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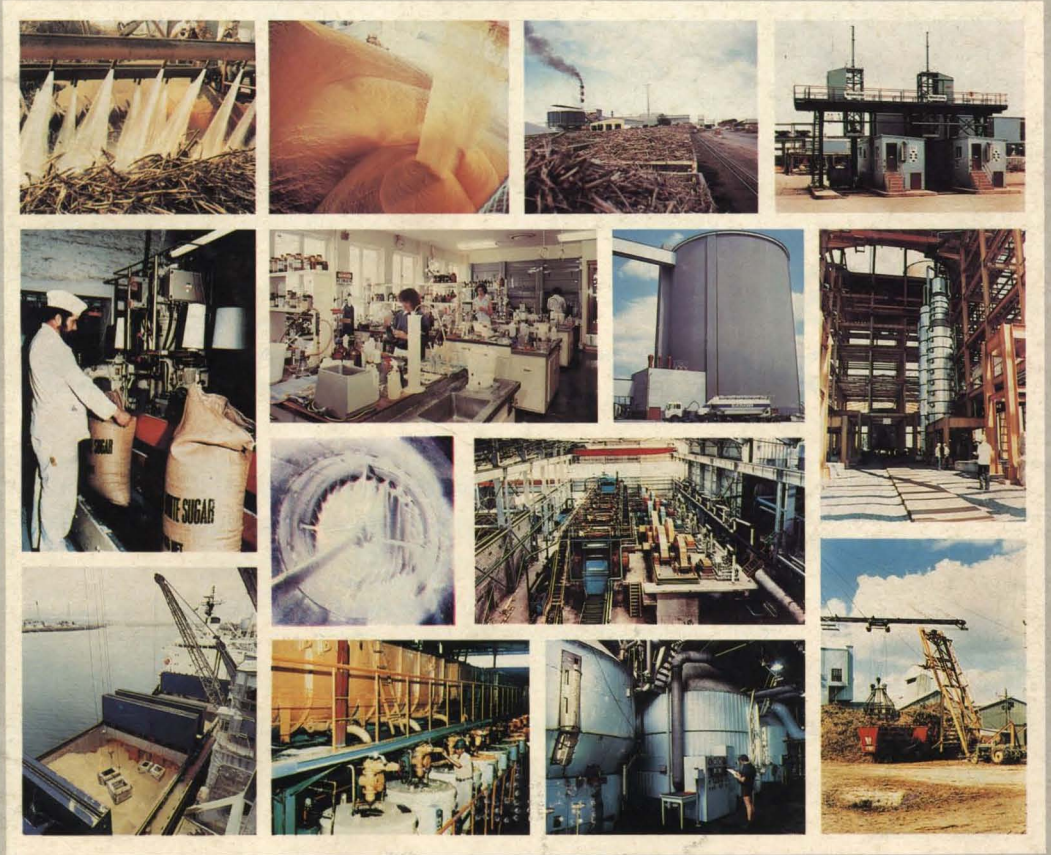

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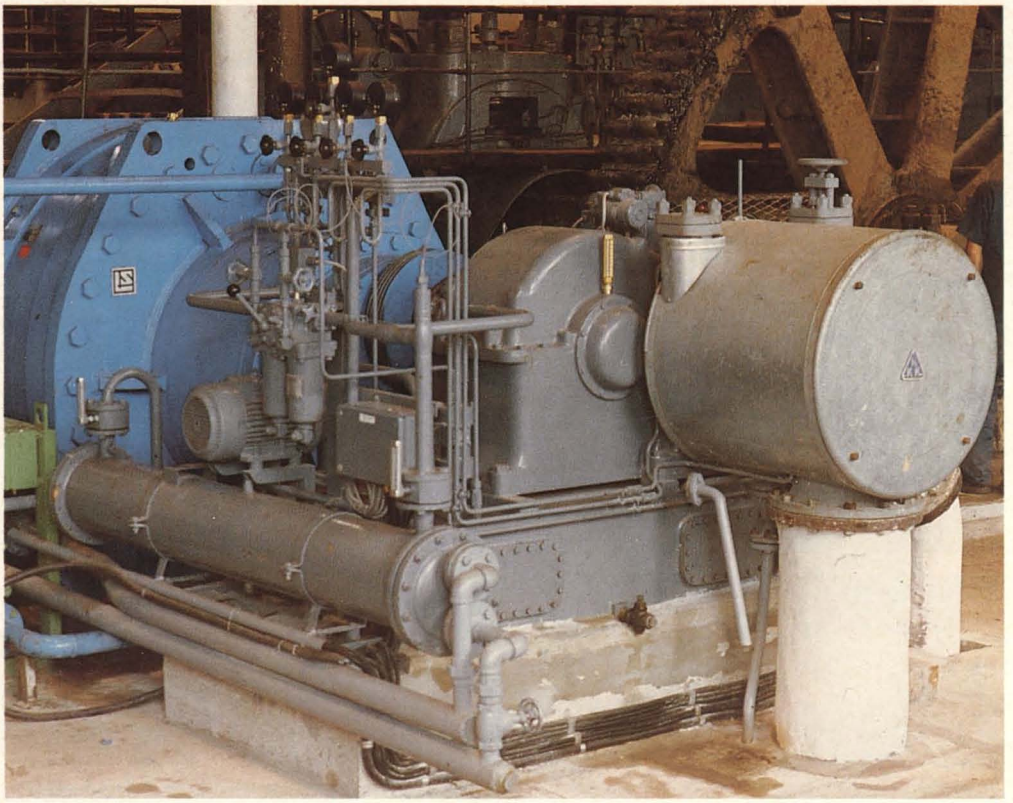

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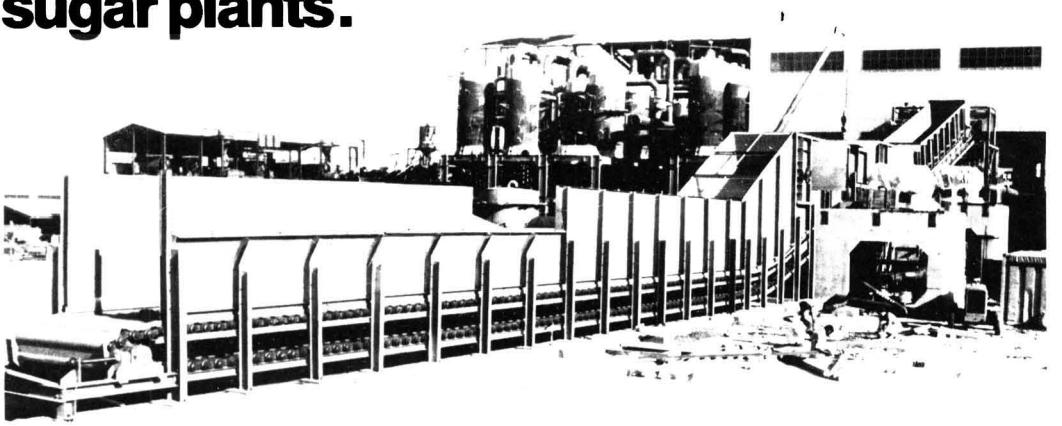

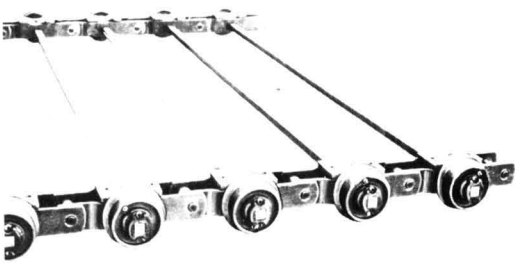

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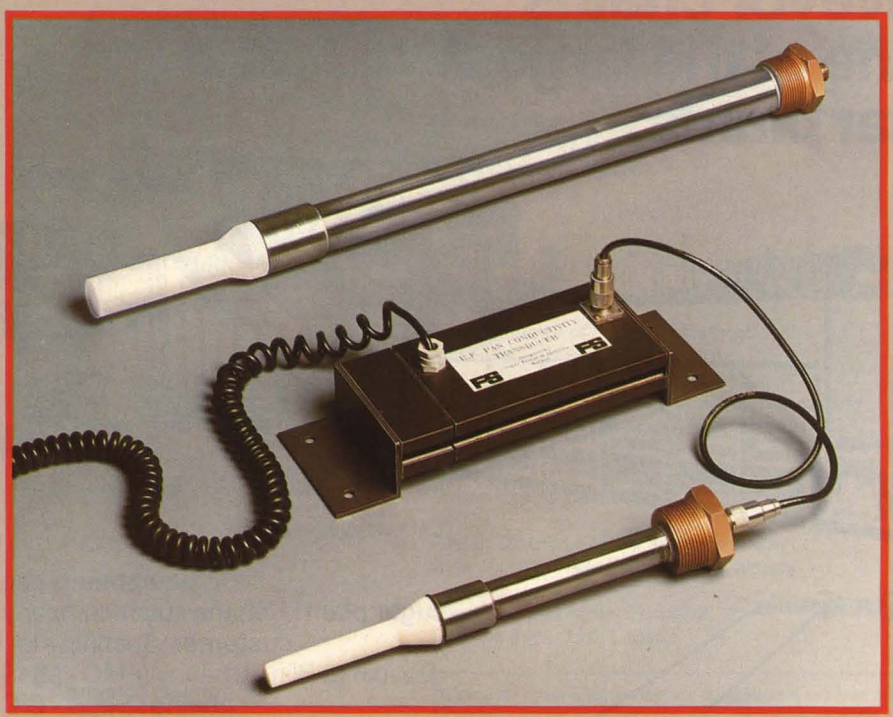

