africa. Bullock performed a number of experiments[2] to determine the relationship under dynamic conditions in Australia. These indicated that high loads can be developed at low crushing speeds (0 to 20 r.p.m.). He has quoted Lindley to explain the occurrence of high loads at low crushing speeds, which can happen when the speed of the roller is greater than the speed of reverse juice drainage through the bagasse. He further stated that, "after passing the point of relative balance between the drainage speed and the speed of approach, the bagasse must exist as juice thickly interspersed with compressed fibre and take on semi-liquid properties. This immediately prohibits any further building-up of pressure and the bagasse trapped from going backwards will go forward, at a speed in excess of the roller speed; the juice being re-absorbed with the release of pressure after passing the point of nearest approach". On these grounds, the pressure/volume relationship as determined by Deerr does not hold in practical milling, as his experiments were done in a press without due regard to the permeability of the bagasse and without taking into account the possible effect of any forward slip. Since better founded data on the pressure/volume relationship under dynamic conditions are not available, Deerr's findings give a useful picture of the links between important variables.

The application of pressure caused a reduction in volume of the blanket of bagasse down to a certain point, but from then on, the mat of bagasse became a rigid body and practically no further reduction in volume was possible. Naturally this point is hard to determine accurately and will differ with varieties of cane and the degree of preparation. On the results of Deerr's experiments, Tromp has mentioned[3] that bagasse compressed at 2000 lb per square inch pressure weighs about 79 lb per cubic foot, and higher compression could not cause any appreciable increase in its specific weight.

Based on Deerr's findings, Hugot, in his book "La sucrerie de cannes", gives a formula for calculating the radial discharge work opening for the mills. Others including Thomas Lowe, Pole and Fletcher & Stewart Ltd. have also used Nöel Deerr's pressure/volume ratio in calculating the discharge work openings for the mills.

It will not be out of place here to mention the contribution of Egeter and Khainovsky in Java as early as the late 1920's. Khainovsky showed how, by simple means, one may determine the proportion of the juice storage cells which are opened by any preparation or crushing device, and thus appreciate more clearly the exact function and duty of the mills, particularly with regard to the value of maceration water applied[4]. Egeter attempted to determine what happens to juice expressed at any mill, producing some very interesting data. He assumed that the solid fibre in the bagasse must have space to pass through at roller speed, considering fibre, and not bagasse, as an incompressible solid with a specific gravity of 1.53. The proportion of the escribed volume occupied by the fibre could readily be calculated knowing the weight of fibre crushed in unit time. He was able to show that the residual volume, with the normal mill settings, was not sufficient to permit all the liquid in the bagasse to pass, unless a portion, at least, moved at greater speed than the fibre. He developed the

1 *Proc. S. African Sugar Tech. Assoc.*, 1959, 49 - 52.
2 *Proc. Queensland Soc. Sugar Cane Tech.*, 1957, 43 - 62.
3 "Machinery and equipment of the cane sugar factory" (Norman Rodger, London), 1936, p. 163.
4 Kerr: *Proc. Queensland Soc. Sugar Cane Tech.*, 1954, 221 - 233.

ISJ Abstracts

Cane sugar manufacture

A filter station design for BSIL (Barbados Sugar Industry Ltd.)

D. H. West. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 8 pp.

After listing factors that influence clarifier mud filtration, the author examines general design principles of a filter station capable of handling up to 200% of the expected load under normal harvest conditions, when it is estimated that a factory would produce 3.5% filter cake on cane. A material balance is given for a factory of 100 tch operating under normal conditions; regulation and maintenance of mud, bagacillo, wash water and steam flow are of fundamental importance. A basic design and dimensions are given of the basic components, including mud tank and pump, bagacillo screens and fan, cyclone, bagacillo storage bin, mud-bagacillo mixer, the filter itself, vacuum system, and pumps for filtrate and wash water. The question of bagacillo quantity needed to give a bagacillo:mud ratio of 0.8 (based on filter cake analyses at Barbados factories in 1984) and design criteria for a bagacillo collection system are discussed.

Cane sugar factory steam economy considerations

M. C. Hutson. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 10 pp.

The amount of inlet steam lost between generation and its use in processing is discussed and the efficiency of the back-pressure turbine is examined. While raising the pressure ratio between inlet and exhaust steam (so as to increase the quantity of available power) can be done by increasing the inlet steam pressure, a reduction in the exhaust steam pressure will give a much greater increase in power, particularly when the inlet steam pressure is low (e.g. 120 - 160 psig). Maximum turbine internal efficiency is a function of rotor diameter, rotary speed and number of stages; a small rotor diameter and high rotary speed relative to volume steam flow improves efficiency by reducing internal steam leakages, while longer blades are more efficient, the overall effect of such a turbine design being to utilize more of the heat in the inlet steam and thus generate more power. Three different steam inlet conditions with a common back pressure are used as examples to show how steam losses can be reduced; while the use of superheated steam is desirable in this regard, there are factors that have to be considered when operating at extremely high temperatures. Advice is given on turbine selection for operation at economical water rates and for a total steam consumption that is somewhat lower than the calculated requirements for process purposes.

The development of a simple pneumatic speed control for a mill turbine

M. Biddlestone and R. G. A. Whitehead. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 6 pp.

After one of three Bellis & Morcom steam turbines used as cane mill drives was replaced with a new unit, making the power parts of the redundant unit available as spares for the other units (thus extending their life), it was decided to build and test an independent speed control system for the drives; since the erection of the factory in question, the three turbines had exhibited very poor speed control. Speed control criteria for a turbine drive are discussed and details are given of the components selected for a single-loop control circuit. Results of the tests showed that the pneumatic control was much better than the conventional governor control, with almost complete elimination of speed fluctuation and considerable reduction in the maximum deviation from set point. The actuator response time was considered too long for control purposes (although quite acceptable for turbine operation) and it was intended to reduce it from 5 to 1 sec. The system was to be installed on both Bellis & Morcom turbines for the 1987 season.

Deterioration of chopstick cane

D. H. West. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 8 pp.

A study was carried out to assess the rate of deterioration of cane billets stored in 5-tonne trailer bins in the cane yard at Carrington factory; weight loss and cane quality were monitored over a 41-hr period of dry and relatively cool weather. The initial cane pol was 17.7, and the cane was relatively free of rodent or insect damage. Analyses of 20 samples from two loads taken initially and then 17, 24 and 41 hr later showed no change in juice purity (initially 90.2) up to 24 hr, after which there was a sharp decline; pol % fibre rose up to 24 hr, after which it fell to below the initial value, while Brix % fibre also increased to 24 hr, after which it fell to an average value that was just above the initial one. Reducing sugars and dextran contents rose markedly, and there was a 1.76% weight loss across the 41-hr period and a significant loss of sugar between 24 and 41 hr.

Venting, etc., of horizontal tube and shell type juice heaters

M. C. Hutson. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 4 pp.

Advice is given on juice heater venting, with two hypothetical cases described for a factory of 100 tch.

The effects of inferior raw material on the Barbados sugar industry

C. M. McCollin. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 5 pp.

Types of extraneous matter are described and their effect on factory processing and equipment indicated. Stale cane is also discussed, and the effects of this and of vegetable matter on reduction in sugar recovery are calculated.

Dextran and the Louisiana sugar industry

D. B. Fontenot and D. F. Day. *Sugar Bull.*, 1987, **66**, (1), 8 - 9.

See *I.S.J.*, 1987, **89**, 90A.

Sugar extraction from cane – LPE system

W. Leibig. *Zuckerind.*, 1987, **112**, 966 - 970.

The low-pressure extraction system described is based on the use of a pair of rollers one above and to the side of the other so that their central plane has a slope of 40° to the horizontal; the lower roller is provided with drainage holes, and the unit is designed to act as a pre-dewatering mill for bagasse from a diffuser of the type in which extraction liquid is sprayed over and percolates through a bed of prepared cane as it is carried on a horizontal drag conveyor. A pilot plant installed at a Brazilian distillery consisted of a diffuser (lix-iviator), five pairs of low-pressure dewatering rollers and a pair of medium-pressure rollers attached to a conventional high-pressure 3-roller dewatering mill; approx. 75% of the total press juice was extracted by the medium-pressure unit which was similar in design to the low-pressure units. At a processing rate of 104 tch, 95.2% extraction was achieved (reduced to 12.5% fibre), falling to 94.6% at 133 tch; a water rate of 1.6 - 1.8 parts per fibre was used and raw juice draft was 85 - 96% on cane, yielding an extraction juice of high Brix. The above results were obtained at ambient temperature, since the process does not call for juice heating, while energy consumption was lower than with conventional milling or diffusion and the total extraction process took only approx. 6 min. The system performed well with cane of 85 - 90 Preparation Index, so that the fiberizer installed after two sets of cane knives operated with only 60 instead of 120 hammers most of the time.

Comparison of extractives from milling and diffusion

P. C. Ivin, M. L. Clarke and J. D. Blake. *Sugar J.*, 1987, **50**, (4), 5 - 9.

Comparison of extraction by cane diffusion at Fairymead and by milling at Inkerman factories in Queensland in 1977/78 and 1983/85 showed that diffusion juice tended to be slightly lower in purity and higher in colour and colour precursor contents than mill juice; a lower content of high-molecular weight components in diffusion juice (which contained a higher level of cell wall polysaccharides) was attributed to the higher overall pol extraction, to the higher temperatures used and to longer residence times. Liming had a marked effect on diffusion juice ash and acetate contents, the acetate level being higher than in mill juice because of poorer lime distribution than at Inkerman, where lime addition was controlled by means of press water clarification; it is emphasized that extraction of acetate raises the ash content in juice and thus contributes to a lower sugar recovery while also wasting lime. Experience at Fairymead suggests that lime addition in diffusers is unnecessary provided bed temperatures of about 75°C can be maintained to control microbial degradation of sucrose and the natural pH of the juice is >5.2, and the practice of liming has been discontinued under normal operating conditions at Fairymead in recent years.

Factory operations (in Barbados) 1987

M. Biddlestone. *Barbados Sugar Rev.*, 1987, (56), 5 - 9.

The performances of the six Barbados sugar factories in 1987 are summarized; although only 83,432 tonnes of 96°S sugar were produced from 720,592 tonnes of cane (the lowest amount of sugar manufactured since 1948) it was still enough to meet premium export and local market requirements. A considerable number of hours (392) were lost at Portvale (the largest sugar factory on the island) because of cane shortages; although it had been estimated that nearly 177,000 tonnes of cane would be delivered, only 146,000 tonnes were received. The smallest amount of time lost through lack of cane was 170 hours at Andrews, although Bulkeley used the highest proportion of its available crushing time.

Modifications to the boiling procedures at Sezela in an attempt to reduce VHP sugar colour

G. F. Mann. *S. African Sugar J.*, 1987, **71**, 379 - 381.

See *I.S.J.*, 1988, **90**, 62A.

Sugar technology: current development and future prospects

J. P. Stupiello. *GEPLACEA Bull.*, 1987, **4**, (12), 6 pp.

Developments that have led to higher cane processing efficiency in Brazilian sugar factories are described; they include: payment for cane on a quality basis; improved preparation, installation of new and additional equipment and changes in the milling process such as replacement of simple with compound imbibition; the introduction of cane diffusers; improvements in boiler equipment and operation; generation of own electricity and more efficient use of power coupled with an increase in the power factor; improvements in juice impurities removal using strainers and hydrocyclones and replacing calcium hydroxide with calcium saccharate in clarification; the installation of longer tubes in evaporators to reduce entrainment losses and improve heating surface utilization; syrup clarification by flotation; the introduction of magnetic equipment to remove impurity particles from sugar; and improvement in chemical and quality control.

Influence of pH and temperature on the extraction of non-sugar in the Egyptian diffuser

A. M. El-Naggar, A. M. El-Sherbiny and A. Abou El-Ela. *Taiwan Sugar*, 1987, **34**, (5), 16 - 19.

A study of the factors affecting non-sugars extraction in bagasse diffusion involved soaking bagasse samples in sugar solutions of varying temperature in the range 60 - 90°C and pH in the range 6.5 - 8.5 under conditions simulating those of diffusion. Results indicated that non-sugars extraction rose with both temperature and pH and was minimum at 70°C and pH 6.5.

Beet sugar manufacture

Change in the rheological properties of the lime-sugar system in the carbonatation process

L. I. Pankin, A. M. Gavrilov, A. R. Sapronov and V. M. Leshchenko. *Sakhar. Prom.*, 1987, (10), 21 - 23 *(Russian).*

A study was made of the changes that occur in the rheology of the system in a carbonatation vessel; a 15% sugar solution containing 1.8% CaO was gassed at room temperature, and samples taken for titration (to determine the degree of lime removal as calcium carbonate) and viscosity measurement. In the first of three stages in the process, up to 40% of the lime was precipitated as carbonate, and the solution lacked shear strength; in the next stage there was a sharp rise in shear strength to a maximum at about 62% carbonate formation, and in the third stage, the structure and properties of the carbonate changed; shear strength fell almost to zero at 90% carbonate formation. Viscosity followed the same pattern as shear strength and rose to a maximum at about 67% carbonate formation, whereas initially plasticity rose evenly to reach a maximum at 65 - 75% carbonate formation, after which it fell at an even rate. The rheological behaviour of the solution is explained in terms of contact and interaction between the carbonate particles and non-sugars coagulation.

Effect of certain factors on crystal adhesion during massecuite boiling

V. O. Shtangeev, A. I. Ukrainets and I. S. Gulyi. *Sakhar. Prom.*, 1987, (10), 23 - 26 *(Russian).*

An experimental plant was used in simulated boiling studies; steel plates were immersed in the massecuite and weighed after a given time to determine the quantity of crystal sugar adhering per unit area. Microscopy revealed three distinct zones in the layer of incrustation: the first zone comprised a strong band of homogeneous structure in which the crystals were linked by bridges; the second zone was of poor strength and contained individual crystals weakly joined to one another but with mother liquor also between them, while the third zone was made up of a large number of separate crystals and was maintained intact only by mother liquor between the crystals. However, the number of crystals making up the incrustation varied under one and the same conditions as a result of irregularity in size and hence in growth rate. The use of artificial massecuites containing known crystal size fractions showed that good reproducibility of results was possible with 0.63 - 1.00 mm crystals, but not otherwise; reduction in crystal size led to increase in the quantity of incrustation. There was an insignificant increase in the amount formed during the first 60 minutes of boiling, after which the rate of build-up increased; the rate of adhesion fell considerably when lower-grade massecuites were boiled, and in all cases rose with increased supersaturation in the initial stages of boiling. There was also a slight increase in the rate with temperature rise in the range 65 - 80°C. The significance of the findings for continuous boiling is emphasized.