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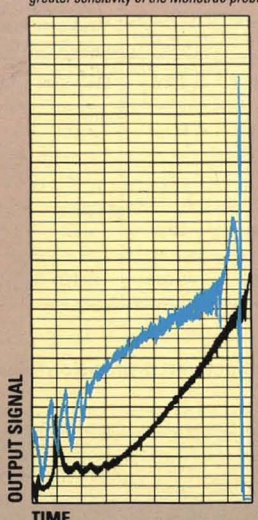
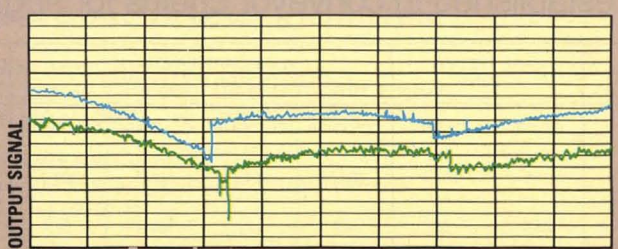
▼ *Chart comparing control and reference signals during a batch boiling cycle and indicating greater sensitivity of the Monotrac probe.*





▲ *Extract from chart comparing reference signals from a nuclear density meter and a Monotrac probe in the final compartment of a continuous pan boiling AP massecuites of 76° purity.*

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News and views

World sugar prices

There was little movement in the world sugar market during October; for most of the month there was expectation of purchases by India but these did not materialize, and while lack of business tended to result in a drift downward of prices, there were some small rallies on reports of purchases by Indonesia and Mexico and attempts by Cuba to defer deliveries of sugar scheduled for this calendar year. However, F. O. Licht's assessment of the world sugar balance indicated that demand was being affected by higher prices and this had a dampening effect on prices. As a consequence of all this, the London Daily Price for raw sugar, which started the month at $357 per tonne only rose to $359 on October 5 before drifting down to $348.40 at the end of the month. The corresponding price for white sugar, $416 on October 2, slipped steadily through the month and ended it at $390.

World sugar production estimates, 1989/90

F. O. Licht GmbH recently published[1] their first estimate of world sugar production for the crop year starting September 1989 and the figures appear elsewhere in this issue. The total crop is set at 107.7 million tonnes, raw value, roughly 1.9 million tonnes more than the previous year but still below potential demand of around 110 million tonnes. This means that there could be another drawdown of stocks in 1989/90. Furthermore, most of the forecast rise in output is expected to occur in such unpredictable countries as India, China and the USSR, which adds to the general uncertainty in the initial stages of a crop year. It can therefore not be taken for granted that production will actually reach the indicated level. If major shortfalls should occur, a boom with all its negative long-term implications for the sugar industry seems to be unavoidable.

The question is why producers have not yet reacted positively to the higher level of world prices. That cane sugar producers have not yet reacted is no real surprise, as in most countries there is a lag of two to three years, because sugar cane is a perennial crop and a more sustained period of higher prices is normally required to prompt growers to expand the cane area. Second, prices have not yet reached a level which could trigger a major expansion process and, third, the memory of low prices from 1983 to 1987 is still vivid and this, coupled with the bleak long-term outlook for world trade, will prevent major investment in export production. Another major factor is the uncertainty concerning the future of the US import market, which keeps producers – especially in Latin America and parts of Asia – from investing.

The beet sugar producing countries are far more flexible and can increase production within nine months, provided the price signal reaches the grower before fields are destined for other crops. The largest beet sugar producer is the EEC and prices in excess of 10 cents/lb will most likely increase the interest in C-sugar production. But here too, the response will be muted as producers still try to assess the implications of the GATT negotiations. Nevertheless, the area sown to sugar beet can certainly be expected to rise if prices stay high, which seems likely. The same is true for the importing beet sugar producers, which will make every effort to expand production in order to curtail imports. However, a big leap forward in production is only a remote possibility, unless prices get totally out of control.

Of total world production in 1989/90, sugar from beets is expected to account for 38.9 million tonnes or 36%. This is somewhat more than 1988/89 owing to the expected rise in the US and USSR. Production in the EEC is not likely to match last season's excellent result, but Austria, Turkey and Yugoslavia are expected to produce more which raises the overall estimate for Western Europe to 18.4 million tonnes. In Eastern Europe crop prospects in Czechoslovakia and Poland have not improved but the USSR expects a good crop. Although there has been drought in the Red River Valley, beet sugar in the US is expected to rise by roughly 5%, offsetting reductions expected in China, Iran and Chile.

Cane sugar production in Asia is expected to rise by 5% to 26.4 million tonnes. In India in 1988/89 the gur and khandsari manufacturers were able to offer higher prices to farmers, which led to large-scale diversion of cane; output in India will depend largely on whether this is repeated in 1989/90. China expects a larger cane sugar crop, partly owing to an increased area, while Indonesian production is expected to recover from the drought-reduced crop of 1988/89. The 50% rise in production last year in Thailand is unlikely to be repeated but with world market prices at their present levels, it must be expected that farmers and sugar factories will aim for another good result. Philippines sugar production recovered in 1988/89 from low levels in the previous two years and a further rise can be expected.

Cane sugar production in North and Central America is not likely to change much in 1989/90, although small increases can be expected in Louisiana, Guatemala and the Dominican Republic. Brazilian sugar output is likely to be limited by the need for alcohol manufacture, while dry weather in Argentina is likely to reduce cane sugar production. Improved weather and a greater cane area may raise output in Peru.

The South African crop is expected to rise but that of Mauritius will have been reduced by cyclone damage. In both Australia and Fiji substantial increases in output are expected.

Brazil alcohol shortage[2]

The alcohol situation in Brazil could become critical before the current crop year finishes. There are no longer any strategic reserves of alcohol and the room for manoeuvre is now extremely limited. As a result some fairly drastic measures are being considered to reduce the sizeable alcohol deficit which it has been estimated will reach 1700 million

1 *Int. Sugar Rpt.*, 1989, 121, 449 - 457.
2 *Czarnikow Sugar Review*, 1989, (1788), 116, 119.

litres by March 1990. Several Ministers and the automobile industry have decided to forward to the President a number of executive orders in an endeavour to contain the situation. These include the addition of 5% of petrol to the fuel for alcohol-only cars; the reduction in the gasohol blend to 12% ethanol except in São Paulo, where 22% will be retained as an anti-pollution measure; the transfer of 350 million litres of alcohol from the North/Northeast to the Centre/South; an increase in alcohol production in the North/Northeast by 240 million litres from the 1989/90 crop plan; an advance in the start of crushing for the 1990/91 Centre/South crop, probably to mid-March in the hope of gaining an early 100 million litres; and a cut-back in the allocation of alcohol to the chemical industry (estimated at some 50 million litres).

Even if these proposals are acted upon immediately, there are doubts that they will be sufficient to bridge the gap between supply and demand for this crop year. Indeed there are doubts that the first proposal is technically feasible, while there may be capacity limits in the Northeast which will prevent the fourth proposal being achieved. However, it illustrates the growing domestic pressures on available cane supplies and the level of concern about resolving this issue.

USSR need for sugar industry development[3]

More than 50% of the sugar factories in the Soviet Union are obsolete, according to sources in the USSR. For example, in the Voronezh region, six of the twelve sugar factories were built more than 150 years ago, and another two before World War II. Lack of production capacity has led to an extension of the processing period in the Russian Federation to 130/140 days compared with the recommended period of 90/100 days. As a result sugar yields at the end of the season are very low.

The integrated program for the development of the sugar industry indicates that in the next five to seven years an additional processing capacity of 136,000 tonnes of beet per day is planned. It is hoped that, by the technical reconstruction of the factories, sugar output can be increased owing to less waste and lower sugar content in molasses. The date for the start of the harvest and the start of beet processing have to be set in such a way that maximum sugar output will be achieved from the available beets, it was said. Realization of this program would permit the USSR to produce 10 - 11 million tonnes annually of sugar, white value, from beets.

German take-over of Belgian sugar group[4]

West Germany's largest sugar producer, Süddeutsche-Zucker AG, has bought a majority shareholding in the sugar-producing activities of Raffinerie Tirlemontoise S.A. of Tienen, Belgium. The latter produces some 635,000 - 650,000 tonnes of white sugar a year while Südzucker produces 1.1 million tonnes. The combined operations may create Europe's biggest sugar group, according to R.T.'s finance director, who said that it would be roughly as big as the Italian-French Ferruzzi group in terms of production quotas. The reason for the take-over was that RT Holding Nederland, the majority shareholder, had concluded that RT was too small to survive in the long term against bigger European rivals.

GEPLACEA programs for sugar industry diversification[5]

A series of programs for diversification of the sugar industry in several Latin American counties is under way, according to *Latin American Commodities Report*. Some of the programs are under the umbrella of an agreement between the UN Development Program and GEPLACEA. Sponsorship is reported to be provided by the Italian and US governments and the UN and private enterprises.

A two-year program is provided for the renewal of the sugar agro-industries of Argentina, Guatemala and Peru; this operates jointly with the Italian International Union for Development Cooperation. It will include surveys of the local industrial situation and the installation of a pilot animal feed plant which will use derivatives of sugar cane. A Japanese firm is reported to have announced plans for a joint venture with Mexican capital to extend production of L-lysine from molasses; production will be increased from 6000 tonnes per year to 10,000 tonnes with a projected output of 15,000 tonnes by 1992, mainly for export. In Bolivia, GEPLACEA has commissioned a feasibility study on the production of fuel alcohol from cane.