Analysis of the process of crystal growth in a batch vacuum pan

A. K. Sushchenko, T. P. Grishagina and V. A. Karpenko. *Sakhar. Prom.*, 1987, (10), 26 - 29 *(Russian).*

Massecuite samples were taken at given time intervals until the end of the strike in a pan equipped with a DDS microprocessor-based automatic boiling control system to determine the weight of the massecuite in the pan, boiling point and mother liquor conductivity; photomicrographs were also taken, from which histograms were constructed showing size distribution and the mean length calculated. Full seeding with icing sugar was used. Results, analysed with the aid of a mathematical model, showed that within the first 10 - 15 minutes of seeding, between 50% and 95% of the crystals in the seed (the finest fraction) dissolved; those remaining grew to 150 - 200 μm within the next 15 - 30 minutes, their number remaining constant to the end of boiling. The value of the DDS system in maintaining stable white sugar granulometry is demonstrated.

Improving the measuring accuracy of industrial pH meters with an UOEA electrode automatic cleaning device

Yu. V. Goryainov, A. N. Gritskevich and L. D. Drobot. *Sakhar. Prom.*, 1987, (10), 36 - 37 *(Russian).*

The efficiency of the automatic cleaning system described earlier[1] was tested on three industrial pH meters used to measure the pH of prelimed, 1st and 2nd carbonatation juices; automatic cleaning of the electrodes with 3.5% HCl solution was carried out for 4 sec every 6 hours in the prelimer, for 2 sec every 8 hr in the 1st carbonatation vessel and for 2 sec every 2 hr in 2nd carbonatation. The pH meters were adjusted to cover a range of only 2.5 units: pH 10.0 - 12.5 in preliming and 1st carbonatation, and pH 8.0 - 10.5 in 2nd carbonatation. Comparison of 30 readings for each process with ionometric values showed absolute errors of – 0.15 units in preliming (compared with – 0.40 when cleaning was carried out manually every 16 hr), of – 0.17 in 1st carbonatation (compared with – 0.45) and of – 0.18 in 2nd carbonatation (compared with – 0.60); the official permissible error is ± 0.2 units.

The application of RZ-PFP candle filters for filtration of syrup with remelt liquor

E. A. Koval'chuk *et al. Sakhar. Prom.*, 1987, (10), 42 - 45 *(Russian).*

A description is given of the RZ-PFP-4 candle filter of 90 m² filtration area, four of which were installed at Ul'yanovka sugar factory in 1985 for treatment of a mixture of syrup and remelt liquor having a Brix in the range 57 - 70° and a temperature of 68 - 72°C; powdered

1 Goryainov *et al.*: *I.S.J.*, 1987, **89**, 58A.

perlite is added to the syrup as filter aid. In 1986 the effective filtration rate of 2.4 litres/m²/min far exceeded that with previous disc filters, and the filtrate was transparent, as were samples of sugar solution obtained from it.

A new drive for inclined diffusers

D. I. Smetana, A. V. Lukash and N. N. Krutikov. *Sakhar. Prom.*, 1987, (10), 45 - 46 *(Russian).*

The chain drives used on all inclined diffusers imported into the Soviet Union have proved unreliable, requiring frequent repairs and careful maintenance during operation. A new sloping diffuser of Soviet manufacture tested in 1976/77 and recommended for mass production has a drive comprising two D.C. motors connected to two standard spur reduction gears via box-pin couplings mounted on a common frame; the slow-running shafts of the gears are connected by toothed couplings to the input shafts of a special duplex reduction gear (consisting of sets of helical and straight spur gears) the output shafts of which are connected to the diffuser scrolls. Tests have shown smoother transmission and reduced motor output as well as greater reliability by comparison with the conventional drive mentioned above.

The kinetics of saponin removal by flotation using fabric dispersers

A. A. Vasilenko, V. V. Sakhnenko and M. V. Issa. *Sakhar. Prom.*, 1987, (10), 46 - 49 *(Russian).*

In tests on removal of saponin from waste water by flotation, fabric sleeves on air dispersion tubes proved cheaper than ceramic sleeves in the removal of half of the initial amount (the rest of the saponin should be removed by coagulation using biological or chemical means). Best results, including simultaneous removal of 30% organic pollutants, were achieved at an air volume of 8 - 10 m^3/m^3 (approx. 0.2 m^3/g saponin) and a residence time of 20 - 40 min in the flotation tank. The fabric sleeves were responsible for only half the quantity of foam given by ceramic sleeves.

Initial results of operation of Ertil' sugar factory with an optimized heat system

V. M. Fursov *et al. Sakhar. Prom.*, 1987, (10), 49 - 52 *(Russian).*

With the need to replace six evaporation vessels (making up the first three effects of a quadruple-effect evaporator plus concentrator), it was decided to calculate the optimum thick juice Brix leaving the evaporator and optimum temperature of the vapour recycled for recompression at which the annual factory expenditure would be minimum; the optimum values were found to be 65°Bx and 138°C, respectively. The new evaporator was installed for the 1986 campaign, results from which are discussed. The diffusion juice draft was raised from 129% to 132%, but the thick juice Brix was still below the optimum at an average of 57.2° compared with 52.4° in 1985; nevertheless, at a higher beet slice, diffusion losses were low and the white sugar yield on beet higher. Other measures to be adopted in addition to the new steps already taken are mentioned.

The Sh1-PUKh beet trash separator

I. A. Marochko, L. A. Kuznetsova and L. I. Potapova. *Sakhar. Prom.*, 1987, (10), 52 - 53 *(Russian).*

Mounted on the base of a beet piler, the trash separator described consists basically of three rotary grids with three smooth rollers between them all mounted on a frame at an angle of 45° to the horizontal and all rotating counter to the direction of the beets falling over them from the end of an inclined conveyor on their way to a funnel transferring them to the main conveyor used for piling. The grids rotate at 135 rpm and the rollers at 72 rpm, and a smooth cylinder at the foot of the slope rotates at 135 rpm to slow the rate of fall of the beets.

Selected problems of sugar factory waste water treatment in open fermentation chambers

B. Polec and T. Wolski. *Gaz. Cukr.*, 1987, **95**, 115 - 117 *(Polish).*

For fastest degradation of pollutants in factory effluent subjected to anaerobic treatment with activated sludge, the temperature should be 33°C and the added sludge should be wet. The importance of a wet sludge was demonstrated by comparative trials in which 71 days' treatment at temperatures in the range 11 - 25°C gave COD reductions of 94.4 and 95.4% (the greater reduction occurring with a thicker bed of sludge) by comparison with only 52.2% where the sludge was added dry; even where anaerobic treatment took place in the absence of sludge, the COD was reduced by 94.5% in the same time. The pattern of decrease in BOD_5 followed that of COD reduction. The results explain why poor results were obtained at one named sugar factory during the 1985/86 campaign.

Anaerobic sludge biofilters and anaerobic coke beds applied to waste water treatment

T. Wolski and B. Polec. *Gaz. Cukr.*, 1987, **95**, 117 - 121 *(Polish).*

Comparative experiments are reported in which effluent was treated (i) anaerobically with sludge supported on a bed of coke and (ii) with a normal bed of sludge. At a pH approx. 7.0, 33°C and a retention time of 0.49 - 1.70 days, treatment (i) reduced the COD and BOD_5 by 43.8 - 89.8% and 50.0 - 93.5%, respectively, from initial levels in the range 3311 - 6174 and 2381 - 5100 mg/dm^3, respectively, while treatment (ii) proved superior by reducing the COD and BOD_5 by 59.6 - 92.0% and 65.7 - 93.5%, respectively. Details are given of the quantities of biogas obtained and of mineral and organic suspension in the treated water.

Modification of a line for storage and dispatch of affined sugar

I. Havránek and D. Lingerová. *Listy*

Cukr., 1987, **103**, 236 - 241 *(Czech).*

Details are given of a modified system for bulk storage, bagging and dispatch of affined sugar at a Czechoslovakian sugar factory; the plant is designed for a conveying rate to the silo of 15 tonnes/hr and to the bagging plant of 10 tonnes/hr (50-kg bags at 200 per hr), while the nominal moisture content of the stored sugar is 0.5%, with 90% of the sugar having a size <2.8 mm and the invert content no greater than 0.25%.

The role of coagulation in adsorption of non-sugars by calcium carbonate in lime-sugar systems

V. M. Leshchenko, L. I. Pankin and A. R. Sapronov. *Sakhar. Prom.*, 1987, (11), 16 - 20 *(Russian).*

The results of research conducted by a number of authors into the mechanism of non-sugars adsorption by calcium carbonate are summarized. The carbonatation process is divided into three periods: (1) Up to precipitation of 35 - 40% excess lime as calcium carbonate; adsorption is reversible and juice alkalinity falls as a result of decrease in lime solubility associated with sucrose adsorption from the carbonate solution formed, while the rate of CO_2 absorption changes, mainly as a consequence of increase in the viscosity of the colloidal system. The calcium carbonate particles start to coagulate only after the concentration of calcium hydroxide ions falls to a given critical level at the end of the period. (2) Until 55 - 65% of the lime is precipitated; adsorption continues to be reversible up to 60% lime neutralization, and there is an apparent increase in colour, lime salts and alkalinity which is greater the higher is the initial concentration of lime and is associated with the presence of a double electrical layer of solid phase. A rise in the specific volumetric concentration of the colloidal micelles coupled with a fall in the concentration of stabilizers in the micelles cause sucrose desorption which in turn affects the lime solubility; the presence of insoluble hydroxide leads to a sharp rise in the active alkali content in the juice. Towards the end of the period, the viscosity of the system reaches its maximum and the CO_2 absorption reach becomes minimum. (3) This period continues until all the lime has been neutralized. A fall in the zeta-potential is accompanied by an improvement in the mud filtration properties, while the active lime content decreases. A reduction in viscosity of the overall system is attributed to the formation of a denser coagulate while the juice viscosity rises slightly in the middle of the period (as a result of dissolution of earlier adsorbed sucrose and the continued formation of carbonate micro-particles) but then falls. CO_2 absorption rises at the start of the period as a consequence of colloid coagulation, after which it falls in step with a reduction in alkalinity.

Stability of raw juice flow during the purification process

Z. S. Voloshin and A. R. Sapronov. *Sakhar. Prom.*, 1987, (11), 20 - 21 *(Russian).*

Two systems mentioned for controlling the length of the cold liming period in fractional cold-hot liming fail to allow for variation in juice flow and result in increased sugar losses, and a new system is described in which control of the juice level in the cold liming tank is linked to the control for juice withdrawal, leading to smoother flow and lower losses.

The effect of the surface layer of beet roots on the technological properties of purified juice

V. S. Shterman, E. V. Ivchenko and M. S. Zhigalov. *Sakhar. Prom.*, 1987, (11), 23 - 25 *(Russian).*

Experiments are reported which demonstrated the benefits of scalping beets[1] in terms of increase in purity and decrease in reducing sugars and amino-N in raw juice and increase in natural alkalinity, settling rate, filtrability and hence purity and reduction in colour of 2nd carbonatation juice. Up to 10% of the beets were removed as outer layers, but most of the results referred to 5% removal by scalping.

Calculation of the diffusion process on programmable calculators

B. N. Valovoi, Yu. A. Pustokhod and V. G. Yarmilko. *Sakhar. Prom.*, 1987, (11), 26 - 30 *(Russian).*

Four continuous diffusion programs are presented for use with Elektronika MK-52 and Elektronika MK-61 calculators to find (1) sugar losses in the exhausted cossettes, (2) undetermined losses, (3) the various quantities involved and (4) the process period in different types of diffuser. Sample calculations are given for each program as a check.

The A2-PKS sulphitation unit

S. A. Zozulya *et al. Sakhar. Prom.*, 1987, (11), 30 - 32 *(Russian).*

A description is given of the A2-PKS sulphitation complex installed at Lokhvitskii sugar factory; it incorporates four sulphur burners and one vessel each for treatment of thin juice, syrup and diffusion water. Designed for a daily throughput equivalent to 9000 - 12,000 tonnes of beet and a gas SO_2 content of 16% by volume at discharge from the burners, it replaces three individual units of three different designs and separate burners. Nominal pH reductions are given for each product.

Filtration of highly concentrated sugar solutions in a centrifugal field

V. V. Smol'yaninov, A. I. Gromkovskii and A. F. Gubenko. *Sakhar. Prom.*, 1987, (11), 32 - 35 *(Russian).*

Trials on the use of centrifugals for filtration at Ol'khovatka are reported. A thick juice-remelt mixture of 55 - 60°Bx was spun at 740 and 980 rpm in a FPN-1251 machine (a type widely used in the Soviet sugar industry) with the distributor removed; a stable, even 4.5 - 5.0 mm precoat of perlite was formed within 3 -

1 Shterman *et al.*: *I.S.J.*, 1987, **89**, 74A.

4 minutes on the filter cloth which was fixed to one of the two backing screens by distance rings. Results showed that at the lower speed, some particles were found at cycles of up to 180 seconds, but transparent filtrate was obtained at 240 - 420 sec; at 980 rpm, transparency was obtained at 180 - 420 sec. Treatment of a syrup of 69 - 70°Bx gave a transparent filtrate at both speeds, but throughput (litres/min) was higher at the greater speed. AVO-1000 centrifugals were also tested on raw sugar remelt liquor of 70°Bx; the filtration rate of 42 - 43 litre/m²/min was far greater than that on a disc or candle filter and was 250% higher than with a Funda filter, but the electricity consumption of the centrifugals was also greater (although a reduction in filter cloth consumption provided some compensation for this). The amount of juice needed for sweetening-off was lower than with normal filtration.

On the question of the kinetics of crystallization during massecuite boiling

V. K. Kudrik, V. O. Shtangeev and V. K. Maidanyuk. *Sakhar. Prom.*, 1987, (11), 35 - 38 *(Russian).*

In investigations of the part played by recrystallization in boiling, sucrose labelled with ^{14}C was used as indicator. In one series of experiments, 0.05 mm sucrose crystals preheated to 65°C were added to a saturated syrup of 100°Bx and the resultant massecuite boiled in a flask under reflux. It was found that the flow of crystallizing sugar from the mother liquor to the solid phase fell with time of boiling, the relationship being expressed by a smooth curve, and it is known that crystal growth in a saturated syrup in the absence of syrup drinks is a result of recrystallization. In another series of experiments, the part played by recrystallization in crystal growth diminished with the Brix of syrup drinks; this fall in recrystallization intensity led to a reduction in energy consumption in boiling. Hence, it is recommended to carry out boiling under a continuous system and ensure even distribution of the syrup feed.

Boiling *A*-massecuite from two syrups of different concentration

V. F. Bereznii, M. P. Spivak, A. K. Sushchenko and B. F. Us. *Sakhar. Prom.*, 1987, (11), 38 - 40 *(Russian).*

Problems with the 2-massecuite boiling scheme at Teofipol'skii sugar factory were solved by boiling *A*-massecuite on a footing of 73 - 77°Bx thick juice from the 5th evaporator effect and feeding low-grade sugar remelt of 63 - 65°Bx after its sulphitation and filtration. Despite the inefficiency of the type of pan used, the new scheme cut the boiling cycle. Details are given of the system and its controls.

Trial on processing product massecuites with subsequent recycle of sugars

N. A. Arkhipovich and M. Takhle. *Sakhar. Prom.*, 1987, (11), 40 - 42 *(Russian).*

Laboratory tests on recycling of B-sugar remelt to the *A*-pan and *C*-sugar remelt to the *B*-pan showed that massecuite quality parameters were better than with conventional 3-massecuite boiling (without crystal footings), while sugar colour was lower and the boiling cycle cut by 10 - 15%.

The effect of 2nd carbonatation juice deliming with ion exchangers on juice quality and sugar losses in molasses

M. I. Egorova, V. V. Spichak, V. A. Tikhomirov and V. F. Tkachenko. *Sakhar. Prom.*, 1987, (110), 42 - 43 *(Russian).*

A survey of the literature on the effects of 2nd carbonatation deliming by replacing Ca^{++} with Na^{+} shows that the treatment has no effect on alkalinity (there being only a slight fall in pH) provided 2nd carbonatation is conducted at optimum alkalinity, but reduces colour by 0.4 - 2.6°St (depending on beet quality and the method used for regeneration of the cation exchange resin), raises purity by 0.15 - 0.80% and reduces molasses yield and sugar content while increasing white sugar yield and quality.

The application of nitriding to increase the durability of anchor pins in the chain of a beet elevator

A. E. Rudyk, M. S. Stechishin, N. A. Sologub and V. A. Kulikov. *Sakhar. Prom.*, 1987, (11), 55 - 57 *(Russian).*

The corrosive and abrasive elements in flume-wash water cause rapid wear of the components of a beet elevator, and nitriding of steel anchor pins used for elevator chains was investigated. Results showed that the treatment increased the resistance of the pins to wear and corrosion to a greater extent than other treatments such as case hardening; use of a nitrided high-chrome steel is advocated.

Harmonization of environmental protection and cost burden using examples from the German sugar industry

K. Korn. *Zuckerind.*, 1987, **112**, 939 - 945 *(German).*

Problems concerning environmental pollution and steps taken to reduce it are discussed using examples taken from the West German sugar industry. While treatment of waste water in oxidation tanks consumed a great amount of energy and could be inadequate with a high pollution load, modern anaerobic processes require little energy input, produce energy in the form of methane and do not present odour problems that could arise with earlier forms of treatment. The question of "acid rain" and associated tree deaths is examined, whereby it is concluded that SO_2 is less to blame than nitrogen oxides and particularly high concentrations of ozone; possible means of reducing the nitrogen oxide content in boiler emission include reducing the flame temperature and installing catalytic converters as used in road vehicle exhaust systems, whereas the use of wet scrubbing does not provide a complete solution while adding to the amount of waste water to be treated.

An alternative approach is the use of boiler flue gas to pre-dry beet pulp in a low-temperature unit; this reduces the overall energy consumption in the factory and decreases the emission of dust as well as nitrogen oxides, SO_2, CO and CO_2 as demonstrated by results from Zeil sugar factory. While the use of filter cake as fertilizer reduces the odour problem associated with storage of the mud, at Ochsenfurt it is used to desulphurize boiler flue gas through reaction of the calcium carbonate with the SO_2 to yield calcium sulphate which is removed by electrostatic filtration and subsequently used elsewhere as an ameliorant in the activated sludge treatment of sewage; the treated flue gas is used for pulp drying, and the sulphur emission thus reduced by about 60%. Soil removed from beets is stored in dumps, from which it is removed for drying and subsequent distribution over arable land; this ensures that there is no unpleasant odour, a problem which has also been solved by the adoption of anaerobic treatment of effluent. Mention is made of noise and how it has been reduced to legally imposed comfort levels. The costs of the various measures to reduce environmental pollution are also indicated.

Odour emission and control in the Dutch sugar industry

B. C. Huismann, L. H. de Nie, H. J. Peters and P. W. van der Poel. *Zuckerind.*, 1987, **112**, 958 - 965.

See *I.S.J.*, 1987, **89**, 106.

Sugar storage in silos. XIII. The granulated sugar section

V. Kavan, L. Budicek and J. Votlucka. *Listy Cukr.*, 1987, **103**, 245 - 252 *(Czech).*

Pre-storage treatment of sugar is described, with details of equipment used for drying and cooling (including both drum-type granulator and fluidized bed equipment), screening (for lump removal as well as classification), dust removal (including a centralized vacuum system for cleaning of equipment and floors) and conditioning. A diagram is presented of a new-generation integrated scheme incorporating all the above-mentioned elements.

Notes from a visit to Bulgarian sugar factories

Z. Hurtová. *Listy Cukr.*, 1987, **103**, 253 - 254 *(Czech).*

Accounts are given of the processes and equipment at Devnja and Kameno sugar factories, of 6000 and 7000 tonnes/day beet slicing capacity, respectively.

Storage of sugar beets left in the ground after topping

K. Szwajcowska, K. Lisik and H. Zaorska. *Gaz. Cukr.*, 1987, **95**, 122 - 124 *(Polish).*

Beets that were topped and then left in the soil for 11 and 13 days before lifting exhibited greater deterioration during storage for up to 60 days than beets that were harvested immediately after topping and stored at an optimum temperature of +4°C; the deterioration in the test beets (increase in reducing matter, invert sugar, invertase activity, total N and amino-N and decrease in pol) was particularly noticeable during the first 30 days of storage.

Results produced by introducing a new juice purification system at Strzelin sugar factory

A. Sobolewski. *Gaz. Cukr.*, 1987, **95**, 124 - 126 *(Polish).*

Details are given of a carbonatation scheme (involving some modifications of the conventional liming, gassing, settling and filtration stages with 2nd carbonatation mud recycling) designed for operation at Strzelin so as to improve sugar output and purity and reduce molasses losses. Despite the fact that not all of its design elements were used, results for 1986 showed that the new system with lower lime consumption reduced juice lime salts, molasses losses and yield, increased sugar output and reduced its colour content by comparison with the earlier results.

A modified filter-thickener

J. Kowal and J. Wolski. *Gaz. Cukr.*, 1987, **95**, 137 - 138 *(Polish).*

A description is given of the standard Polish-built filter-thickener used in the sugar industry and of modifications made to it to facilitate maintenance and improve the efficiency of the various seals.

Process technology principles of mechanical dewatering of pulp. III. Technical press performance. IV. "Diffusive dewatering"

K. E. Austmeyer. *Zuckerind.*, 1987, **112**, 946 - 950, 1068 - 1074 *(German).*

See *I.S.J.*, 1987, **89**, 108.

Mass transfer coefficient of diffusion at sucrose crystals in solution

S. K. Heffels, C. M. H. Weber, P. R. de Bruin and E. J. de Jong. *Zuckerind.*, 1987, **112**, 1075 - 1081.

The mass transfer coefficient of diffusion in the form of the Sherwood number is clearly defined by the Nelson & Galloway equation as confirmed by various experiments involving single crystals measuring 20 - 1500 µm grown in undersaturated solutions and by some experiments on crystal dissolution in a 1.4 m^3 batch crystallizer, in which the stirrer rate had little effect on the coefficient in contrast to that found in the laboratory studies. The results showed that the size dependence of crystal growth reported in the literature could not be explained in terms of the crystal size dependence of the mass transfer coefficient. Moreover, it was found that the dissolution rates of crystals of the same size differed under identical conditions where there was a difference in shape; this growth dispersion was not solely attributable to differences between the reaction coefficients of individual crystals.

Experiences with the personal computer in a sugar beet delivery system

A. F. H. Beening. *Zuckerind.*, 1987, **112**, 1082 - 1085 *(German).*

Details are given of the beet reception system at a Dutch sugar factory where most of the beet are delivered by road (although some comes by rail and water). The data for each consignment, gross and tare weights and sample identification are keyed into personal computers linked to a host computer which calculates payments. While the MS-DOS system used has some drawbacks for PC's, the advantages (much alien software, familiarity and low price) could not be found with any other system.

Development and testing of a special mixed bacterial culture for improving the purification efficiency of sugar factory waste water holding tanks using Schöppenstedt sugar factory as example

H. Bock and D. Iwert. *Zuckerind.*, 1987, **112**, 1086 - 1089 *(German).*

A special mixed culture developed by Mikro-Bak Biotechnik GmbH contained chemotrophs (bacteria depending on reduction/oxidation reactions for their energy) and phototrophs (bacteria depending on light energy) in a definite ratio. Trials are reported in which the culture was added to waste water shortly after its discharge into a storage lagoon at the end of the 1986 campaign; a second dose of the culture was added in July of the following year. Results showed that the degree of degradation was clearly greater than achieved by normal lagooning at Schöppenstedt in previous years and in a smaller lagoon used as control during the trial period; the COD was reduced from 2170 to 108 mg/litre, while the final BOD_5 was 7 mg/litre. Odour emission normally associated with uncontrolled fermentation and putrefaction was drastically reduced (as indicated by the absence of hydrogen sulphide in the treated water), and the final nitrogen level was 10 mg/litre (suggested as the future official upper limit for water discharge to waterways).

Trends in the development of sugar industry machinery and equipment

J. Bakonyi. *Cukoripar*, 1987, **40**, 128 - 132 *(Hungarian).*

The author examines the question of increase in factory slicing capacity and the financial aspects of building a new factory, rebuilding and expanding the existing one or installing new equipment of greater efficiency and capacity. The possible location of certain equipment such as diffusers, vertical crystallizers, pulp presses, etc. in the open air is discussed, followed by consideration of the pros and cons of continuous as against batch equipment, energy economy and automation.

Comparison of juice purification processes used in the Yugoslavian sugar industry

K. Sörös and K. Hangyál. *Cukoripar*, 1987, **40**, 106 - 109, 132 - 136 *(Hungarian).*

Of the 23 sugar factories in Yugoslavia, 8 use the Novi Sad carbonatation process, 6 use the BMA system and 4 operate the DDS process, while other systems are used at the remaining factories. Results of comparison of the three main processes over the period 1981/85 are discussed in detail. While the Novi Sad system gave the poorest degree of invert sugar degradation (DDS carbonatation giving the best results), it did provide the highest juice thermostability and was the most efficient in non-sugars removal (followed by DDS and then BMA carbonatation), but consumed more lime and coke % beet (the DDS system being the best in this respect). The lowest thin and thick juice colour contents were obtained with DDS carbonatation and the highest with the BMA system, while the lowest thick juice lime salts content occurred with the Novi Sad and the highest with the DDS systems. Molasses yield and sugar content were also lowest with the Novi Sad process (although molasses purity was highest) and highest with the BMA system (which gave the lowest molasses purity). The economic efficiencies of the three processes are also indicated.

Juice purification - practice and development. II

A. Vigh. *Cukoripar*, 1987, **40**, 147 - 151 *(Hungarian).*

The performances of the carbonatation stations in Hungarian sugar factories in 1986/87 are discussed and possibilities of improvement examined, covering the use of modern, efficient equipment as well as application of newly developed techniques; 40 references are given to the literature and descriptions included of a Soviet external pipe system for recirculation of juice to a carbonatation vessel[1], of a countercurrent vessel and of the Enviro-Clear rapid settler.

A Schwing pump at Acs sugar factory

I. Soós. *Cukoripar*, 1987, **40**, 160 - 161 *(Hungarian).*

Details are given of a KSP-17 piston pump manufactured by F. W. Schwing GmbH of West Germany which was installed to transfer mud from the rotary filters at Acs sugar factory; at 26 strokes per min and a pressure of 80 bar, the pump is capable of handling mud of 52 - 55% dry solids content at 20 m^3/hr, which is equivalent to a daily beet slice of 3000 tonnes. Prior to installation of the pump, the mud had required a high degree of dilution, considerably adding to the water consumption of the factory. The mud can be removed from the storage dump earlier than previously, thus reducing the odour emission.

Sedimentation test and clarification surface requirement

H. Yakouti. *Sucr. Maghrebine*, 1987, **3**, (32), 3 - 8 *(French).*

Equations are given for calculating the concentration of suspended matter in carbonatation juice, the settling rate of the mud particles and the clarification surface area requirements for a factory slicing 3000 tonnes of beet daily where

1 Daishev & Molotilin: *I.S.J.*, 1985, **87**, 38A.

no clarifier is available and it is necessary to know the size of equipment needed; the settling rate and mud depth as a function of time are found by means of a graduated cylinder and a stopwatch.

Analysis and assessment of the boiling house performance of sugar factories on the basis of molasses sugar content

T. P. Khvalkovskii. *Sakhar. Prom.*, 1987, (12), 8 - 9 *(Russian).*

A survey of molasses average Brix, purity and sugar content for each of the 10 sugar-producing republics of the USSR and for the entire Soviet Union in the three campaigns 1982/85 shows that, despite shortcomings in the boiling house operations of the factories, the standard molasses properties, particularly the sugar content, set for each republic were higher than the true values, indicating error in the setting of the standards. Guidance is given on how to calculate the molasses norms sufficiently accurately as a contribution to increased white sugar output.

Removal of predefecation mud by centrifugation

A. R. Sapronov, M. S. Zhigalov, G. A. Vovk and A. M. Konyaev. *Sakhar. Prom.*, 1987, (12), 11 - 12 *(Russian).*

Details are given of the operation and design of the Polish ZW-02 scroll type centrifuge with a conical-cylindrical basket as used in the starch and chemical industries and which was tested at Ul'yanovka sugar factory on removal of predefecation mud from juice. The separated mud, having a density of 1.28 - 1.30 g/cm^3, was mixed with 1st carbonatation mud from the filter-thickeners and filtered, while the juice was transferred from the centrifuge to the cold (first) stage of fractional liming. A mud separation efficiency of 80 - 88% was achieved without any difficulty, resulting in a 5- 7% rise in juice purification efficiency or a 0.6 - 0.8% (on beet) reduction in lime consumption without any reduction in juice quality. Although foaming and partial mechanical damage to the mud structure caused the quality of juice from the centrifuge to be slightly lower than that of juice clarified by sedimentation in laboratory cylinders, the turbidity left by the foam in the centrifuge overflow had no effect on the quality of carbonatation juice since the major part of the non-sugars was removed with the mud. Foaming also slightly reduced centrifuge capacity but was inhibited by addition of surfactant. Centrifuging gave a 2- to 3-fold increase in the 1st carbonatation juice settling rate and a lower mud volume than with conventional juice purification. Further tests are planned with a number of other centrifuges.