EEC - ACP negotiations

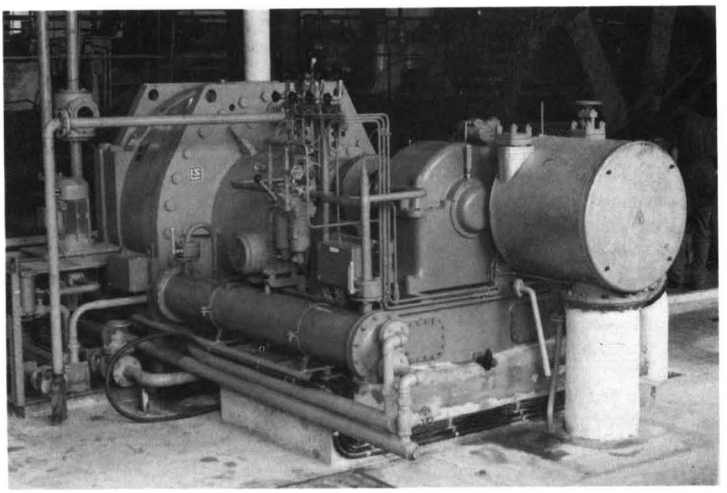
Negotiations to settle terms for renewing the Lomé Convention have not gone well, according to E. D. & F. Man (Sugar) Ltd.[6]. The latest ACP/EEC ministerial conference held in Luxembourg during October 27 - 29 ended in deadlock over the question of funding for the fourth convention period. The ministers have until the end of this year to settle their differences before Lomé III expires in February 1990. The ACP countries have asked for 15,500 million E.C.U., which compares with 7500 million in aid and 1000 million in soft loans under the current convention. France and Italy have proposed 12,000 million but the UK and Holland are reluctant to go beyond 9000 million E.C.U. In the meantime, the EEC Agriculture Council has adopted a tough mandate for negotiations on cutting guaranteed sugar prices for 1989/90. They decided that talks should go ahead on a 2% price cut with no direct compensatory measures. One problem is that the EEC has no strong demand for the products of the ACP countries and also there are increasing calls nearer to hand for aid to the countries of Eastern Europe who are seeking help for their economies escape from the ruins of communism and central planning.

3 F. O. Licht, *Int. Sugar Rpt.*, 1989, 121, 461 - 462.
4 *Public Ledger's Commodity Week*, November 4, 1989.
5 F. O. Licht, *Int. Sugar Rpt.*, 1989, 121, 463.
6 *The Sugar Situation*, 1989, (462), 3.

Product news

New cane mill drive commissioned

AG Kühnle, Kopp & Kausch (KKK) have achieved another first with the installation of two geared steam turbines to drive a sugar cane mill via epicyclic gearboxes in a sugar factory in Barbados.



For more than 30 years KKK has been a supplier to the sugar industry and during the past ten years alone more than 250 KKK steam turbines have been delivered to the cane sugar industry world-wide. These turbines are used to drive generators, mills, shredders, cane knives, boiler feed pumps and blowers.

The Barbados installation, commissioned in February 1989, is a pair of steam turbines, type CF 5 Gs, rated at 740 kW. The boiler plant supplies live steam at a gauge pressure of 15 bar and a temperature of 260°C. The exhaust steam has a gauge pressure of 1 bar and is required as process steam for pan boiling. The turbine output speed is variable from a maximum of 1800 rpm, while the cane mill itself runs at a maximum of 6 rpm. The three-stage epicyclic gears provide the necessary reduction ratio.

The particular advantages of such a drive configuration for cane mills are:

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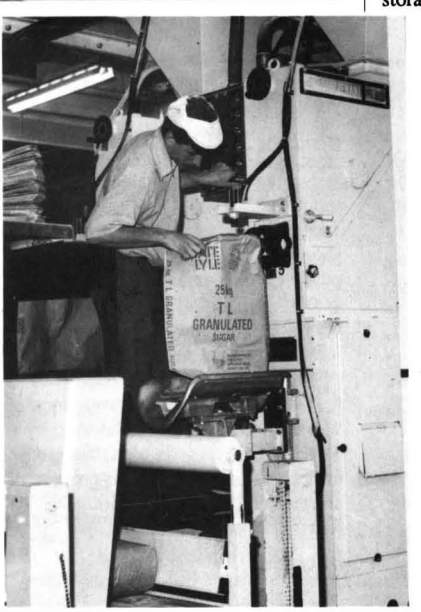

Further details:

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Economics of using a biocide at a milling tandem

By Kenneth M. Onna and Wayne K. Hashimoto
(Sugar Technology Department, Experiment Station, Hawaiian Sugar Planter's Association, P.O. Box 1057, Aiea, Hawaii 96701, U.S.A.)

Introduction

Biocides for controlling micro-organisms in sugar cane juice have long been available; and tests have been conducted at Hawaiian factories where copper sulphate, chlorine, Clorox, Steri-Chlor 4X, and Busan 881 were applied at the milling tandem. However, data obtained from these tests were generally not conclusive. More recently, renewed interest developed in using biocides in the tandem, but data to determine the economics seemed to be lacking. A process-scale test was therefore conducted in 1988 at the McBryde Sugar Company factory on the island of Kauai to obtain the data and to evaluate the economics of using a biocide.

Procedure

Biocide

The permissible combination of organic agents or single agents and the dosages which may be used for controlling micro-organisms in the cane sugar factories in the United States have been listed by the U.S. Food and Drug Administration[1]. The particular biocide tested was Midland Laboratories' PCS 6001 which contains 15% each of sodium dimethyldithiocarbamate and disodium ethylenebisdithiocarbamate and 70% inert material. (Mazer Chemicals' Mazide BC-800 and Vining Chemical Company's AMA-30 are comparable biocides.) The total biocide dosage was 17.8 ppm on prepared cane weight: 6.2 ppm was added to knifed cane and 11.6 ppm to last mill juice.

Comparison of control and test conditions

The factory started up weekly grinding operations on Sunday afternoons. However, weekly testing was not initiated until Monday mornings to reduce the possible effects of varying amounts of carry-over cane (cane burned before the weekly factory shutdown and processed after start-up) on the test results. Weekly testings were concluded at the end of the third work shift on Fridays.

K. M. Onna

W. K. Hashimoto

The use of biocides was started or stopped each day at the beginning of the first of three work shifts per day. Routine factory laboratory figures obtained during the second and third shifts were used to determine the daily averages. The daily averages were then used to compare the effects of control (no biocide used) and test (biocide used) conditions on the apparent purities (pol % on refractometer solids) of the first expressed juice, mixed juice, combined filtrate, clarified juice, and syrup. The comparison was made over a four-week period.

The first, third, and fourth weeks each consisted of three test days (Monday, Wednesday, and Friday) and two control days (Tuesday and Thursday). The second week consisted of two test days (Tuesday and Thursday) and three control days (Monday, Wednesday, and Friday). The test pattern yielded 9 control data points and 11 test data points.

Results

The raw data obtained during the test period are shown in Table I. Two additional control data points (not shown) were generated by a standard procedure to form pairs with data for June 10 and 17, 1989. The additional points added nothing in the way of information; they merely completed the symmetry of the data. In this method, data obtained each Friday were paired with those obtained the following Monday. Paired t-tests were then used to evaluate the differences between control and test purities obtained during the four-week period (Table II).

Discussion

A number of methods have been described for evaluating the effects of a biocide added at the milling tandem[2]. These methods are based on the analysis of mill juices – the upstream effect of the biocide. However, if the biocide also exerts a downstream effect, e.g. in the clarifier mud-handling system, the total effect would be reflected more in clarified juice or syrup than in mill juice. Variations in clarified juice characteristics tend to be integrated in syrup; hence, syrup is to be preferred for sampling and analysis. This is especially so when pan boiling material is not being recirculated into syrup before being sampled for analysis, as is the case at the McBryde factory. The use of apparent purity data routinely obtained by the factory analysts should then be sufficient to evaluate the effectiveness of the biocide being tested.

In some of the previous tests, changes in characteristics from first expressed juice to mixed juice were used to measure biocide effectiveness; and variations in cane characteristics were not considered to be very significant. In these tests the control or test conditions were maintained for one week or more; therefore, the number of test cycles tended to be low.

In the current test, variations in cane characteristics were considered to be potentially significant. The one-day juxtaposition of control and test conditions reduced the variations and, at the same time, enabled an adequate number of cycles to be conducted during the four-week period.

The downstream effect of the biocide in the McBryde clarifier mud-handling system may be deduced from the higher purity of the combined filtrate that resulted when the biocide was used – 87.45 *vs.* 86.20 in Table II.

The paired t-tests (Table II) showed that the biocide treatment increased syrup purity by 0.72 point; the confidence level was very high, 94%.

* Published as Paper No. 689 in the journal series of the Experiment Station, Hawaiian Sugar Planters' Association.

1 Code of Federal Regulations, Title 21, Section 173.320, revised April 1, 1988.
2 Upadhiaya: *Sugar J.*, 1987, **50**, (2), 8 - 11.

Table I. Apparent juice and syrup purities in McBryde biocide test

Test week	Date	First expressed juice Apparent purity Control (no biocide)	First expressed juice Apparent purity Test (biocide)	Filtrate Apparent purity Control (no biocide)	Filtrate Apparent purity Test (biocide)	Mixed juice Apparent purity Control (no biocide)	Mixed juice Apparent purity Test (biocide)	Clarified juice Apparent purity Control (no biocide)	Clarified juice Apparent purity Test (biocide)	Syrup Apparent purity Control (no biocide)	Syrup Apparent purity Test (biocide)
1	May 16, 1988	–	89.80	–	88.63	–	88.47	–	90.53	–	88.51
	May 17,1988	89.65	–	86.55	–	86.92	–	88.73	–	86.64	–
	May 18, 1988	–	90.11	–	84.84	–	86.41	–	88.11	–	86.68
	May 19, 1988	87.51	–	85.06	–	85.17	–	88.20	–	84.85	–
	May 20, 1988	–	88.71	–	85.23	–	85.92	–	87.40	–	85.36
2	May 23, 1988	89.30	–	86.16	–	87.10	–	89.18	–	86.19	–
	May 24, 1988	–	90.74	–	85.07	–	87.17	–	86.85	–	86.42
	May 25, 1988	89.39	–	85.10	–	87.15	–	87.46	–	86.95	–
	May 26, 1988	–	91.63	–	89.11	–	89.63	–	91.01	–	89.53
	May 27, 1988	90.44	–	86.55	–	88.04	–	88.14	–	88.68	–
3	June 6, 1988	–	90.69	–	88.73	–	88.73	–	89.72	–	89.46
	June 7, 1988	90.80	–	86.93	–	88.50	–	89.31	–	87.95	–
	June 8, 1988	–	90.19	–	86.89	–	88.06	–	89.55	–	89.08
	June 9, 1988	91.15	–	88.62	–	88.19	–	90.46	–	88.45	–
	June 10, 1988	–	90.27	–	89.28	–	86.62	–	91.26	–	88.27
4	June 13, 1988	–	91.28	–	88.48	–	88.12	–	89.31	–	88.18
	June 14, 1988	92.01	–	87.08	–	87.89	–	88.81	–	88.99	–
	June 15, 1988	–	91.68	–	89.82	–	88.46	–	89.04	–	88.98
	June 16, 1988	91.20	–	83.78	–	89.19	–	88.33	–	87.66	–
	June 17, 1988	–	90.91	–	85.82	–	88.73	–	89.19	–	88.57

Table II. Paired t-tests for McBryde date

	Apparent purity Test	Apparent purity Control	Test – control	Confidence level, %
First expressed juice	90.55	90.16	0.39	68
Mixed juice	87.85	87.57	0.28	59
Combined filtrate (High and low vacuum)	87.45	86.20	1.25	88
Clarified juice	89.27	88.74	0.53	76
Syrup	88.09	87.37	0.72	94

The increase in combined filtrate purity was also high, 1.25 points at the 88% confidence level. The increase in clarified juice purity was smaller (0.53 point, 76% confidence level); and the increase for first expressed juice purity (0.39 point, 68% confidence level) and mixed juice purity (0.28 point, 59% confidence level) were not considered to be significant. The pattern of purity increases indicates that the biocide tested exerted both an upstream effect at the milling tandem and a downstream effect, particularly in the clarifier mud-handling system. The total effect of the biocide was then more properly reflected by the change in syrup purity than by the change in mixed juice purity.

The higher syrup purity obtained when PCS 6001 was used would not likely be negated even if the solids content of juice was reduced by the micro-organisms. For example, over a short period, reducing sugars in juice may be destroyed faster than sucrose under control conditions. The faster destruction of reducing sugars would increase apparent purity. Since apparent purity of syrup was higher under test conditions than under control conditions, the incremental purity represents a measurable minimum.

Based on the 0.72-point purity rise in syrup, 0.82% more sugar would be recovered; this is equivalent to a net savings of US$1.88 per ton 96 DA sugar now being produced (Table III).

Conclusions and recommendations

1. Biocides applied at the milling tandem may exert both upstream and a downstream effect. Therefore, the total effect would be more properly reflected by a change in syrup purity than by a change in mill juice purity. This would more likely occur when pan-boiling material is not recycled into juice or syrup.

2. Based on the increase in syrup purity, the use of a biocide containing 15% each of sodium dimethyldithiocarbamate and disodium ethylenebisdithiocarbamate at the McBryde milling tandem is economically feasible and, therefore, recommended.

3. Use of the biocide at 17.8 ppm on prepared cane weight increased syrup purity by a minimum of 0.72 point, which is equivalent to 0.82% additional sugar recovered.

4. Based on the 0.72-point higher purity of syrup, use of the biocide provides an estimated saving of US$1.88 per ton 96 DA sugar now being produced. The estimated annual savings to McBryde is US$111,000.

5. Payback will occur quickly since the capital cost of using the biocide is negligible and there is no added labour cost.

6. Since cane deterioration and sanitation practice vary, process-scale

Table III. Example of income from added sugar recovered with biocide treatment (Syrup purity increase = 0.72 point)

Input data	Abbreviation	Control (no biocide)	Test (biocide)
Short tons pol in syrup per year	TPOL	60,352.00	60,849.00
Purity, raw sugar	S	99.37	99.37
Purity, syrup	J	87.37	88.09
Purity, final molasses (deleaded pol)	M	35.34	36.95
Pol, raw sugar	SPOL	99.20	99.20
96 DA sugar factor	96DAFACT	1.0560	1.0560
Return/ton 96 DA sugar, $	$S	333.00	333.00
Return/ton 85 solids molasses, $	$M	43.00	43.00
Tons prepared cane per year	TPC	636,630.00	636,630.00
PCS 6001 biocide dosage, ppm	PPM	0.00	17.80
Costs/lb biocide, $	$LB	–	1.24

Calculations		Control (no biocide)	Test (biocide)
1. S-J-M recovery = 100 × S × (J – M)/J × (S – M)	=	92.42%	92.42%
2. Tons pol recovered = TPOL × (S-J-M recovery)	=	55,777	56,237
3. Tons raw sugar = 100 × (Tons pol recovered)/SPOL	=	56,227	56,690
4. Tonnes 96 DA sugar = 96DAFACT × (Tons raw sugar)	=	59,375	59,865
5. Value of 96 DA sugar = (Tons 96 DA sugar) × $S	=	$19,772,037	$19,934,969
6. Tonnes pol in molasses = TPOL – tonnes pol recovered	=	4,575	4,612
7. Tons 85% Ref Sol Mol = 10,000 × (Mol tons pol)/(85 × Mol purity)	=	15,230	14,686
8. Value of molasses = (Tons 85% Ref Sol Mol) × $M	=	$654,902	$631,483
9. Total value = Value of 96 DA sugar + value of molasses	=	$20,426,940	$20,566,452
10. Cost of biocide per year = 0.002 × (tons prepared cane) × PPM × $LB	=	$0	$28,103
11. Net value = Total value – cost of biocide per year	=	$20,426,940	$20,538,349
12. Savings = Net value (test) – Net value (control)	=	–	$111,409
13. Savings per tonne 96DA sugar	=	–	$1.88

tests of the biocide added to knifed cane and last mill juice should be conducted at specific factories to evaluate the economics of the treatment.

Acknowledgement

The cooperation of McBryde Sugar Company factory personnel – Chester M. Shishido, Leonard C Britton, and Clyde T. Yoshimori – is gratefully acknowledged.

Summary

A process-scale test to evaluate the economics of using a biocide containing sodium dimethyldithiocarbamate and disodium ethylenebisdithiocarbamate to treat mill juices was conducted at the McBryde Sugar Company factory on Kauai, Hawaii. Use of the biocide would result in a savings of about US$1.88 per short ton 96 DA sugar or, based on the amount of sugar now being produced at McBryde, about US$111,000 per year.

La economía del uso de un biocida en un tándem de molienda

En la fábrica McBryde Sugar Company de Kauai, en Hawaii, se ha llevado a cabo un test a escala de procesos para evaluar la economía del uso de un biocida que contiene dimetilditiocarbamato sódico y etilenbisditiocarbamato disódico para tratar los jugos del trapiche. El uso del biocida resultaría en ahorros cercanos a 1.88 U.S.A. dólares por tonelada corta de azúcar 96 DA o, basados en la cantidad de azúcar que está siendo producida ahora en McBryde, alrededor de 111,000 U.S.A. dólares por año.

Les economiques de l'utilisation d'un biocide dans un tandem de moulins

Dans un sucrerie de la McBryde Sugar Company à Kauai à Hawaii, on a effectué un essai industriel pour évaluer l'intérêt économique de l'utilisation dans le jus des moulins du dicarbamate de sodium et de l'ethylènebisdithiocarbamate bisodique. L'utilisation du biocide conduirait à une économie de US$1.88 par tonne courte de sucre 96 DA. En se basant sur la quantité de sucre actuellement produite à McBryde, cela signifie une économie d'environ US$111,000 par an.

Washing sugar out of cane

A proposed new hydrodynamic extraction process

By Maxime P. Rivière

Introduction

Extraction of juice from sugar cane has long been a mere solid/liquid separation process. The rate of juice extraction achieved by dry crushing in roller mills has gradually improved as it evolved from the animal-driven wooden mills to modern steam-driven cast iron mills, but dry crushing can only extract 60 - 70% of the juice.

A great improvement was achieved by the introduction of the imbibition process. The remaining 40 - 30% of juice is removed in a solid/liquid countercurrent extraction process, using water as the diluting liquid.

Milling and diffusion as countercurrent multistage extraction processes

As we shall see later, the dilution required to achieve 95 - 98% extraction is too high to be done in a single operation and, consequently, imbibition has to be a multistage countercurrent process. The number of stages to be used depends mainly on dilution efficiency and on the solid/liquid separation efficiency.

Dilution efficiency (or stage efficiency) is best assessed by the Murphree criterion:

Stage efficiency = Achieved drop in Brix through the stage/Achievable drop in Brix through the stage.

Whether the drop in Brix is achieved by lixiviation, by displacement or by diffusion is immaterial.