Deammoniation of condensates with the aim of using them in diffusers

V. P. Adamenko and A. P. Adamenko. *Sakhar. Prom.*, 1987, (12), 17 - 19 *(Russian).*

In a system installed at Luka sugar factory, condensate from the evaporator is atomized and ejected by centrifugal nozzles into a stream of pan vapour under reduced pressure and having a temperature 5 - 10°C lower than the condensate. The latter boils as a result of flash evaporation and the solubility of the ammonia in it falls to zero; the boiling also leads to intensive break-up of the droplets of condensate, thus causing a sharp rise in the surface area through which the ammonia escapes, to be entrained by the pan vapour. The temperature of the treated condensate is raised to a required level in a contact heat exchanger; it is then sulphited and transferred to the diffuser. The deammoniation of the condensate takes place in the lower section of a barometric condenser, in the upper segmented section of which the pan vapour is condensed and subsequently cooled before recirculation as cooling water to the upper section. Where factories do not have sufficient available condenser capacity, the deammoniation can be carried out by the same method but in a separate cell linked to a barometric condenser. The treatment reduces the ammonia content from 150 - 250 to 10 - 20 mg/litre and has raised raw juice purity by 0.3 - 0.5% by comparison with the use of barometric water.

Sucrose losses by thermal degradation during melting of intermediate sugars in juice and syrup

V. V. Spichak. *Sakhar. Prom.*, 1987, (12), 19 - 20 *(Russian).*

Experiments showed that melting intermediate sugar in thick juice reduced the rate constant of sucrose degradation by 45% by comparison with conventional melting in 2nd carbonatation juice. In the study, melt samples were maintained at a constant 80°C for 24 and 48 hr before cooling to 20°C and determination of pH, refractometric Brix and pol. In the 10 or 20 minutes of the melting process (in thick juice and carbonatation juice, respectively) there was no fall in pH, so that the rate constant could be calculated for pH_{80} 6.18. However, at constant pH the rate constant rose with fall in Brix, which explains the advantage of the use of thick juice.

Juice purification at CSM

P. W. van der Poel and N. H. M. de Visser. *Zuckerind.*, 1988, **113**, 22 - 26 *(German).*

The juice purification scheme used at CSM sugar factories in Holland is described, including the equipment used. Conventional treatment (preliming, fractional cold and hot liming, 1st and 2nd carbonatation) is followed by thin juice sulphitation and deliming by anion exchange resin whereby Ca is replaced by Na. Investigations of the concentrations of specific anions and cations in juice at the various purification stages are reported and the details tabulated and indicated by histogram. Reasons are given for the adoption of sulphitation (increased decolorization and pH optimization) and deliming (minimal molasses formation by Na salts and a reduction in lime salts to <2 mg CaO/100 ml which is difficult to achieve by other means) and the benefits for white sugar quality indicated.

Sugar refining

Method for decolorization of intermediate products of sugar manufacture with H_2O_2

D. Khadzhikinov, N. Lambrev, V. A. Vakrilov and S. Rozova. *Khranitelno-prom. Nauka,* 1986, **2**, (3), 56 - 59; through *S.I.A.*, 1987, **49**, Abs. 87-1290.

During refining of cane raw sugar at V. Kolarov combine (Bulgaria), yellow sugar was dissolved to give 20 - 50°Bx solutions and treated with up to 0.3% (on Brix) hydrogen peroxide (as per-hydrol, 26% H_2O_2) at 60 - 90 °C for 5 - 40 minutes. Optimal were 0.1% peroxide for 10 - 15 min at 70°C, which gave 64% decolorization at 51 - 54°Bx; greater doses increased the reducing sugars content, decreased purity and pH and impaired the organoleptic properties. 3% activated carbon had better effects on all parameters. The process is considered suitable for making liquid sugar from intermediates of sugar manufacture.

Automatic intermittent sugar boiling method using the limit boundary control system

H. Hashimoto *et al. Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 12 - 19 *(Japanese).*

In automatic boiling control based on a rheometer, the rheometer reading should not exceed nor fall excessively below the critical value for false grain formation; this critical value is related to the quantity of seed injected and is governed by purity, consistency and steam feed. A critical curve is obtained by connecting critical points for given times, and a control program based on it must be corrected for any changes that occur. A conventional intermittent control method is described together with the features of a critical curve, and details are given of a critical boundary control which provides automatic compensation for changes in the curve. Introduction of the scheme reduced steam consumption, significantly shortened the boiling time and raised product quality by comparison with the conventional method.

Application of surface-active agents for the sugar manufacturing industry

Y. Ohyama, H. Nishi, N. Yamashita and M. Yuda. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 20 - 28 *(Japanese).*

The effects of 40 food-grade surfactants on molasses and massecuite viscosities were determined at concentrations in the range 80 - 282 ppm. The measurements were carried out using (i) a B-type rotating-cylinder viscometer, (ii) a Brabender viscograph and (iii) a plate expansion method; (iii) gave good results with molasses, while (ii) was suitable for massecuite. The best results in terms of viscosity reduction were obtained with those surfactants containing an unsaturated fatty acid such as oleic or linoleic acid or a straight-chain polyhydric alcohol. The most effective surfactant for both viscosity reduction and foam prevention was glycerol monooleate. In some cases surfactant treatment had no effect whatsoever on viscosity.

Theoretical analysis of sucrose crystallization

T. Numa and I. Takahashi. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 41 - 44 *(Japanese).*

The granulated sugar boiling process at the authors' refinery was analysed by measuring the crystal growth and nucleation rates. Diagrams of crystal size distribution up to 90 minutes after seeding show how in the initial stages the mean crystal size increased by 0.62 mm/hr (up to about 60 minutes after seeding), after which the growth rate fell to 0.28 mm/hr because of lower supersaturation. Crystals measuring 0.3 and 0.5 mm constituted the highest proportion (10% each) 90 min after seeding. Measurement of the number of crystals in the massecuite showed that the nucleation rate in the first 30 min after seeding was $9 \times 10^{10}/m^3/hr$ and thereafter became zero. A large amount of balancing water was generally used 20 min after seeding to dissolve false grain; slight dissolution of the original crystals also occurred with rounding of their corners, but the crystal growth rate was unaffected.

Establishment of material balances for cane raw sugar storage and processing

E. Gutknecht and T. Mörle-Heynisch. *Lebensmittelind.*, 1987, **34**, 210 - 212 *(German).*

The value of material balances as a means of monitoring quantitative and qualitative changes during raw sugar storage and during refining is demonstrated and guidance given on how to calculate balances, including the requisite parameters and interpretation of the results.

Industrial tests on ion exchange cloths

A. R. Sapronov, Yu. I. Sidorenko, A. A. Slavyanskii, Yu. V. Ogol'tsova, V. S. Pavlenko and M. S. Mezhirov. *Sakhar. Prom.*, 1987, (12), 12 - 15 *(Russian).*

Laboratory and refinery tests were conducted on the use of ion exchange cloths[1] for syrup decolorization; in the refinery tests, the cloths were inserted between the frames in a horizontal plate-and-frame filter, and the syrup (of 65°Bx and an optical density of 0.2 units at 590 nm) passed through at a rate in the range 0.04 - 1.6 m^3/kg/hr. After 30 - 65 hr, depending on the flow rate, the cloths had to be regenerated with 12% NaCl over a period of 10 hr. The colour of the treated syrup ranged from 0 to 0.5 optical density. Optimum wash water consumption was approx. 80 litres/kg and the optimum regenerant usage of 180 litres/kg was almost the same as for the normal granular form of anion exchange resin used at the refinery. The main advantage of the cloth over the conventional resin lay in its much smaller specific consumption, 1 kg of resin in cloth form treating 30 m^3 of syrup as against only 0.8 - 1.0 m^3 treated normally.

1 Slavyanskii *et al.: I.S.J.*, 1986, **88**, 128A.

Starch-based sweeteners

Characterization of a commercial isoglucose

A. Azzi and I. Niola. *Ind. Alimentari*, 1987, **26**, 550 - 552 *(Italian)*.

The physico-chemical properties of a commercial fructose-glucose syrup of 10% concentration were determined by GLC and are discussed.

Numerical simulation of a semi-continuous counter-current adsorption unit for fructose-glucose separation

K. Hidajat, C. B. Ching and D. M. Ruthven. *Chem. Eng. J.*, 1986, **33**, (3), B55 - B61; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (12), Abs. 12 R467.

A mathematical model of a semi-continuous counter-current adsorption unit for fructose-glucose separation has been developed and tested for transient and steady-state conditions. The system is considered as a cascade of ideal theoretical stages, the number of which is determined *a priori* from chromatographic analysis. It was found experimentally that approx. 60 hours is the time needed to attain steady-state conditions for fructose separation, while only 37 hr are needed for glucose. This period can be substantially reduced by partial pre-loading of the system.

Basic trends in glucose-fructose syrup production in the USSR and elsewhere

T. A. Ladur. *Obz. Inf. Gosagroprom SSSR. NII Inf. i Tekhn.-Ekon. Issled. Pishch. Prom., Krakhmalo-Patoch. Prom.*, 1987, (1), 32 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (12), Abs. 12 R468.

Information is given on development of the technology and equipment used in the production of glucose-fructose syrups containing 42% fructose and on the technology used in HFS manufacture in the USSR and other countries. The requirements of enzyme preparations and ancillary materials for glucose-fructose syrup production are examined as well as the fields of application of the syrups as a substitute for beet sugar in the Soviet Union. The economic effectiveness of using the new sugar substitute is shown.

High fructose: a growing world role ?

J. A. Hodgkin. *Sugar y Azúcar*, 1987, **82**, (8), 15, 18 - 19, 22 - 23.

The prospects for further increases in world production and consumption of HFS are examined. It is considered that the marked increases in world production that have taken place in the past 7 years (almost all in the USA) cannot be expected to repeat themselves; while the average US consumption in 1980/85 rose by 20% per year, the rate of expansion is expected to be <2% per year during the next 10 years, although the annual rate of growth in world production and consumption could be 5% (as against 19% previously) as a result of increases in Asia and Eastern Europe.

Economic advantages of the utilization of amylase in the production of sugar

I. Namer. *Revista ICIDCA*, 1984, (2/3), 22 - 26 *(Spanish)*.

The most important economic aspects of the use in Cuba of amylase to produce a sweetener from starch sources such as maize, barley, rice, yucca, etc., are discussed.

The quality of crystalline glucose obtained by fermentation hydrolysis of starch

T. A. Ladur. *Sakhar. Prom.*, 1987, (11), 58 - 59 *(Russian)*.

The hydrolysate obtained by starch fermentation was found to contain 92 - 93% glucose by comparison with only 85% in acid hydrolysate, while the colour was lower at 0.20 - 0.25 optical density units as against 2.0 - 2.2. The reducing sugars, dextrin, total ash, iron and protein contents are given for glucose obtained from both types of hydrolysate as well as moisture and colour contents, transparency and specific rotation. The Luff-Schoorl method gave lower values than the Lane-Eynon method unless corrected using sodium thiosulphate. The protein content of corn starch for glucose production should not exceed 0.6% and should preferably be 0.1% so as to give a maximum of 0.05% in the final glucose product.

Examination of glucose solubility in the presence of fructose

N. I. Odorod'ko, N. A. Arkhipovich and A. A. Ostrovskaya. *Pishch. Prom.*, 1987, (33), 54 - 55; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (21), Abs. 21 R390.

Experimental investigations showed that glucose solubility increases with temperature rise in the presence of fructose, whereas the solubility of small quantities of fructose (up to 10%) falls at 25 - 30°C. The data obtained may be used to develop a process for glucose crystallization from glucose syrups produced during fructose manufacture.

Growth kinetics of fructose crystals formed by contact nucleation

L. D. Shiau and K. A. Berglund. *AIChE J.*, 1987, **33**, (6), 1028 - 1033; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (23), Abs. 23 R422.

Results are reported of investigations on nucleation and growth of fructose crystals in aqueous solutions. It was noted that the study of these processes in the case of saturated solutions is made difficult by the high solubility and viscosity of fructose; at 50°C, 662 g fructose can dissolve in 100 g water and the viscosity reaches 4 - 5 Pa/sec. Tests were conducted in a unit consisting of a transparent constant-temperature cell. A number of photographs were taken during each experiment and the negatives then enlarged and used on an automatic analyser to determine the area of the crystals. Mathematical relationships are given between the basic parameters.

Laboratory studies

Sucrose crystallization in the presence of sodium acetate

V. F. Tishchenko and R. S. Burdukova. *Rpt. Kiev Technol. Inst. Food Ind.*, 1987, 6 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (19), Abs. 19 R397.

Small-angle light diffusion was used to study the effect of sodium acetate on sucrose crystallization. From a study of the intensity of light diffused near the direction of a beam of incident light, curves were plotted of sucrose crystal size distribution. The relative rates of crystal formation and growth were determined from the change in area below the distribution curves. The results showed that a small quantity of sodium acetate as impurity has an accelerating effect on sucrose crystal formation and growth.

Specific coefficients of molasses non-sugars

T. P. Khvalkovskii. *Sakhar. Prom.*, 1987, (10), 32 - 34 *(Russian)*.

The melassigenic coefficient μ differs from the coefficient m in allowing for the melassigenic properties of water, so that it more accurately delineates the role of the particular non-sugar. The method used by N. P. Silina to calculate the values of both coefficients is considered too involved, and the author of the present paper presents his own method which he considers very much simpler. Comparison is made between the values found by both methods for non-sugars in molasses from 10 different factories, and values are tabulated for 20 non-sugars, showing substantial differences between the two methods, although within the limits of the effect of the total complex of non-sugars in a molasses and within the limits of analytical error (except for hydrophilic salts that form crystal hydrates with water and raise molasses viscosity).

Determination of sugars in heat-treated molasses solutions

E. V. Karpun, V. V. Pis'mennyi, I. A. Semenova and A. V. Inyutkina. *Ferment. Spirt. Prom.*, 1987, (4), 32 - 35; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (20), Abs. 20 R375.

It is shown that reducing matter formed in molasses solutions in an acid medium may be effectively removed with basic lead acetate and dichloroethane. To determine the losses of sugars in molasses solutions after sterilization in an alkaline medium, the solutions should be treated or untreated with active carbon before and after heat treatment and the results of analyses compared. The sugars may be determined by the Lane & Eynon method at optimum dilution with a relative error not exceeding 1%.

A simplified method of determining the quantity of extractable sugar

G. Cucci, A. de Caro and S. Vannella. *Ann. Fac. Agr. Univ. Bari*, 1983/84, **33**, 373 - 383; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (20), Abs. 20 R447.