For the same stage efficiency a mill tandem will achieve a given pol extraction with fewer stages (3 to 6) than a diffuser (12 to 18). This is because a mill has a higher separation efficiency (70%) than a diffuser (30%). For a given separation efficiency, the number of stages needed to achieve a given pol extraction will vary widely with the stage efficiency.

If the stage efficiency is 100%, the number of stages theoretically needed to achieve 98% pol extraction (as can be shown using the Ponchon Savarit diagram) is 1 to 2 in milling and 5 - 7 in diffusion, depending on the rate of imbibition.

In practice, the number of stages is 2 to 4 times higher, which gives an idea of the stage efficiency that prevails.

Stage efficiency is the theoretical number of stages required, divided by the actual number of stages used and, throughout our industry is usually between 20% and 50%, which is really nothing to be proud of!

Basically, this is because, both in milling and diffusion, when we mix the solid with the liquid phase, we end up with a solid and not a fluid mixture. This is clear from the name "imbibition" (from the Latin "bibere", to drink), which can only describe the absorption of a liquid by a solid. What we should be striving for is dilution.

Dilution refers to the homogeneous mixture of two liquids; in our case the extractable juice in cane or bagasse and the "imbibition juice" or, ultimately, water. In order to achieve this mixture we must first make the extractable juice accessible. This is usually done with heavy duty preparation devices such as shredders, where up to 92% of the juice is made accessible for mixing by rupturing the juice-containing cells. An additional 4 to 6% cell opening occurs in

Paper presented to the 20th Congr. ISSCT, 1989.

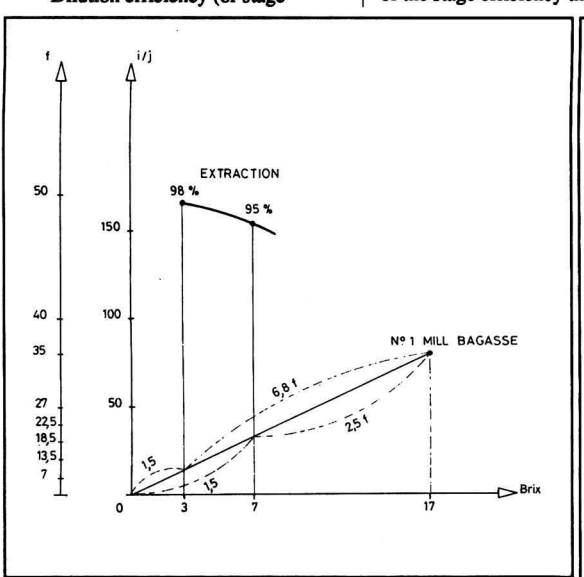

Fig.1A. Milling: imbibition rate needed to dilute extractable juice in No. 1 mill bagasse *in one stage* to achieve 95% or 98% extraction after dewatering

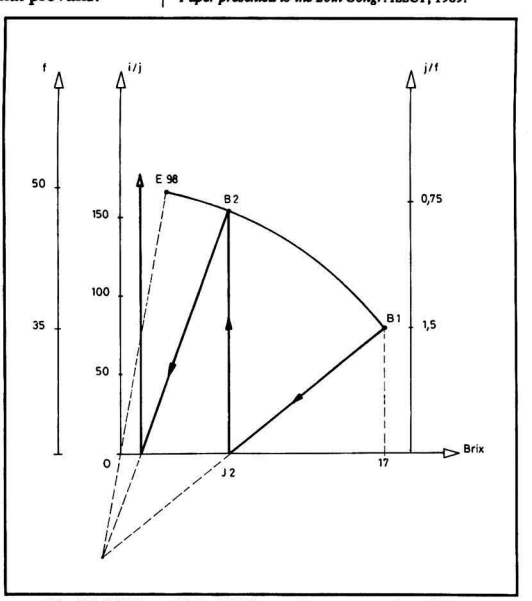

Fig. 1B. Milling with imbibition on bagasse: number of stages needed to achieve 98% extraction

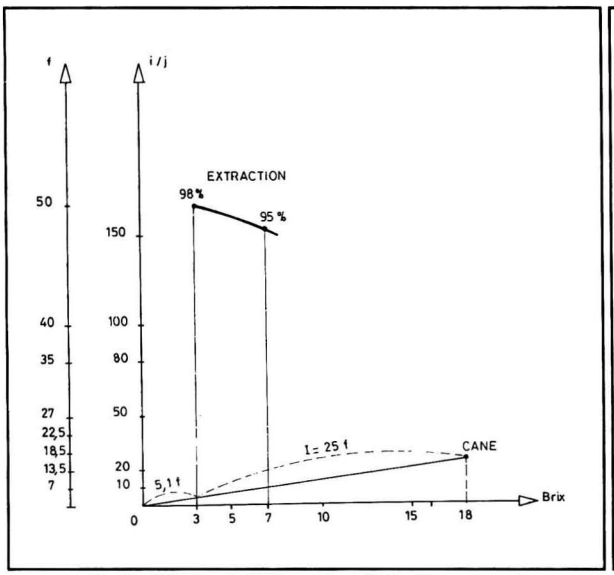

Fig. 2A. Diffusion: imbibition rate needed to dilute extractable juice in cane *in one stage* to achieve 95% or 98% extraction

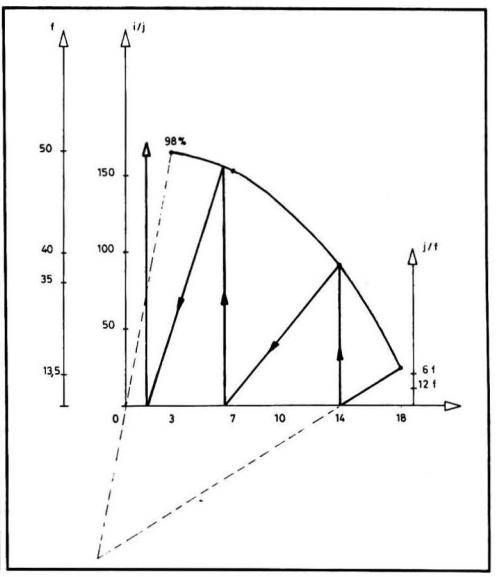

Fig. 2B. Milling with imbibition on cane: number of stages needed to achieve 98% extraction

milling by the churning effect of the grooved mill rollers. In diffusion, scalding helps to make the juice accessible by softening the cell walls, thus rendering them permeable.

However, in bagasse emerging from a high pressure mill, even if 100% of the cells were opened, the extractable juice would not be readily accessible to an imbibition liquid. This is because the bagasse particles, after being subjected to extreme pressure, act like small air-containing sponges. Since the work of Khainovsky in Java in the 1930's, we know that it is the presence of air inside the bagasse particles that hinders the penetration of the diluting liquid.

In order to obviate the air problem we can either:

(a) prevent the air from entering the bagasse particle as it is discharged by the mill, or

(b) remove the air.

The first alternative is the basic idea of the "Integral imbibition system"[1]. The idea was very sound indeed, but difficult to put into practice.

The second would involve conducting the imbibition under vacuum[2].

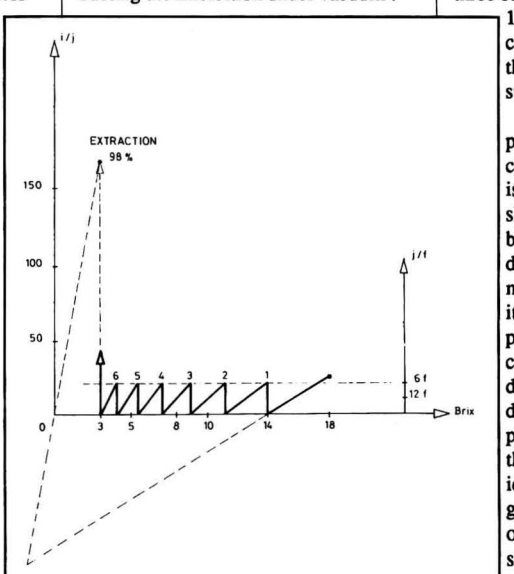

Fig. 2C. Diffusion: number of stages needed to achieve 98% extraction

This was done on an industrial scale at Quartier Français factory in Réunion for three consecutive years in the mid-1970's. Stage efficiency was increased from 35% to 95%. Again, the idea proved sound but it was still difficult to realise in practice.

Wise from the above two experiences, we have come to the conclusion that the easy solution is to apply the imbibition to the shredded cane and not to the bagasse. In other words, we must dilute the extractable juice as much as possible before squeezing it out of the fibre, using high pressure. Basically this is what cane diffusion does, but cane diffusion still suffers from two defects: (i) it is a hydrostatic process without agitation, and (ii) the solid/liquid separation efficiency is very low as it depends on gravity alone to achieve separation of the liquid phase from the bed of solid cane.

1 Hugot: *Proc. 17th Congr. ISSCT*, 1980, 2231 - 2235.
2 FCB - Maxime Rivière patent.

TWO NEW QUALITY INSTRUMENTS

SUMA PRODUCTS

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Our new **Saturascope** is designed for easy visual determination of the saturation temperature of a massecuite. The sample cup and resistance bulb are in close proximity in the heated block which is of solid copper. This arrangement allows measurement of the temperature in the sample cup to within ±0.1°C.

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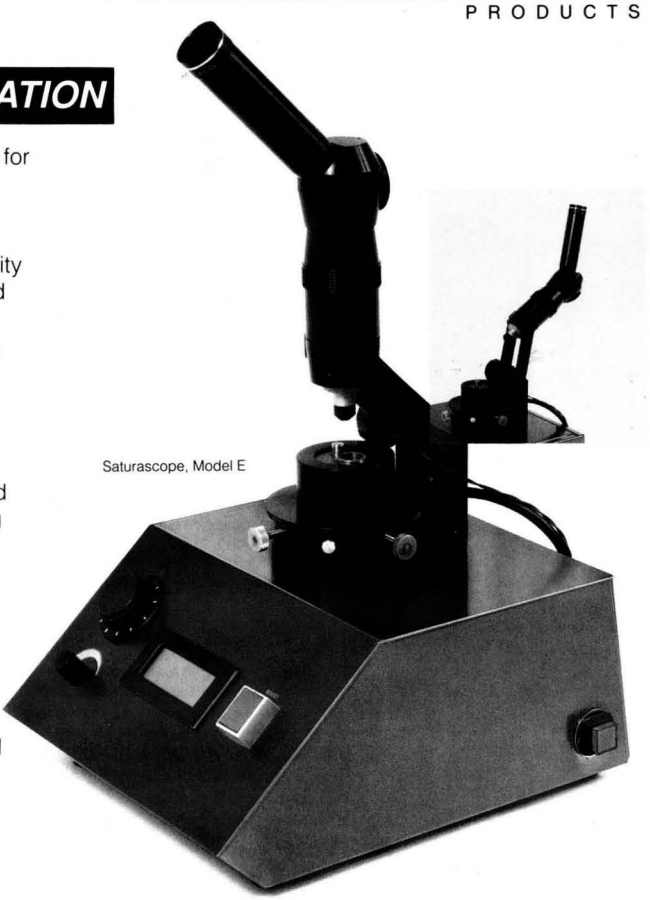

Saturascope, Model E

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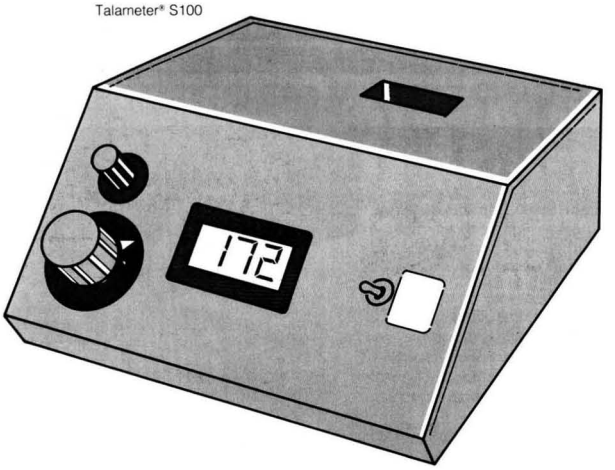

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The 500 gram sample size **Deerr Type Bagasse Digester** is fabricated entirely in stainless steel, and is designed for operation by a 220V, single-phase electric immersion heating system.

The outer vessel is lagged to prevent heat losses. The spiral conductor tube, surrounded by a water jacket with cooling water inlet and outlet, is permanently connected to the digester body top cover which in turn is fitted to the body by means of thumb screws and rubber gasket.

The inner perforated container is supplied with a lid to prevent the escape of bagasse particles during extraction. A handle for removing the inner basket is provided.

For the rapid and accurate determination of moisture in Bagasse (or suitably prepared Cane samples). Equal in accuracy to the oven drying method.

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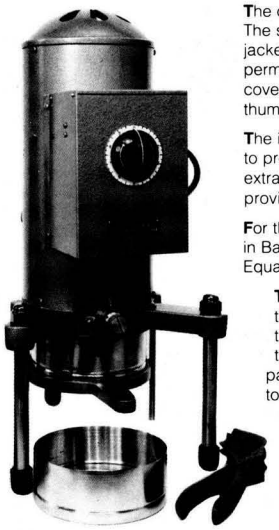
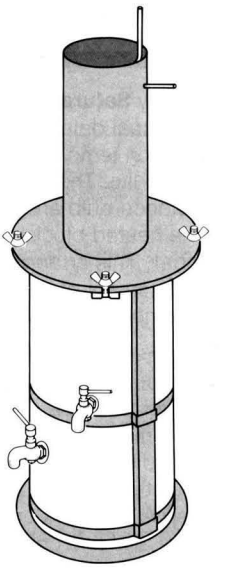
It has an automatic time switch from 0 - 60 minutes and a temperature range of 90 - 170°C.



Moisture Teller



Deerr Type Bagasse Digester

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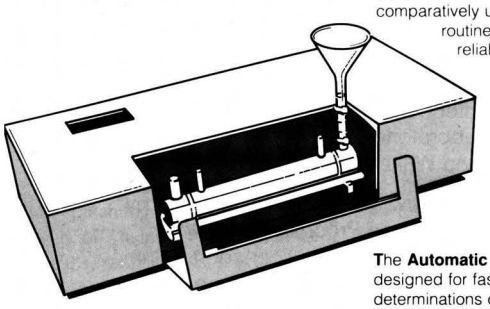
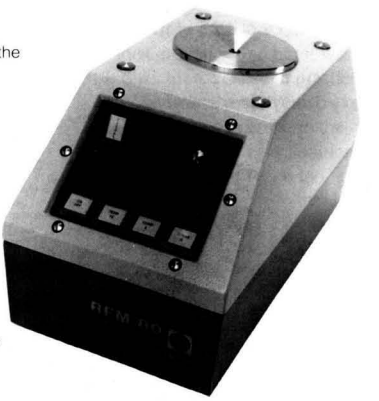


Automatic Digital Polarimeter



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ISJ Abstracts

Cane sugar manufacture

Modifications to and experiences with RapiDorr clarifiers including saccharate liming at Amatikulu

R. P. Scott. *S. African Sugar J.*, 1989, 73, 50 - 53.

See *I.S.J.*, 1989, **91**, 68A.

Improve your juice clarification with a manometer

M. Bharadwaj. *Bharatiya Sugar*, 1989, 14, (5), 45, 47, 49.

Problems that may occur in the sulphur burner and sulphitation vessel as a result of inadequate air feed from the compressor are discussed. The need for regular cleaning of the air filter on the suction side of the compressor is stressed and the value of a manometer to indicate the state of the filter indicated. Advice is given on air filter cleaning.

Vapour line juice heater (patent applied for)

B. Mittal. *Bharatiya Sugar*, 1989, **14**, (5), 59 - 60.

A design for a vertical vapour line juice heater is described in which the vapour enters at the top and is discharged at the bottom and in which the heat transfer coefficient is claimed to be double that in a conventional vapour line heater, thus giving a hotter juice and saving 1.6% steam on cane.

Modelling flow in a continuous vacuum pan with the Langreney pan as example

J. M. Perrin. *Ind. Alim. Agric.*, 1989, 106, 23 - 30 *(French)*.

LiCl was used as tracer to determine residence time in a Langreney continuous pan used for *B*-massecuite boiling at Bois Rouge factory in Mauritius. Comparison of the results with the classical model based on a cascade of theoretical perfectly mixed vessels showed that the model did not describe the conditions in a complex system such as a vacuum pan with more than one feed inlet. A model was then developed to represent more closely the actual boiling conditions with a feed representing one-third of the discharged massecuite and syrup additions at regular intervals throughout the strike. By contrast with the classical model, which showed that flow dispersion falls with increase in the number of theoretical vessels, it was found that flow deteriorated as the number of vessels rose and became even worse when the ratio of footing to discharged massecuite fell. It is concluded that the only valid method of determining residence time dispersion resulting from the pan geometry would be one in which the amount of footing equalled that of the discharged massecuite. Boiling on a reduced amount of footing could cause a marked variation in crystal size and should be examined more closely.

The effect of some operational factors on colour transfer during pan boiling

G. R. E. Lionnet. *Sugar J.*, 1989, **51**, (8), 4 - 6.

See *I.S.J.*, 1989, **91**, 68A.

Continuous sampling and analysis of clear juice, filtrate return and syrup at Darnall

A. Dunsmore and P. Mellet. *Sugar J.*, 1989, **51**, (8), 11 - 12.

See *I.S.J.*, 1989, **91**, 68A.

Investigation into the causes of vapour pipe corrosion

K. J. Schäffler, C. M. J. Day-Lewis and G. Montocchio. *Sugar J.*, 1989, **51**, (9), 11 - 14.

See *I.S.J.*, 1989, **91**, 67A.

A computer control system for cane juice sulphitation pH control

Y. C. Hsiao, C. H. Chen, H. M. Chen and M. D. Huang. *Rpt. Taiwan Sugar Research Inst.*, 1988, (119), 7 - 16 *(Chinese)*.

A considerable time delay in the supply of SO_2 gas by a jet burner system prevents adequate pH control by a simple feedback system in sulphitation, and pH has fluctuated by ±1 in past years. To overcome this, a computer-based feed-forward control system was developed which uses the leading flow signal as the major ratio factor and the current sulphitation pH signal as the minor compensation factor to preset the temperature at which the sulphur burner operates. In tests at Suantou sugar factory in 1987/88 the fluctuation in sulphitation pH was reduced to ±0.5.

Effect of stale cane on clarification

S. Y. Jadhav and M. B. Londhe. *Indian Sugar*, 1989, **38**, 801 - 807.

Investigations of post-harvest deterioration of cane stored for up to 120 hours showed an increase in juice Brix and a decrease in cane weight and juice purity with storage time, while laboratory clarification studies showed an increase in mud volume, reducing sugars content and lime requirements and a fall in settling rate.