The possibility was investigated of determining, and deriving equations for calculation of, the quantity of recoverable sugar based on a series of sugar beet analyses. Best results were obtained with two equations, the use of which in place of the Wieninger-Kubadinow formula gave values with an error <5% with the second equation and an error of 5 - 10% with the first.

Simple method for the visualization of the separated zones of sugars on silica gel TLC plates without spray reagent

K. Suyama and S. Adachi. *J. Chromatogr. Sci.*, 1987, **25**, (3), 130 - 131; through *Anal. Abs.*, 1987, **49**, Abs. 11D170.

Aluminium-backed silica gel 60 plates on which sugar mixtures have been separated are dried at room temperature and immersed in hexane. After 5 minutes the silica layer appears slightly transparent, whereas the spots due to sugars remain opaque.

Determination of the consistency of non-Newtonian fluids using a Brookfield HBT viscometer

E. J. Durgueil. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 32 - 39.

The principle of the method of measurement of consistency of a Newtonian fluid using a Brookfield rotating-spindle viscometer is outlined and equations are developed for the conversion of torque readings to consistency and for the determination of the flow behaviour index of non-Newtonian fluids such as low-grade massecuite and *C*-molasses. An equation has also been developed which correlates the consistency of low-grade massecuite and *C*-molasses with total solids content, crystal content, pol and temperature; calculated values were 0.6 - 1.6 times measured values at the factory where the studies were conducted, but the equation may need to be modified for application to material from other factories. It is also stressed that the results obtained with the Brookfield viscometer have not been compared with values given by other viscometers.

Examination of colouring matter in white sugar

I. F. Bugaenko, M. Garcia F. and V. D. Shcherbukhin. *Sakhar. Prom.*, 1987, (11), 43 - 45 *(Russian)*.

See *I.S.J.*, 1988, **90**, 7A.

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

N. M. Podgornova, V. M. Perelygin and I. F. Bugaenko. *Gaz. Cukr.*, 1987, **95**, 126 - 128 *(Polish)*.

See *I.S.J.*, 1987, **89**, 76A.

Instrumental colour measurement of white sugar

V. Merken and L. van Coillie. *Belgian J. Food Chem. Biotech.*, 1987, **42**, (5), 123 - 127.

The reflectance of the standard white

sugar colour samples of the Braunschweig system was measured using a D65 illuminant and the CIE tristimulus values calculated. The degree of whiteness was calculated using CIE and Ciba-Geigy formulae. Almost linear correlation was found between the seven standard grades on the one hand and (i) the chromaticity coordinates x, y, (ii) difference in colour saturation of CIE Chroma C, (iii) total colour differences, and (iv) CIE whiteness. Instrumental measurement at 426 and 620 nm, with the reading expressed as the ratio between the two reflectance values, and calculation of whiteness using the CIE formula gave an acceptable correlation with visual assessment of white sugar according to the Braunschweig grades. Particle size was found to have a significant effect on whiteness evaluation, and it would be possible to upgrade a white sugar sample visually by grinding the sugar to produce finer particles; the Braunschweig standards have sizes in the range 0.5 - 1.0 mm, and visual evaluation of a white sugar having particle sizes differing from this range is very difficult.

Sugar cane analysis using near-infra-red spectroscopy

C. B. Sverzut, L. R. Verma and A. D. French. *Trans. Amer. Soc. Agr. Eng.*, 1987, **30**, (1), 255 - 258; through *Anal. Abs.*, 1987, **49**, Abs. 12F17.

NIR reflectance spectrometry was applied in the determination of the pol, fibre, sugar and moisture contents of shredded sugar cane. Analysis of the data was based on the second derivative of the logarithmic (1/R) values, where R = reflectance. A set of four wavelengths was then selected and calibration correlations were determined for these wavelengths for each constituent. There was no significant difference between values obtained thus and those obtained by the standard press method.

Enzyme electrode for the determination of sucrose in food products

M. A. Nabi R., G. J. Lubrano and G. G. Guilbault. *J. Agric. Food Chem.*, 1987, **35**, 1001 - 1004.

An electrode developed for the determination of sucrose in food and agricultural products is based on the co-immobilization of glucose oxidase, invertase and mutarotase. The linear dynamic range is between 3.33×10^{-5} and 1.3×10^{-3} M for the initial-rate method and between 3.33×10^{-5} and 1.5×10^{-3} M for the steady-state method. Recovery was in the range 90.9 - 105.7% with a coefficient of variation of ± 4.41%. Close correlation was found between values given by the sucrose electrode and by a method based on use of a glucose electrode and soluble invertase. In standard solutions of fructose, lactose, melibiose and raffinose, none of these sugars caused interference. The sucrose electrode is very stable and gives a fast response.

Biochemical changes in stored sugar beet

K. Hangyál. *Cukoripar*, 1987, **40**, 137 - 145 *(Hungarian)*.

Current knowledge on the biochemical changes that take place in the sugar beet during storage is summarized with 39 references to the literature, covering the processes caused by respiration (sucrose inversion, glycolysis, the citric acid or Krebs cycle, oxidation processes such as oxidative phosphorylation and the actions of the various oxidases, metabolic processes involving polysaccharides and raffinose, the enzymatic degradation of sucrose and pectin, and invertase activity), the activity of polyphenol oxidase, and the metabolism of nitrogenous non-sugars.

Removal of colouring matter with magnesium silicate

M. Garcia F., V. Abarque and I. F. Bugaenko. *Sakhar. Prom.*, 1987, (12), 28 - 30 *(Russian)*.

Laboratory investigations were conducted on the use of Mg silicate to decolorize a model solution containing colouring matter resulting from glucose degradation; filtration was followed by desorption with alcohol and measurement of the optical density at 560nm, after which the extract was neutralized and treated with anion exchange resin in OH^- form. The silicate adsorbed only 3.6% of the original colouring matter, and only 10% of the colouring matter adsorbed by the resin was desorbed by elution with NaCl; elution with HCl failed to increase desorption. Subsequent decolorization experiments using the resin alone without pretreatment by Mg silicate yielded an eluate which contained about the same amount of colouring matter as the alcohol solution after desorption of the silicate in the initial study, and spectrometry revealed that the colorants were identical to phenolic compounds isolated from cane sugar products and molasses. Hence, the use of Mg silicate to adsorb phenolic colorants as a pre-liminary step would contribute to increased decolorization by subsequent anion exchange.

Liquid chromatography – electrochemical detection of carbohydrates at a cobalt phthalocyanine-containing chemically modified electrode

L. M. Santos and R. P. Baldwin. *Anal. Chem.*, 1987, **59**, 1766 - 1770; through *Anal. Abs.*, 1988, **50**, Abs. 1D128.

Carbohydrates, including mono- and di-saccharides, pyranoses and furanoses and reducing and non-reducing sugars, were oxidized at low positive potentials at chemically modified carbon-paste electrodes containing Co phthalocyanine. In 0.15M NaOH, the oxidations exhibited a cyclic voltammetric peak potential of +0.4 V *vs.* silver-AgCl; the waves decrease in size and shift to more positive potentials at less basic pH. The Co phthalocyanine-modified electrodes could be used for detection of the carbohydrates in HPLC provided the applied potential was regularly pulsed to -0.3 V or lower. Detection limits ranged from 100 pmol for glucose and maltose to 500 pmol for fructose and sucrose. These modified electrodes compare well with metallic electrodes and gave greater selectivity and larger rectilinear ranges for calibration graphs.

By-products

Investigation of colloidal fractions in molasses feed media undergoing preparation for fermentation

E. A. Merkulova *et al. Khlebopek. Konditer. Prom.*, 1987, (5), 36 - 38; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (19), Abs. 19 R317.

The colloidal fractions in molasses media undergoing preparation for fermentation to citric acid were investigated. Determination of the mass of the colloids and their precipitation for preparation of an initial colloidal solution were carried out gravimetrically at a coagulation pH of 5 using a modified method of the Leningrad Research Institute of the Food Industry. Traditional precipitants (potassium ferrocyanide or ammonium oxalate) were used to adjust the mineral composition of the molasses solution before fermentation. Experiments showed that the rheological properties of the feed solutions depended not only on the initial colloid content in the molasses but also on the nature of the interaction between the molasses components and the precipitants. During molasses preparation for fermentation, both quantitative and qualitative changes were observed in the colloidal matter.

Estimation of sugars loss in stored high-grade molasses

I. A. Smith and J. S. Cazalet. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 18 - 21.

An investigation is reported into the effect of storage conditions on the loss of sugars in high-grade molasses intended for alcoholic fermentation. Samples of *A*- and *B*-molasses of 70 - 80°Bx from a number of factories were held in laboratory incubators at 25 -55°C for up to 48 weeks, and samples withdrawn at monthly intervals for analysis. It was found that at high temperatures most of the sucrose was hydrolysed to fructose and glucose, and degradation of the monosaccharides also occurred but at a lower rate (initially more glucose being lost but later more fructose being degraded). The net loss of total sugars was significant. At low temperatures fermentable sugars were converted to ethanol by microbial action, but at lower rates. The optimum storage temperature appeared to be between 35 and 45°C; below 35°C, problems of sucrose crystallization or microbial activity may arise and the costs of cooling become high.

Sugar, derivatives and diversification

L. O. Gálvez T. *GEPLACEA Bull.*, 1987, **4**, (11), 8 pp.

The marketing problems facing the sugar industries in developing countries are discussed and an account is given of the history and development of the Cuban sugar industry and of its program for sugar and cane by-products utilization.

Pantothenic acid content in beet molasses

L. D. Belova, N. M. Semikhatova, M. I. Tsibul'skaya and N. V. Pomortseva. *Khlebopek. i Konditer. Prom.*, 1987, (7), 37 - 39; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (21), Abs. 21 R274.

The vitamin B_3 (pantothenic acid) content in beet molasses from different campaigns was determined by a microbiological method. It was found that the acid was present at 1.05 - 4.08 ppm in all the samples studied. For maximum yield of yeasts (saccharomycetes), molasses should contain 50 ppm pantothenic acid. Allowance should be made for the fact that ß-alanine, found in molasses in an earlier study, also exhibits vitamin activity relative to saccharomycetes. Future work should aim to establish the optimum concentration of pantothenic acid in a medium used for yeast growth.

A modified method for determining the biotin content in molasses and yeasts

T. V. Meledina, N. K. Palagina and I. A. Karpisheva. *Khlebopekar. i Konditer. Prom.*, 1987, (7), 39 - 40; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (21), Abs. 21 R275.

A microbiological method is proposed for determining the biotin content in complex mixtures (e.g. of molasses and wheat extract) and in yeast cells. The method is based on the use as test culture of strain LV-7 from the collection held at the Leningrad Laboratory of Yeast Technology; the species requires three agents for its growth: Ca pantothenate, mesoinosite and biotin, which are added to the feed medium (dethiobiotin may be added instead of biotin) together with mineral nutrients in progressively increasing quantities in flasks of a standard series. The method suggested covers preparation of the dish and of the feed medium, production of the seed material, preparation of the samples for analysis, isolation of biotin from the yeasts and determination and calculation of the biotin content in the test samples.

A note on the pyrolysis behaviour of sugar cane fibrous products

K. Deepchand. *Biol. Wastes*, 1987, **20**, (3), 203 - 208; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (21), Abs. 21 R383.

A study of pyrolysis of bagasse and cane tops and leaves showed that these fibrous materials undergo two degradation processes instead of only one in the case of wood and cellulose and produce a smaller quantity of volatile compounds and a larger amount of ash and carbon. It is noted that such materials have a potential for pyrolysis and gasification processes.

Novel ethanol fermentations from sugar cane and straw

B. S. Hartley and G. Shama. *Phil. Trans. Roy. Soc. London*, 1987, **A321**, (1561), 558 - 568.

Sugars obtained by hydrolysis and fermentation of bagasse at an elevated temperature are capable of raising the alcohol yield. A mutant strain of *Bacillus stearothermophilus* (LLD-15) provides the same alcohol yield and efficiency of sucrose fermentation at

70°C as yeasts at 30°C. Under aerobic conditions this strain of micro-organism multiplies rapidly in the presence of many sugars; it also develops quickly under anaerobic conditions to yield mainly L-lactate and traces of acetate, formates and alcohol and opens up new possibilities of a high-yielding, high-temperature fermentation process for production of alcohol in a high yield with a wide range of substrates.

Experiences with continuous ethanol production

W. Swyzen. *Zuckerind.*, 1987, **112**, 955 - 957 *(German).*

Experiments on continuous fermentation with *Zymomonas mobilis* at the Dormagen factory of Pfeifer & Langen revealed a number of problems connected with infection by lactic acid bacteria: while 28 - 32°C was optimum for *Z. mobilis*, lactic acid bacteria were also active in this temperature range and very active at pH 4.5 - 4.6 (the lower limit for the fermentation). No significant improvement was achieved by pasteurization of the substrate at 90°C, and lactic acid bacteria could not be washed out despite increase in the flow rate; even in the absence of glucose, sufficient pentoses (xylose and arabinose) were present to support lactic acid bacteria growth, while the maximum alcohol concentration was inadequate at 50 - 60 g/litre to suppress infection. Although it proved possible to maintain sterile conditions, the costs proved prohibitive. Current trials using a strain of yeast isolated at Dormagen have proved more successful; under specific conditions the yeast is not susceptible to lactic acid infection, although a reduction in pH is sufficient to eliminate any infection that does occur. Details are given of enzymatic starch liquefaction and hydrolysis and of subsequent alcohol fermentation but not of the yeast, which is inferior to *Z. mobilis* in that it needs oxygen and gives a lower alcohol yield in terms of glucose although is less demanding of the substrate, while the two organisms are of similar alcohol tolerance.

Bioethanol study tour in Brazil and Paraguay

E. Thier. *Zuckerind.*, 1987, **112**, 972 - 975 *(German).*

A condensed version of a report prepared for a German distillers' association includes mainly an account of the history and development of the alcohol program in Brazil, including the quality of the alcohol for use as motor fuel, the requisite engine modifications and some problems that had to be overcome, exhaust emission and the aldehyde levels in the atmosphere surrounding the streets of São Paulo, the growing of cane for alcohol production, marketing of the alcohol (90% of which in 1986 was consumed as motor fuel while the remainder went to the chemical industry or was used for other purposes or exported) and utilization of the cane by-products, vinasse treatment and disposal, and the production costs of cane and alcohol. Mention is also made of alcohol from sorghum, which constitutes 2% of the raw material. A brief account is also given of the Paraguayan alcohol program which is based on a state-owned distillery (producing 75% of the total from cane supplied by 1236 farmers with an average cane holding of 4 ha) and sugar factories using molasses as raw material.