Energy conservation through automatic control in the cane sugar industry - a case study

M. R. Cesca and H. R. Demo. *Sugar J.*, 1989, **51**, (9), 4 - 8, (10), 11 - 12.

A static and a dynamic mathematical model were developed for simulation of an automatic single-loop control system proposed for steam generation and distribution in a sugar factory. With La Providencia factory in Argentina as example, the static model was used to calculate potential energy savings as a function of the imbibition ratio, the fuel:air ratio in the boilers, evaporator syrup Brix and water evaporation in boiling. The dynamic model, derived from basic and real data, was used to determine important savings associated with non-steady state conditions. Simulation demonstrated the usefulness, feasibility and simplicity of the control strategy and showed how one of the

major disadvantages, namely fluctuations in syrup Brix, could be effectively overcome by partial decoupling techniques, making use of the thin juice tank capacity.

Hydraulic drive powers sugar mill

J. Theriot and G. Delaune. *Sugar y Azúcar*, 1989, **84**, (6), 42, 44.

A turbine-driven hydraulic drive on No.2 mill at the sugar factory of Breaux Bridge Sugar Coop. Inc. in Louisiana is described. Previously the 4-mill tandem had been driven by two Corliss engines, one for No.1 mill and the other for the other three mills. The components of the new system include a main pump driven by the 400-hp turbine through a speed reduction gear, a charge system that maintains oil supply to the pump and three Hydrex motors driving an enclosed gear connected directly to the top roller, adequate power being provided even if one of the motors fails. The speed of the mill (0 - 9 rpm) is determined by the flow of oil from the pump which is varied by a potentiometer while the turbine runs at a fixed speed. In its first season, the drive permitted an average daily crush of 3438 tons of cane, an increase of 270 tons/day over the previous year. Advantages of the hydraulic drive are listed.

Louisiana cane mill solves tramp iron problem

R. A. Germinsky. *Sugar y Azúcar*, 1989, **84**, (6), 45 - 46.

Problems created by increasing quantities of tramp iron in the cane supply were solved at the factory of Caldwell Sugars Coop Inc. at Thibodaux, Louisiana, by replacing an electromagnet at the base of the chute immediately before the mill tandem by a larger Eriez electromagnet suspended over a short, high-speed conveyor installed after the main cane carrier. Tests showed that the new conveyor should have a belt speed of 140 ft/min to meet the requirements of the 17kW electromagnet; this allowed the depth of the cane mat to be reduced from 14 to 6 inches. Location of the magnet at the end of the conveyor to allow the natural trajectory of the belt to bring the loose, free-falling cane into contact with the surface of the magnet allows removal of up to 99% of the tramp iron.

Evaluation of polyacrylamide for the sugar industry

C. S. Ting and Y. C. Hsiao. *Rpt. Taiwan Sugar Research Inst.*, 1989, (120), 21 - 27.

Tests are reported on clarification of limed juice in raw sugar manufacture and (in plantation white sugar manufacture) of sulphitation juice as well as flotation clarification of phosphatation syrup. The optimum DH (degree of hydrolysis) was 45 - 50% for limed juice, 30 - 35% for sulphitation juice and 30% for syrup. While limed juice settling rates were highly sensitive to polyacrylamide dosage rate in the range 1 - 5 ppm, juice clarity was relatively unaffected; with sulphitation juice, settling rate was little affected by >4 ppm flocculant but clarity was more sensitive to dosage rate than limed juice. For syrup treatment, the dosage rate depended on Brix and DH: at 30% DH, a satisfactorily short flotation time was obtained with 4 ppm at 55° and 60°Bx, whereas at 45% DH even doubling this amount failed to induce flotation of the scum.

Some measurements of the effect of tops and trash on cane quality

P. C. Ivin and C. D. Doyle. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 1 - 7.

Investigations showed higher concentrations of colour, ash and reducing sugars in cane tops than in clean cane, although the tops contained more sucrose and had a higher juice purity than expected. While inclusion of tops and particularly trash adversely affected juice colour, cane variety had by far the greatest influence; the colour content of clarified juice from Q 96 cane was up to 300% of that from any other variety as against a 25% increase caused by inclusion of 6% trash. Calculations based on the analytical data suggested that there would be negligible losses of pol in milling if harvested tops were included and that the main effect would be an increase in molasses quantity. However, further comparative measurements should be carried out over an entire season to confirm the data from the tests.

Continuous seven day crushing - Fiji experience

H. Singh and N. J. Patel. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 16 - 20.

Comparison of continuous 7-day crushing with scheduled stoppages only for cleaning and maintenance (as used in Fiji for about 30 years) with non-continuous operation showed that 5-day operation with a 2-day weekend stoppage and scheduled stoppages for cleaning and maintenance would extend the season by 13 weeks with a consequential loss in seasonal c.c.s. of 0.88 units and a 11.7% increase in molasses yield, while 6-day operation without any stoppages for cleaning and maintenance would increase the season by 6 weeks, cause a c.c.s. loss of 0.53 units and increase molasses yield by 5.5%; the reduction in c.c.s. would result from the need to start crushing earlier (and hence the processing of immature cane), since extending the season beyond mid-December would involve excessive burning and harvesting delays as a result of wet weather. It is calculated that countries practising weekend stoppages could increase factory capacity by 15 - 27% by adopting continuous crushing without any capital expenditure and save fuel, a factor of importance in Fiji where the cane fibre content is low (10 - 14%). Other benefits of continuous crushing are also indicated.

An alternative method for assessing cane preparation

J. G. Loughran and C. R. Murry. *Proc.*

11th Conf. Australian Soc. Sugar Cane Tech., 1989, 116 - 123.

Measures of cane comminution used in the sugar industry are considered of limited value in predicting the performance of preparation equipment because of their failure to allow for variation in cane fibre content. An experimental shredder operating at nominally constant values of cane rate, rotary speed and tip clearance was used in 171 duplicate bulk density tests on 10 cane varieties to show that the response of compression ratio C_0 to f (fibre % cane) was roughly reciprocal, so that $1/C_0$ is approximately linear and there is a family of parallel straight lines that can be used to characterize the response of $1/C_0$ to f for different cane treatments. A "treatment number" â was defined as the level of preparation having a value that depends on the treatment and is apparently higher for cane receiving poorer treatment; statistical analysis of the experimental data yielded $\hat{a} = 1/C_0 - 0.063f$. A study of 10 cane varieties covering a fibre content range of 9.5 - 18.0% showed no intrinsic varietal effect on the response of $1/C_0$ to f and all varieties except one (for which only a few data points were available) exhibited a significant linear relationship. Poor correlation was found between â and pol in open cells (POC); however, it has been found that POC is not a good measure of mechanical treatment. The major application of the treatment number, which can be easily determined by experiment using a small hydraulic press with suitable instrumentation, is in empirical prediction models of the extraction and mechanical efficiency of No.1 mills; a value of 0.4 corresponds to very finely prepared cane as obtained in a Waddell hammer mill, 0.6 represents an average treatment by heavy-duty shredders while 1.1 would be the value for very coarsely prepared cane.

Evaluation of a proprietary instrument for the on-line determination of bagasse moisture

C. A. Garson and B. G. Noble. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 124 - 127.

An instrument manufactured by Mineral Control Instrumentation Ltd. under licence to the CSIRO was installed beneath the bagasse delivery belt from the final mill at Racecourse factory for continuous bagasse moisture measurement testing. It comprised a junction box, an electronic control cabinet and two sensors mounted under the conveyor belt, namely a capacitance sensor responsive to the bagasse moisture content and a density sensor (containing a very small caesium reference source and a ^{133}Ba measuring source) which was used to compensate for variations in bulk density and in bagasse blanket depth; the capacitance and back-scatter radiation from the radio-barium were recorded each as two numerical parameters and combined mathematically to yield a value of moisture content every 10 sec. The test procedure used is described. Comparison of measurements of 40 composited samples taken irregularly over a 60-day period with oven drying results gave a significant correlation (r = 0.91) with a standard deviation of ±1.18% moisture; the correlation coefficient fell to 0.87 without the density sensor and the standard deviation was then ±1.33%. Uneven loading of the belt had no adverse effect on instrument performance.

An agitated drum extractor for studying cane diffusion rates: preliminary study using simulated cane

L. J. Qin, T. Picaro and E. T. White. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 128 - 132.

Prepared cane in a diffuser is usually in the form of a loosely packed, fixed bed through which the extracting liquid percolates. Contact between the particles of cane reduces the rate of sugar extraction by hampering fluid flow and allowing pools of 'stagnant' juice to form. The magnitude of the interference caused by neighbouring particles can be determined by comparing the actual extraction rate with an ultimate rate obtained where the cane particles are freely and separately suspended in the extracting liquid and there is thus no significant interference. A rotary drum extractor is described which was used to determine such ultimate rates. Four large counter-spiralled wall baffles prevent conglomeration of the cane particles and, by causing them to surge backwards and forwards with rotation of the drum, create an excellent suspension provided the amount of cane treated is no more than typically about 2% by weight of dry fibre. The extraction rate is determined by on-line measurement of Brix of the extraction liquid. Experiments were conducted with weighed quantities of cane and liquid (water or juice) preheated to a given temperature and fed into the drum; diffusion was continued until a steady final Brix was achieved (after several hours). Sugar may be contained within a cane particle (either freely distributed within the juice between the fibrous structure or enclosed within cell membranes), may be in a film of liquid adhering to the outside of the particle or (in the case of wet cane or bagasse) may occur in an excess of juice that is greater than that required for the film and internal liquid. The mechanisms involved in extraction are washing (displacement) and diffusion, starting with removal of the excess juice and ending with transfer of the internal sugar. The process is considered as diffusion from a film or particle in which concentration gradients exist rather than from well-mixed reservoirs; a complex model has been developed from partial differential equations with the aim of allowing a more accurate representation of diffusion.