Technical aspects of ethanol production in Brazil

H. Wunsch. *Zuckerind.*, 1987, **112**, 975 - 978 *(German).*

Details are given of the stages in production and treatment of the cane juice in the sugar factory, of the various batch fermentation processes used in Brazilian distilleries to produce alcohol from the juice (continuous fermentation is used at only nine plants out of a total of 600), including the Melle-Boinot system and cascade fermentation (both of which include yeast recycle) and the Biostil single-vessel process, and of the standard distillation process used. Illustrations and diagrams accompany the text.

A profile of the Indian paper industry (a case for bagasse as a vital raw material)

A. Y. Kulkarni. *Bharatiya Sugar*, 1987, **12**, (11), 11 - 15.

Despite the large quantities of bagasse available in the Indian sugar industry, only a relatively small proportion has been used for paper making. In view of the depletion of forests and the future paper requirements, the author considers that greater use should be made of bagasse, especially since it is calculated that by the end of the century 40 million tonnes will be produced by the sugar factories. Some aspects of bagasse transport, storage and depithing are briefly discussed.

Biodegradation of bagasse for various end uses

R. H. Balasubramanya, A. J. Shaikh and V. Sundaram. *Bharatiya Sugar*, 1987, **12**, (11), 25 - 28.

Uses and treatment of bagasse other than as sugar factory fuel are surveyed, including: autohydrolysis followed by saccharification and alcoholic fermentation of the resultant glucose; anaerobic fermentation to yield methane, carbon dioxide, fertilizer and a material suitable for pulping; depithing as a preparatory stage in high-grade pulp manufacture; and use of bagasse as a substrate for mushrooms.

Preparation of chemi-mechanical bagasse pulp for newsprint

W. F. Yee, H. C. Huang, W. C. Hsieh and L. H. Wang. *Rpt. Taiwan Sugar Research Inst.*, 1987, (116), 27 - 37.

A process for the production of bagasse chemi-mechanical pulp (CMP) has been successfully developed in which the pulp has properties similar to those of ground pulp from wood. Bagasse was soaked for 60 minutes at 100 - 120°C in a mixture of sodium hydroxide (2.5 - 4.0% w/w) and sodium sulphite (2.9 - 4.5%) at a 4:1 liquor:bagasse ratio. The properties of the pulp varied with the soaking conditions and on whether wet-stored bagasse or green bagasse was used, but an acceptable newsprint could be produced from 40% CMP, 50% de-inked pulp and 10% Kraft pulp.

idea of the "squirting factor". Closely related to the "squirting factor" is the quantity of juice reabsorbed in the bagasse, which he defined as the ratio of the volume of juice passing through, to the free volume it has to pass. His work clearly indicated that reabsorption increases at higher volumetric coefficients. Since its effect on the volume of juice which escapes is opposite to that of forcing more fibre into the discharge opening, an optimum volumetric coefficient was found, corresponding to a minimum volume of juice lost, expressed as a fraction of the escribed volume. The ratio of volume of juice lost to the volumetric coefficient of a large number of Java No. 1 mills, indicate a loss of 90 volumetric parts of juice at a volumetric coefficient of 19 lb of fibre per cubic foot escribed volume. This loss is reduced to 78 parts at coefficients between 31 and 35, and at higher coefficients tends to increase, first slowly, then rapidly. At 45 lb of fibre per cubic foot escribed volume the loss is already 118 parts, and at 55 lb it is 203 parts. Hence, there was no advantage in Java in pushing the volumetric coefficient to over 35 lb of fibre per cubic foot escribed volume in No. 1 mills. Unfortunately, there are no proper data available for the study of intermediate mills, but, for the last mills, it was found that the optimum volumetric coefficient was approximately 55 lb of fibre per cubic foot escribed volume. At lower coefficients more juice escaped but, contrary to what was observed at No. 1 mills, the loss remained constant at higher coefficients. The beneficial effect of higher coefficients here was obviously just balanced by the deleterious effect of increasing reabsorption[5].

As milling is a volumetric process, the separation of juice from fibre is achieved by forcing the juice/fibre mixture through a restricted opening, thus stripping off the excess juice. A certain quantity of juice is expected to be lost in this way, as it is not possible to completely fill the discharge work opening of the mill with fibre, so that no juice can pass through it. For this reason, the quantitative effect of the operation depends very much on the fraction of the opening filled with fibre, as we have learnt from the works of Egeter about the behaviour of bagasse as it passes between the rollers. In 1929, Helders, in Java, suggested that the discharge work opening of a mill should be based on the factor lb of fibre per cubic foot escribed volume using empirically-founded optimum data for each mill. This is termed the volumetric coefficient or fibre index and is used in many methods for calculating the discharge work opening. The equivalent terms used in Australia are compression ratio, fibre rating, or fibre filling ratio, which is the ratio of no-void dry fibre volume to the escribed volume (see Appendix 1).

The South African and Australian methods for calculating work opening of the mills are based on the optimum fibre index or fibre rating for each individual mill in the tandem. The third major method of calculating the discharge work opening is based on the conversion of the weight of cane or bagasse to volume by dividing the weight by the specific weight of bagasse under no-void conditions. This method of calculating the delivery work opening has been proposed by Ashe, Hugot, Pole, Chergwin and Royston. The capacity of a milling plant, given other factors, is directly proportional to the quantity of fibre it passes. Most of the methods in use, as we have seen, use the value of fibre in calculating the volume of bagasse from different mills. On comparing these methods one will find the following differences[6]:

(1) The Java, South African and Australian methods use dry fibre in calculations. Hugot has shown that, in the method used in South Africa (the Douwes Dekker & van Hengel method), which uses the weight of fibre per unit escribed volume, the reabsorption factor is incorporated in the figure for fibre index and does not appear in the calculation[7]. It does not matter whether the bagasse moves faster than the roller or at roller speed; a certain weight of fibre passes through a known escribed volume as expressed by fibre index.

(2) Lowe's (Louisiana) method uses dry fibre in bagasse, calculated at its maximum density with no voids.

(3) Hugot's one method uses the figure of natural fibre (dry fibre + Brix-free water), in calculating the specific weight of bagasse from each mill. If the calculation is based on the weight of fibre per unit bagasse volume, as in Hugot's method, a figure for the reabsorption factor has to be introduced into the calculations.

Besides these methods of calculating discharge work openings there are various "rule-of-thumb" methods developed for selecting the discharge opening from graphs, using bagasse coefficients[8] and the 600 cubic inch method. As these methods are not very popular, they will not be discussed in this paper.

Of the methods studied, six have been selected which are used in different parts of the world, and are illustrated in detail, in alphabetical order.

Australian method (Walker method)

Table I gives the standard fibre filling ratios (lb/cu.ft. e.v.) for a 15-roller tandem at the discharge.

Table I. Fibre filling ratios, lb/cu.ft. e.v.

Mill No.	For mills without pressure feeder	For mills with pressure feeder
1	28	36
2	30	38
3	32	40
4	40	46
5	50	55

Escribed volume through mill in cu.ft./min. = lb fibre per minute/fibre filling ratio.

Discharge work opening in inches = (escribed volume in cu.ft./min. × 12) / (roller speed in ft./min. × roller length in ft.)

The method used in Australia is very similar to that used in South Africa.

5 Douwes Dekker: *Proc. 10th Congr. ISSCT*, 1959, 86 - 99.

6 Gunn: *Proc. S. African Sugar Tech. Assoc.*, 1959, 43 - 48.

7 "Handbook of cane sugar engineering", 2nd Edn. (Elsevier, Amsterdam), 1972, p. 202.

8 Royston: *I.S.J.*, 1948, **50**, 43 - 46.

Farrel method[9]

According to this method, the radial work discharge opening is equal to the thickness of the fibre blanket, plus the thickness of the moisture blanket, Th = $Th_f + Th_m$. Thickness of the fibre blanket Th_f = volume of fibre (cubic inches/min.) divided by the roller surface (square inches per minute).

Thickness of the moisture blanket, Th_m, is calculated from the weight ratio of moisture and fibre (m/f) in the bagasse; this ratio is given in Table II for a six-mill unit with a three-roller crusher. These figures are assumed to be after the bagasse leaves the bite and reabsorption has taken place.

Table II. Weight ratio of moisture and fibre (m/f) in bagasse

Mill No.	m	f
1	67	33
2	60	40
3	55	45
4	52	48
5	50	50
6	48	52

In order to calculate the volume of fibre and moisture under compression, Chirgwin assumed the values of density, in lb/cu.ft. (specific weights) for fibre and moisture for an 18-roller mill tandem, given in Table III.

Table III

Mill No.	Fibre	Moisture
1	66	66
2	87	66
3	105	65
4	116	64
5	126	63
6	135	62

In his method, he assumed one short ton of cane per 24 hours per inch of roller surface per foot per minute of roller speed for cane with 10% fibre and calculated the blanket thickness Th which equals "O". This is given for an 18-roller tandem in Table IV. Using this value of "O" the actual discharge work opening for a given set of mill conditions is calculated by multiplying the "O" value for the mill by the mill factor. The mill factor is calculated by the following formula:

Mill factor = (short tons of cane per 24 hours × % fibre) / [Face (inches) × speed (ft/min) × 0.1]

Table IV

Mill No.	Th = "0"
1	0.840
2	0.614
3	0.475
4	0.400
5	0.362
6	0.337

Later in Farrel Bulletin 312-C, he introduced the "R" factor for blanket thickness, which is given as: = (arrobas fibre per hour) / [roller speed (ft/min) × roller length (feet)]; one arroba = 25 lb.

As a matter of fact the blanket thickness "R" is basically a fibre loading factor, expressed in arrobas of fibre per hour per sq.ft. escribed apparent surface per minute. This "R" factor was introduced later on to check that the fibre loading of the mill would be within the optimum range, and helps in determining the optimum roller speeds.

Prior to Farrel's publication on mill settings, Pole, in South Africa, published a method[1] in 1959 for calculating mill settings in which he used the same terms as fibre blanket thickness and moisture blanket thickness.

According to Pole's method the thickness of the fibre blanket is obtained from:

$$Th_f = (200 \times T \times \%f)/(Wt_f \times S \times L)$$

where: T = Short tons of cane per 24 hours, %f = the fibre % cane, Wt_f = the fibre density in lb/cu.ft. (specific weight), S = is the peripheral roller speed in ft/min, and L = the roller length in inches.

The thickness of the moisture blanket is calculated from:

$$Th_m = Th_f \times (Wt_f/Wt_m) \times (m/f)$$

where Wt_m = the density of the moisture in the bagasse, m = the fraction of moisture in the bagasse, and f = the fraction of fibre in the bagasse. The total work opening is thus $Th_f + Th_m$. The composition of the bagasse leaving each mill is assumed to be as shown in Table V. In his paper, Pole gave an illustration of selecting roller speeds from the Farrel graph, as was suggested in the Farrel Bulletin.

Table V

Mill No.	m	f
1	65	35
2	58	42
3	53	47
4	50	50
5	48	52
6	46	54

On comparing Pole's method with Chirgwin's Farrel method, one will see that both are identical in concept, but differ in that Pole's method uses slightly higher concentrations of fibre in each mill discharge work opening, and uses the specific weight of fibre given by Tippet.

Chirgwin's method assumes that the density of fibre varies down the milling train; this is not correct, as pointed out by Murry & Holt[10]. As a matter of fact, the no-void density of fibre does not change under different pressures, as shown by Pidduck[11]. The density of fibre in contact with water has been determined as 1.512 g/ml (94.5 lb/cu.ft.) at atmospheric pressure. At a pressure of 12,000 p.s.i., the density is 1.53 g/ml (95.7 lb/cu.ft.), showing that fibre is only slightly compressible. Thus it is the fibre index that varies down the milling train, and not the fibre density.

Hugot's method

Hugot has given a method through a concrete example for a 12-roller milling plant. The specific no-void volume of each mill's bagasse has been calculated by his formula[12]

$$V_0 = 1/d_j - (1.20/d_j - 0.86)f$$

when Brix-free water in cane or bagasse is 20% of the weight of bone dry fibre. In the formula, V_0 = specific no-void volume of cane or bagasse, f = fibre content of cane or bagasse, and d_j = specific gravity of juice (or mixture of juice and imbibition water) under pressure. The specific gravity of juice

9 Chirgwin: *Sugar J.*, 1960, **23**, (3), 27 - 31.
10 *I.S.J.*, 1961, **63**, 336 - 368.
11 *Proc. Queensland Soc. Sugar Cane Tech.*, 1955, 147 - 153.
12 "Handbook of cane sugar engineering", 2nd Edn. (Elsevier, Amsterdam), 1972, p. 135.

(d_j) under operating pressure can be estimated (with sufficient accuracy) as $d_j = 1.01\ d_{j0}$.

Table VI

Mill No.	1	2	3	4
Desired fibre content in bagasse	0.33	0.42	0.47	0.50
Specific gravity of juice d_{j0} in unopened cells under atmospheric pressure	1.08	1.04	1.02	1.01

The specific volume of bagasse for the last mill,
$V_0 = 1/(1.01 \times 1.01) - 0.5[1.20/(1.01 \times 1.01) - 0.86] = 0.8221$ dm³/kg
Specific gravity of bagasse = 1/0.8221 = 1.216
Specific weight of bagasse under operating pressure = 1.216×62.4 = 75.9 lb/cu.ft.
Reabsorption factor r for the first mill, i.e. r_1, is obtained from the formula:

$$r_1 = 0.75 + 0.0052v + 0.01\phi$$

where: v = velocity of the roller in ft/min, and ϕ = fibre index in lb/cu.ft. In this formula the constant 0.75 would drop for other mills in the tandem and would fall to the neighbourhood of 0.6 for the final mill.

If we assume that v = 42 ft/min. and $\phi/f = 109$ (using the observations of Douwes Dekker & van Hengel, as given in the South African method) then, $\phi = 109f$ or $0.01\phi = 1.09f$
Reabsorption factor for the fourth mill, r_4, is given by:
$r_4 = 0.6 + (0.0052 \times 42) + (1.09 \times 0.5)$
$= 0.6 + 0.218 + 0.545$
$= 1.36$

The weight of bagasse passing through the discharge work opening per hour = the volume of bagasse × sp. wt. × reabsorption factor in lb/hr = $60\pi nDLe_A dr = F/f$ lb. From this, $e_A = (F/60\pi nDL) \times (1/fdr)$
where n = roller speed in rpm, D = mean roller diameter in feet, L = roller length in feet, e_A = discharge work opening in feet, d = specific weight of bagasse in the work opening, r = reabsorption factor, F = weight of fibre in lb per hour, f = fibre content of bagasse and q = fibre loading in lb/sq.ft. q is given by $F/60\pi nDL$ and the discharge work opening in inches = $(q \times 12)/fdr$.

Hugot's method for calculating the discharge work opening uses the figure of natural fibre in determining the specific weight of bagasse under no-void conditions. In this method, the weight of bagasse passing through the discharge work opening is determined by further multiplying by the reabsorption factor.

Louisiana method[13]

Table VII shows the bagasse analysis for optimum operation of a 12-roller mill tandem.

Table VII

Mill No.	1	2	3	4
Bagasse moisture, %	57.0	53.5	50.0	47.0
Bagasse soluble solids, %	7.0	5.5	4.0	3.0
Bagasse fibre, %	36.0	41.0	46.0	50.0
Specific weight of bagasse	80.0	80.0	80.0	80.0

If D = mean diameter of roller in inches, L = length of roller in inches, T = long tons of cane per hour, F = fibre % cane, and SS = surface speed of roller in ft/min, the weight of dry fibre per minute = $T \times (F/100) \times (2240/60)$ lb.
Weight of bagasse per minute = [weight of fibre/min (lb) × 100] / (Fibre % bagasse).
Volume of bagasse in cu.ft./min = (Weight of bagasse/min) / (Sp. wt. of bagasse)
Area of the bagasse opening (sq.in.) at the point of closest approach = volume of bagasse in cu.ft. × 114/SS.
Discharge work opening = Bagasse opening area (sq.in.) / Length of roller (in)

This method uses dry fibre in calculating the discharge work opening, and employs a rather high value of 80 lb/cu.ft. no-void specific weight of bagasse.

Mauritius method[14]

The fibre content and bagasse specific weight values in the Mauritius method are given in Table VIII.
Fibre rate (lb/min) = $C \times 2000 \times f/60 = 33.3\ Cf$
where C = short tons of cane crushed per hour and f = fractional fibre in cane.

Bagasse throughput (lb/min) = $33.3Cf \times 1/F$
where F = fractional fibre content of bagasse.
The volume of bagasse in cu.ft./min = $33.3Cf/F \times 1/d = 33.3Cf/dF$
where d = specific weight of bagasse.
The escribed volume/minute = $\pi KLDn/1728$ cu.ft.
where K = discharge work opening in inches, L = length of roller in inches, D = mean diameter of the roller in inches, and n = number of revolutions of the roller per minute.
Hence $33.3Cf/dF = \pi KLDn/1728$
and $K = (33.3 \times 1728 \times Cf) / (\pi dnDLF) = 18{,}308.9Cf/dnDLF$.

From this the work opening for any mill can be calculated using values for F and d taken from Table VIII.

Table VIII

Mill No.	Fractional fibre content (F)	Sp. wt. of bagasse under no-void conditions lb/cu.ft. (d)
1	65	35
2	58	42
3	53	47
4	50	50
5	48	52
6	46	54

In Mauritius the set openings are calculated by a ratio of discharge settings to discharge work openings which are given in Table IX below. If the value of K for the Mauritius and South African formula are equated, using the same nomenclature:
K = 167Cf/nDLF (South African method)
= 18308.9Cf/dnDLF (Mauritius method).

Table IX. Ratio of discharge settings to discharge work openings

Three roller crusher	0.7
First mill	0.6
Intermediate mills	0.5
Last mill	0.4

13 Lowe: *I.S.J.*, 1947, **49**, 12 - 14.
14 van Hengel: *S.M.R.I. Bull.*, (8).

This would give a value for d of 18308.9/167 = 109.6. This represents the specific weight of no-void bagasse and is much higher than the values stated in the formula of 75.0 to 79.4 lb/cu.ft. Consequently the Mauritius method will give a wider work opening than one estimated by the South African method. The question arises then, how are good milling results achieved by the Mauritius method of calculating the mill openings. The answer is that, in South Africa, the set openings are calculated by deducting a length equal to 0.8 of the average lift of the top roller from work openings. In Mauritius, the set openings are estimated by multiplying the work opening by the ratio of discharge set openings to discharge work openings, as given in Table IX. This brings the set openings calculated by the Mauritius method close to those calculated by the South African method below.

The question arises as to how the South African method achieves a specific weight of bagasse as high as 109.6 lb/cu.ft.? This is the same value as given by the ratio V/F, as discussed below. The acceptable explanation of higher values of d (specific weight of bagasse) is that re-absorption to a factor of 1.4 has occurred owing to the cane juice passing through the mill opening faster than the fibre and this has therefore inflated the "d" value above those considered in the Mauritius method.

South African method[15]

The escribed volume per minute = $\pi KLDn/1728$ cu.ft./min., and the weight of fibre passing per minute = $Cf \times 2000/60$ lb/min. Therefore, the fibre index V or lb fibre per cu.ft. escribed volume = $2000Cf/60 \times (1728/\pi KLDn)$, whence $K = 57600Cf/n\pi DLV$, where K = the radial discharge work opening in inches, C = short tons of cane passing through the tandem per hour, f= the fractional fibre content of the cane, n = number of revolutions per minute of the top roller, L and D are length and mean diameter of the rollers in inches, and V= lb of fibre/cu.ft. escribed volume (fibre index).

As the bagasse passes through the milling train its fractional fibre content F increases. It is assumed that natural fibre in bagasse is associated with 30% Brix-free water and that the volume of natural fibre is equal to the sum of the volume of the bone dry fibre and the Brix-free water contained in it. The volume I (in cu.ft.) of 1 lb of bagasse is:

$I = F/(1.53 \times 62.4) + 0.3F/(1.0 \times 62.4) + (1 - 1.3F)/(d_j \times 62.4)$

where 1.53 is the specific gravity of dry fibre, F the fractional fibre content of the bagasse and d_j is the specific gravity of juice.

If one assumes that no re-absorption is taking place, the value of V can be calculated from the values of F and I for a particular mill in a tandem, when the discharge work opening is completely filled with bagasse. From this it follows that:

$V = F/I = F/[F/(1.53 \times 62.4) + 0.3F/(1.0 \times 62.4) + (1 - 1.3F)/(d_j \times 62.4)]$ which simplifies to

$V/F = 62.4/[F/1.53 + 0.3F + (1 - 1.3F)/d_j]$

$= 62.4/[0.654F + 0.3F + (1 - 1.3F)/d_j]$

$= 62.4/[0.954F + (1 - 1.3F)/d_j]$

$= 100/[1.53F + (1.6 - 2.08F)/d_j]$.

This ratio, V/F = 1/I, represents the specific weight of bagasse in the discharge opening. By the help of the above formula the specific weight of each mill bagasse in the discharge work opening can be found by substituting the values for the specific gravity of juice (d_j) and the attainable fractional fibre content in the bagasse (F). From this, eventually, the discharge work opening for any mill in the tandem can be calculated.

Referring to the earlier work done by Egeter in Java, we can see that a higher fibre content F in bagasse was not obtained, even when the fibre index V (fibre compaction coefficient) was raised beyond 35 lb fibre per cu.ft. escribed volume for the first mills and 55 lb/cu.ft. for the last mill.

These values of V were considered to be optimum when the fibre content F of the first and the last mill bagasses were 0.32 and 0.5, respectively, for a 15-roller tandem. Under such conditions the specific weight of bagasse = 1/I = V/F (for the first mill) is: 35/0.32 = 109.4 lb bagasse/cu.ft. e.v. Similarly, the V/F ratio for the last mill is: 55/0.5 = 110 lb bagasse/cu.ft. e.v.

This was a great observation made by van Hengel & Douwes Dekker and they assumed that the weight of bagasse per cu.ft escribed volume for the intermediate mills would also be 110 lb or, in other words, the fibre index "V" is equal to 110F for each mill. We have earlier seen that the radial discharge work opening, K, in inches, is given by $57600Cf/n\pi DLV$. After substituting the values of π and "V" in terms of 110F we get:

$K = 57600Cf/(3.14 \times 110nNDLF)$

inches = 166.76Cf/nDLF inches.

The figure of 166.76 has been rounded in the formula and the discharge work opening K in inches has been represented by the following formula:

$K = 167CF/nDLF$ inches.

For 15-roller and 18-roller tandems, the authors suggest the following fractional target values of fibre "F" in bagasse, at the discharge end of the mill, for calculating the radial discharge work opening in inches for individual mill units in the tandem, based on Java milling data. These F values are given in Table X below.

Table X

Unit No.	15-roller tandem	18-roller tandem
1	0.32	0.30
2	0.40	0.39
3	0.45	0.43
4	0.48	0.46
5	0.50	0.48
6		0.50

As stated earlier, this method uses the weight of dry fibre in the escribed volume, but Hugot has shown that a reabsorption factor, ranging from 1.54 to 1.43, is incorporated in the figure for fibre and does not appear in the calculation.

The simplicity of the formula lies in the fact that it avoids the tedious calculation of densities, or specific weight in lb/cu.ft. for individual mill

15 van Hengel & K. Douwes Dekker. *Proc. S. African Sugar Tech. Assoc.*, 1958, 57 - 67.

bagasse, in the discharge work opening. Even if the lengthy calculations for estimating the densities or specific weight of bagasse from different mills are undertaken, their accuracy will again depend on the determination of juice Brix and Brix-free water % dry fibre in cane.

In order to demonstrate the difference in work openings obtained by different methods for the last mill of the tandem we have assumed the following conditions:

Weight of cane = 1 short ton/hour
Width of roller = 1 ft
Surface speed = 1 ft/min
Fibre % cane = 10

The work opening and fibre index as calculated by each method are tabulated in Table XI.

Table XI

Method	Work opening, in	Fibre index, lb/cu.ft. e.v.
Australian	0.727	55.00
Farrel	0.676	59.34
Hugot	0.775	51.60
Louisiana	0.996	40.16
Mauritius	0.968	41.30
South Africa	0.727	55.00

From the above table we see that higher fibre index values are achieved by the Farrel method and lower values by the Louisiana method. If we define milling as a process to extract the maximum possible sugar in juice, and to render bagasse with a minimum moisture content so that it can be burnt in boiler furnaces straight from the mill, then how do the methods which achieve a lower fibre index cope with the embarrassing situation of high bagasse moisture? The answer is that, like the different methods for calculating mill work openings, there are different methods for the determination of set openings, where adjustments are made, as has been pointed out in the case of the Mauritius method. Different methods for the determination of set openings will be discussed elsewhere.

Summary

The concept behind each method of estimating the work opening has been derived from another method. The South African method is based on data from Java, where it was determined that, for optimum performance of each individual mill, there exists an optimum value of fibre index. The Australian method uses more or less the same fibre values as advocated by the South African method and also presents a simple method for estimating the mill work opening.

The Farrel method used varying no-void densities of fibre, the values of which increase appreciably down the milling train. It has been demonstrated by Pidduck that fibre density in contact with water did not change appreciably when the pressure was raised from atmospheric condition to 12,000 lb/sq.in. The Mauritius and Louisiana methods use the specific weight of bagasse for calculating the volume of bagasse passing the work opening. The methods do not include the reabsorption factor in the calculation, whereas Hugot's method does, resulting in estimating a wider opening than other methods.

Hugot's method uses the figure of natural fibre in calculating the specific weight of bagasse. This method includes the reabsorption factor in the calculation. The method is based on many variables, such as juice specific gravity, reabsorption factor from each mill and Brix-free water % dry fibre. Inclusion of all these variables results in a lengthy calculation.

In order to achieve good milling performance it is suggested that the openings be shown in cubic feet per ton of fibre passing per minute (see Appendix 2). These openings, plotted with the cubic feet per ton of fibre per minute as the abscissae and the rollers passed as ordinates, give a picture of what is happening at the various mills.

APPENDIX 1

Fibre filling ratio = weight of fibre per unit time / $WSLd_F$
where: W = work opening at point of nearest approach in feet
S = nominal bagasse speed at that position in feet per unit time
L = roller length in feet
d_F = fibre specific weight (95.5 lb/cu.ft.)
Fibre rating = fibre filling ratio × 95.5

APPENDIX 2

Cubic feet per ton of fibre passing per minute = Opening of rollers in inches × roller length in inches/144
= sq.ft. of opening
Cubic feet per minute of opening = sq.ft. of opening × mean speed of rollers in feet
Cubic feet per ton of fibre per minute = cu.ft. per minute of opening/tons of fibre per min.

Facts and figures

Canada sugar exports, 1987[1]

White sugar exports by Canada in 1987 amounted to 68,771 tonnes of which 65,322 tonnes went to the USA. This compares with 87,738 tonnes in 1986, when 83,333 tonnes went to the USA.

Indian sugar factory expansion[2]

The capacity of the Zira sugar factory, about 30 km from Ferozepore, belonging to Punjab Khand Udyog Ltd., is being doubled from 1250 to 2500 t.c.d. Machinery has been purchased and the expansion program is expected to be completed by mid-1989.

Fletcher and Stewart results, 1987

Sales in 1987 increased by 15% and included a third contract from Pakistan for the design and supply of equipment for a new sugar factory. Orders for unit equipment and spares increased, and included major orders from the Sudan, Kenya, Nigeria, Pakistan and the Dominican Republic. Further orders for continuous vacuum pans, which are designed for both cane and beet sugar production, were won in Austria, Indonesia and Pakistan.

Larger Malaysia sugar shortfall[3]

Sugar output in Malaysia is expected to fall to 87,000 tonnes this year from 92,000 tonnes in 1987 owing to the adverse effect of abnormally dry weather on yields; last year's rise in oputput was due to ideal weather in the sugar growing areas and compared with 86,000 tonnes produced in 1986. Most of Malaysia's sugar requirements are met by imports which fell from 663,000 tonnes in 1986 to 661,000 tonnes last year but are expected to rise in 1988. Around 80% of imports come from Australia and Fiji.

1 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, S98, S146.
2 *Indian Sugar*, 1987, **37**, 457.
3 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 214.

ANALYSIS

International Commission announces changes to sugar scale and polarization method

By M. R. Player, President, ICUMSA

At the 19th Session of ICUMSA (International Commision for Uniform Methods of Sugar Analysis) held in Cannes between May 25 and 30, 1986, an important change was made to the definition of the International Sugar Scale. The new scale was set in force on July 1, 1988, the previous scale having remained valid until then.

On the new scale the definition of the "normal sugar solution" remains unchanged, i.e. the "normal sugar solution" is defined as 26.0160 g of pure sucrose weighed *in vacuo* and dissolved in pure water at 20.00°C to 100.000 cm^3. This corresponds to a concentration of 26.000 g of sucrose weighed with brass weights in air under normal conditions (1013 hPa pressure, 20°C, 50% relative humidity) in 100.000 cm^3 of solution at 20°C.

The basis of the 100°S point on the International Sugar Scale is the optical rotation of the "normal sugar solution" at the vacuum wavelength of the green line of the mercury isotope ^{198}Hg (λ=546.2271 nm) measured at 20.000°C in a 200.000 mm polarimeter tube. On the scale in force up to July 1, this rotation value was 40.765°. However, measurements of the "normal sugar solution" carried out by Physikalisch Technische Bundesanstalt, Braunschweig, in collaboration with the Braunschweig Sugar Institute, and originally reported by F. Schneider at the 16th Session of ICUMSA in 1974, gave an optical rotation value at a wavelength of 546.2271 nm of 40.777° (20.000°C and 200.000 mm path length). This value of 40.777° was confirmed by further measurements at the Braunschweig group and, after some initial disagreement, by the National Bureau of Standards, Washington (Reported at the 18th Session of ICUMSA in 1982).

To avoid possible confusion between values on the old and new scale, sugar values on the new International Sugar Scale will be designated °Z rather than °S. On the new International Sugar Scale the optical rotation of the 100°Z point under the standard conditions specified above will be 40.777 ± 0.001° at the vacuum wavelength of 546.2271 nm compared with the 100°S value of 40.765° on the scale currently in force.

Scales on polarimeters and saccharimeters

The scales on existing polarimeters and saccharimeters where calibrated in "degrees S" will read too high upon the adoption of the new "degrees Z" scale on July 1, 1988. To convert values in °S on the old scale to values in °Z on the new scale it is simply necessary to multiply the °S value by the factor 0.99971, i.e. to reduce the °S value by 0.029%. Because the magnitude of this change is small it will not be necessary to physically install new scales on existing instruments; rather, the change can be accommodated by adjusting the values of the quartz control plates used to standardize instruments. Quartz control plates will have a new °Z value which is 0.99971 times the old °S value.

The laboratories which normally calibrate quartz plates in sugar degrees are requested to calibrate only in terms of °Z after July 1, 1988.

In the following Table I the angular rotation values corresponding to the 100°Z point on the new International Scale for a polarimeter tube length of 200.000 mm are given for a number of different wavelengths. The values in brackets refer to the 100°S point on the current scale.

Table I. Angular rotation of 100°Z point

Vacuum wavelength, nm	Angular rotation	
	New value, degrees	Previous value, degrees
546.2271	40.777	(40.765)
587.0000*	34.934	(34.924)
589.4400**	34.626	(34.616)
632.9914	29.751	(29.743)

* Effective wavelength of the standard quartz wedge saccharimeter
** Mean effective wavelength of spectrally filtered sodium yellow light

Quartz control plates

A quartz control plate has a sugar value of 100°Z at a specified wavelength if its rotation is equal to the values given in the above table at that particular wavelength.

For a quartz control plate calibrated in °S on the current scale at any of the above wavelengths, conversion to the °Z value on the new International Sugar Scale can be effected, as outlined above, by multiplying the °S value by the factor 0.99971.

Because this recalibration simply involves an arthimetic calculation of a new value it is not necessary to send quartz control plates to a certifying authority to establish the new values. Quartz plates should specify clearly the scale upon which they have been calibrated as well as the wavelength for which that value applies.

Owing to the slightly different rotatory dispersions of sucrose and quartz, the °Z value, and likewise the °S value, of a quartz control plate is slightly wavelength-dependent. The following factors may be used to calculate the sugar values for quartz plates from values for mercury green light to values appropriate to other illumination conditions. Also, conversion from one illumination condition to another may be achieved by making a ratio of these factors.

Table II. Factors to convert quartz plate sugar values for mercury green light to values for other light sources

Quartz wedge instrument	587 nm	1.001809
Yellow sodium light	589 nm	1.001898
He-Ne laser	633 nm	1.003172

The values obtained for a 100.00°Z quartz plate using mercury green light for different illumination conditions are tabulated below:

Table III. Values in degrees Z for quartz control plate

Mercury green light	100.00°Z
Quartz wedge instrument	100.18°Z
Yellow sodium light	100.19°Z
He-Ne laser	100.32°Z

The regular calibration of polarimeters using quartz control plates

certified for the illumination conditions applying in the instrument is recommended. This allows compensation for errors in the polarimeter scale and is particularly important for circular scale instruments where the calibration can be significantly affected by slight variations in the effective wavelength of the light source.

Polarimetric method

Coincidental with the new sugar scale coming into effect on July 1, 1988, the Commission has removed the optional 0.1°S deduction from raw sugar polarimetery results when reporting analysis "according to an equivalent dry lead method". From that date there will be only one method of reporting raw sugar pol values. This will be the result which arises out of preparing a solution of 26 g of raw sugar made up to 100 cm^3 with lead clarification and measuring the degrees Z of this solution in a 200 mm tube in a polarimeter with a sugar scale described above.

Summary

From July 1, 1988 a new International Sugar Scale has come into force. To avoid possible confusion between the old and new scales, sugar values on the new scale will be designated °Z rather than °S.

On the new International Sugar Scale the optical rotation of the 100°Z point under standard conditions will be 40.777° and 34.626° at the mercury green and sodium yellow wavelengths, respectively (compared with values of 40.765° and 34.616° on the scale previously in force). To convert values in °S on the old scale to values in °Z on the new scale it is simply necessary to multiply the °S value by the factor 0.99971, i.e. to reduce the °S value by 0.029%. This conversion factor applies also for quartz control plates.

Coincidental with the new sugar scale coming into effect, the Commission has removed the optional 0.1°S deduction from raw sugar pol values when reporting analysis "according to an equivalent dry lead method".

Correspondence

To the Editor,
International Sugar Journal.
Dear Sir,

Sugar bags and related materials

The rules and regulations of the Refined Sugar Association of London state: "PACKAGES: 2. The sugar shall be packed in new sound bags suitable for export."

The purpose of this letter is to express concern about the suitability of some pre-lined 50-kg bags (i.e. bags which arrive at the factory with the polyethylene liner inside the outer) for the export sugar trade.

When polyethylene liners were introduced in 1951, hessian sacks were lined by hand and the fitting was loose. The liner was oversize. When bags are prelined and machine-sewn during manufacture there is a danger that variation in the registration results in a tight fit and as a consequence the liner effectively tries to support the weight of the sugar.

Liners are not designed to do this and will tear. The bags are then no longer effectively waterproofed and protected against rain, sea spray, odour or condensation. Sugar can get wet and become a source of complaint.

Manufactured lined bags have been inspected where the liner was sewn at the bottom but not at the top. In this case the sugar will force the liner to fill the outer and, provided the sewer takes care, there should be no danger to the liner. Some pre-sewn bags have been seen which are sewn at the top selvage and the bottom seam. These will tear if the poly liner is not effectively larger than the outer and thus never in danger of "taking the strain" of the weight of sugar during the filling operation.

There is a variety of factory-made polypropylene liner which incorporates a heat seal at the bottom and is sewn through the top selvage. Unless the liner is oversize this can be torn during filling or subsequent handling. Such potential damage should be discovered during "drop" tests but, as observation centres on the outer rather than the inner, can be missed.

There are also varieties of valve pack– some without effective seals – offered for sugar exports. The same considerations apply; the liner must be loose inside the bag during the filling and handling stages but not shift position and allow sugar to get between liner and outer bag.

The sole duty of the liner is to provide a hygienic moisture barrier and it must be designed, fitted and protected from undue strain during the filling and subsequent handling operations. It is recommended that purchasing and operations managers take due note as well as those in charge of quality assurance.

Yours faithfully,

James E. Somner

Facts and figures

Indonesia sugar import rise forecast[1]

Indonesian sugar imports in calendar year 1988 are forecast to rise to 180,000 tonnes from 156,000 tonnes in 1987, according to the annual Agricultural Situation Report of the US Embassy. The forecast is lower than many trade estimates, which have predicted that Indonesia may need more than 250,000 tonnes of raw sugar this year. The embassy said production in 1988 was likely to stagnate at last year's 1.9 million tonnes, a figures sharply lower than official estimates, and has not explained the discrepancy. The government says raw sugar output will rise slightly to 2,175,000 tonnes against 2,125,000 tonnes in 1987. Indonesia has already said it imported 125,000 tonnes of sugar to buttress stocks and to meet demand during the fasting month of Ramadan which began in mid-April but, according to the report, "domestic sugar production in recent years has not been able to keep up with demand ... and it appears the gap is widening as imports increase".

Uganda sugar factory rehabilitation finance[2]

The African Development Bank will lend US $17.8 million to the Kakira sugar factory in Eastern Uganda, an estate which is now a joint venture between the Uganda government and the Madhvani family. The World Bank is also providing finance for the rehabilitation of the Kakira facility.

1 *Reuter Sugar Newsletter*, March 21, 1988.
2 *Amerop-Westway Newsletter*, 1988, (173), 11.

Facts and figures

Tanzania sugar industry rehabilitation plans[1]

Sugar production from the five sugar factories in Tanzania is currently running at only 112,400 tonnes of white sugar, but it is hoped to rehabilitate the industry so that output may eventually rise to 230,000 tonnes. The Minister of Agriculture and Livestock Development hopes that under the new program additional factories will be constructed through joint undertakings with local and overseas firms. The state-owned Sugar Development Corporation is the umbrella organization under which the sugar factories operate and will study ways of improving the industry in the future. As with other sectors in the economy, the sugar industry in Tanzania has been affected by the lack of foreign exchange which has curtailed the import of necessary inputs and spare parts.

UK beet rhizomania inspection program

To ensure that infection has not spread from the farm in Suffolk where rhizomania was discovered last year, all fields growing beet this year within 5 km of the site, and also crops on farms visited by the sugar beet contractor who worked on the farm between 1981 and 1987 are to be inspected and sample beets tested in the laboratories of the Ministry of Agriculture. The program will cover about 2000 fields but is considered justifiable to maintain protection against the disease. It follows widespread surveys in 1987 and programs of inspection in the three previous seasons which found no signs of rhizomania infection.

New US beet research journal

The American Society of Sugar Beet Technologists is introducing a new publication, the *Journal of Sugar Beet Research*, which will include peer-reviewed scientific research results, scientific papers and abstracts, covering all areas of sugar beet research from crop studies to factory processing. One issue will be an entitlement for members of the Society, while the price for non-members is $20.00 per year. Details are available from the Society at 2301 Research Blvd., Suite 107, Fort Collins, CO 80526, U.S.A.

Sockerbolaget annual report, 1987

In 1986, Sockerbolaget – formerly Svenska Sockerfabriks AB, the Swedish Sugar Company – produced 355,000 tonnes of sugar, against 318,000 tonnes in the previous year. This entailed a higher level of capacity utilization during the 1986, lower manufacturing cost per tonne and improved Group budget contribution on sales in 1987, when it was not necessary to import sugar. The very poor harvest in 1987, only achieving 253,000 tonnes of sugar, will have a negative influence on earnings for 1988. The need for imported raw sugar, to be refined at the company's Arlöv facility, rose to 80,000 tonnes against the normal 17,000 tonnes and this is likely to continue in 1988. The poor crop followed unusually harsh weather; sowing was delayed by 10 days and the temperature was 2-3°C below normal throughout the growing period. Rainfall was higher and sunshine lower than normal so that yield per acre fell to 33 tonnes although the sugar content was slightly higher. A computer program for reception, weighing and sampling has now been made fully operational at all factories and connected to the programs for accounting and payment. A new solid fuel-fired boiler at Jordberga factory is due to be operational for the 1989 campaign and replaces one 50 years old. Capital investments during the year amounted to 83 million Swedish kroner (£7.6 million).

Cuba sugar exports, 1987[2]

	1987	1986
	tonnes, raw value	
Albania	23,501	22,154
Algeria	33,677	98,767
Angola	32,421	57,991
Bangladesh	0	12,349
Bulgaria	304,699	302,838
Canada	87,011	168,025
China	611,827	307,241
Colombia	113	0
Czechoslovakia	128,509	105,803
Egypt	76,922	138,569
EEC	0	12,438
Finland	56,689	61,744
Germany, East	283,510	271,079
Ghana	13,032	12,388
Guinea Bissau	0	1,083
India	122,799	0
Indonesia	26,434	0
Iraq	26,322	55,318
Japan	222,931	534,487
Kampuchea	0	3,254
Korea, North	36,762	19,582
Libya	23,232	57,819
Malaysia	0	56,311
Mongolia	0	4,729
Pakistan	0	28,458
Peru	12,354	40,859
Poland	54,029	104,786
Rumania	228,009	56,385
Sri Lanka	0	12,999
Sweden	25,130	25,129
Switzerland	3,023	3,257
Syria	76,740	50,775
Tunisia	37,833	37,563
Uganda	23,628	5,416
USSR	3,863,158	4,019,793
Venezuela	17,817	0
Vietnam	27,069	10,487
Unknown and donations	2,954	2,712
Total	6,482,135	6,702,588

Spanish sugar company take-over[3]

The defence put forward by Torras Hostench reported earlier[4] was not successful and, after their bid was raised to 30,000 pesetas per share, the Kuwait Investment Office succeeded in acquiring nearly 35% of the company's shares. This, added to their existing holding of 16.1%, has given them control of the Spanish company and so over the Ebro sugar company.

Kenya sugar factory closure[5]

The Ramisi sugar factory, south of Mombasa, has been closed.

Brazil distillery projects[6]

The Brazilian National Executive Alcohol Commission (CENAL) has approved and authorized new projects establishing distilleries and increasing output at existing distilleries. The projects – ten in all – will provide an increase of 850,000 litres/day in the country's alcohol production capacity.

China sugar imports and exports, 1987[7]

	tonnes, raw value
Imports	
Australia	408,740
Cuba	411,191
Fiji	46,993
Hong Kong	1,217
Japan	3,412
Malawi	11,229
Paraguay	25,500
Philippines	15,945
Thailand	727,158
USA	177,205
Others	2,751
Total	1,831,341
Exports	
Burma	872
Djibouti	332
Hong Kong	42,679
Macao	2,256
Malaysia	1,185
Pakistan	335,766
Saudi Arabia	81,097
Singapore	4,575
United Arab Emirates	14,056
Yemen	295
Others	799
Total	483,912

1 *Czarnikow Sugar Review*, 1988, (1772), 60 - 61.
2 *I.S.O. Stat. Bull.*, 1988, **47**, (3), 9 - 10.
3 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 256 - 257.
4 *I.S.J.*, 1988, **90**, 97.
5 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 283.
6 *GEPLACEA Bull.*, 1988, **5**, (4), Sugar Inf. 1-2.
7 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 230.

PERSONAL NOTES

Dr. Margaret A. Clarke, Managing Director of Sugar Processing Research Inc., of New Orleans, Louisiana, has received the Dyer Memorial Award as "Sugar Man of the Year, 1987"; it should be emphasized that "Man" in the title is not specific to the male gender. The Award, given yearly by the Dyer company of sugar brokers and economists, is for significant and meritorious service to the sugar industry, a phrase which aptly describes the individual research and team leadership displayed by Dr. Clarke during her years with SPRI and its predecessor, the Cane Sugar Refining Research Project from 1972. The Award includes a large silver bowl and a citation which were presented to Dr. Clarke at a dinner in her honour in April.

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