Controlling air pollution from bagasse fuel boilers

K. K. Ford. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 133 - 139.

The performances of mechanical dry dust collectors used for bagasse fly ash removal from flue gas in Queensland

sugar factories were investigated after some had failed to meet official emission control requirements. The collectors, consisting of a number of axial-entry cyclonic tubes, have a number of operating problems which, however, can be solved by adding a relatively inexpensive hopper aspiration system; this extracts 10 - 15% of the gas from the collector hopper(s), transfers it to a secondary dust collector and then returns it to the outlet ducting of the first collector. The overall reduction in emission depends on the condition (concentration, specific gravity and particle size) of the gas feed, with the contribution of the collector decreasing and that of the aspiration system increasing with fall in particle size; lowest emission rates have been observed at an aspiration rate of about 10%, but this optimum rate may vary with the design and performance of the mechanical collector.

Boiler tube failure from steam blanketing

G. W. Coleman, G. H. Williams and A. G. Crooks. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 140 - 146.

Major repairs carried out to the boiler at Moreton (after severe damage had been caused by furnace overheating) included installation of 150 replacement tubes. During 1985, rippling was observed on the external fireside of some tubes and corresponding cracking on the internal waterside; water was found in tube sections removed for inspection and it was noted that the tubes had a very slight downward slope towards the front end of the boiler. Examination revealed that the mechanical properties and chemical analysis of the tube material met the specifications, that water quality was satisfactory and that the temperatures were not excessive. However, failure was found to be due to thermal/corrosive fatigue and/or stress corrosion and was a result of high tube restraint and the downward slope of the tubes which allowed steam retention, concentration of dissolved salts and a preferential tensile stress distribution at the waterside. Solutions to the problem included replacing the bottom section of every screen wall tube and sloping the tubes upwards towards the front of the boiler. No deterioration was found in the new tube sections after one season's operation, mostly at a full continuous steam rate of 113 tonnes/hr.

The flocculation of fly ash slurries

F. A. Corica, O. L. Crees, D. J. Hale and E. Whayman. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 147 - 151.

Batch fly ash settling tests with a range of anionic, cationic and non-ionic flocculants at three factories showed that Al^{+++} is the dominant ion controlling flocculation, particularly in the presence of Ca^{++} and Mg^{++}, and that addition of as little as 5 ppm alum will increase the settling properties of high molecular weight anionic polymers at low doses where the Al^{+++} content in the water is inadequate. No flocculation occurred in the presence of Na^{+} alone. The addition of cationic polyelectrolytes was found to have no beneficial effect on settling.

Commissioning trials on the SRI continuous high-grade pan at Maryborough factory

R. Broadfoot, K. F. Miller and L. W. Davies. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 152 - 161.

The performance of the SRI high-grade pan during 6 weeks of trial operation is discussed. The pan, similar in horizontal layout to the low-grade pan at Tully[1], has a massecuite volume of 75 m^3 at a nominal boiling height of 0.4 m above the calandria and consists of two modules (interconnected by a butterfly valve in the downtake) having a common vapour hood with entrainment baffles but with separate calandrias. Each of the total nine cells contains a proof stick and conductivity electrode, and some of the cells are provided with additional short baffles above the calandria to restrict the forward flow of massecuite along the boiling surface. Feed is to the underside of the pan. The major problems during the trials on *A*- and *B*-boiling concerned the conductivity transducers which made feed control of the 9 cells very difficult with formation of fine grain in some cases. Preliminary results showed an almost 40% increase in crystal mean residence time to 5.4 hr with a coefficient of variation of 0.30 (an even narrower residence time distribution being considered possible). Incrustation observed on steel sections in the pan could be prevented by routine use of a spray wash system installed for that purpose in the vapour space. Pressures in the calandrias were below atmospheric under all operating conditions, and there was good circulation even at low steaming rates.

Improving the performance of the 120 m^3 continuous low-grade pan at Farleigh

C. Pozzetti and B. B. Sheedy. *Proc. 11th Conf. Australian Soc. Sugar Cane Tech.*, 1989, 168 - 174.

In trials on the new SRI 7-cell, low-grade pan at Farleigh, a massecuite production rate of 40 tonnes/hr was achieved at an average seed size of 0.09 - 0.10 mm (boiled to an average of 0.30 mm) as against a rated capacity of 34 tonnes/hr. Exhaustion was good, with apparent purity drops across the pan in the range 10.3 - 16.5. Fine grain formation, a major problem, was solved by altering the conductivity profile throughout the pan. Changes in vacuum had dramatic effects on the boiling/feed rate; replacement of steam flow rate control with calandria pressure control proved more suitable for accommodating large fluctuations in vacuum. Incrustation on the baffles was caused by splashing of massecuite; once the layer reached a certain thickness or the pan was cooled, lumps would fall into the massecuite, but were easily removed by screening. The formation of other lumps by sugar caramelization when the massecuite splashed onto hot surfaces was largely prevented by special pipe lagging.

1 Broadfoot *et al.*: *I.S.J.*, 1984, **86**, 35 - 40.

Beet sugar manufacture

Precarbonatation

V. Tibensky and M. Konecna. *Listy Cukr.*, 1989, **105**, 19 - 24 *(Czech)*.

Introduction of simultaneous precarbonatation with forced circulation of the juice followed by liming and 1st and 2nd carbonatation gave a mud of better structure than that resulting from pregassing of predefecation juice, while the amount of mud formed within the first 10 minutes was almost independent of precarbonatation alkalinity in the range 0.060 - 0.090% CaO, the mud was easy to separate and sweeten-off in filtration and the filtration coefficient F_k had values of 4 - 8 when only small amounts of lime were added in precarbonatation. For precarbonatation of predefecation juice to give satisfactory results, the juice must be overcarbonatated; this resulted in improved 1st carbonatation mud filtrability and a marked reduction in thin juice hardness, while recycling overcarbonatated prelimed juice to raw juice increased the effect of precarbonatation by causing further reduction in thin juice hardness and in F_k. Best results were obtained when preliming was conducted at 60°C rather than 85°C, but there was no significant difference in terms of filtration and thin juice hardness and colour between progressive and non-progressive preliming.

Chemical preparations that facilitate sucrose crystallization in the vacuum pans

H. Gruszecka. *Gaz. Cukr.*, 1988, **96**, 180 - 181 *(Polish)*.

The effect of viscosity on crystallization is discussed and the requirements of suitable massecuite additives are listed. Tests with a number of Polish and other preparations added to an artificial massecuite are briefly reported in which viscosity was reduced by a maximum of 45%. During the 1987/88 campaign, preliminary results from the use of three Polish additives showed an approximate 25% decrease in the low-grade boiling time.

A mathematical model of the heat economy of a sugar factory

J. Iciek, G. Rogacki, P. Wawrzyniak, I. Zbicienski and R. Zylla. *Gaz. Cukr.*, 1988, **96**, 181 - 182 *(Polish)*.

Four variants of a mathematical model of the heat system in a sugar factory are outlined and a flow diagram presented. The model and computer programs derived from it simulate the work of the evaporator with the associated system of juice heaters, vacuum pans and diffuser. Tabulated data from a sugar factory demonstrate application of the model.

A falling-film evaporator

J. Marczynski. *Gaz. Cukr.*, 988, **96**, 183 - 184 *(Polish)*.

The advantages of film evaporators over conventional Robert systems are discussed and details given of a falling-film unit of Polish manufacture installed at Klecina sugar factory in 1985. Analysis of its performance showed an average 5.8 unit rise in Brix to 60.9° by comparison with a conventional evaporator effect; the evaporator is easy to maintain and provides a high heat transfer coefficient, although considerable fluctuations in juice flow occurred.

Producing a seed massecuite

J. Grabka. *Gaz. Cukr.*, 1988, **96**, 184 - 185 *(Polish)*.

Details with a flow diagram are given of a patented system developed in Poland for preparation of seed massecuite of 20% crystal content and 89 - 90°Bx by low-temperature crystallization of white sugar melt at reduced pressure with addition of cold water.

Why computer-assisted maintenance? Why Sirlog? Experience at Générale Sucrière

R. Thellier. *Sucr. Franç.*, 1989, **130**, 58 - 60 *(French)*.

Eppeville and Roye sugar factories, owned by Générale Sucrière, have been equipped with a computerized maintenance management system using Sirlog software, and ultimately all factories in the group will have the same system. Reasons for the choice of software, an outline of the system and economic data are presented.

Maintenance management at Compagnie Française de Sucrerie

F. Persyn. *Sucr. Franç.*, 1989, **130**, 61 - 63 *(French)*.

Reasons for installation of the Sirlog maintenance management system in factories operated by the title company, the advantages of the software and future prospects are discussed.

Computer-assisted maintenance management at Béghin-Say sugar factories. A tool integrated into the decentralized information environment of each establishment

-. Verleene and -. Verscheide. *Sucr. Franç.*, 1989, **130**, 64 - 68 *(French)*.

A system based on Corfou software is used for personnel, stock and maintenance management as well as for management and analytical accounting. Details are given of its application with print-out samples.

Application of a radio-isotope method to determine the state of a massecuite

J. Wajs. *Gaz. Cukr.*, 1988, **96**, 196 - 201 *(Polish)*.

The theory of measurement using γ-radiation is expounded and means of increasing sensitivity and reducing measuring error are indicated. Tests on continuous determination of the state of A-massecuite in a vacuum pan were conducted with a mass-produced electronic isotope-absorption Brix meter designed to cover the range 60 - 95°Bx. The meter had automatic temperature compensation but corrections had to be made for changes in purity. The ionization chamber, acting as detector and operating at a permissible temperature limit of

110°C, was installed in a pipe intruding into the massecuite space of the pan at the level of the upper edge of the calandria. Comparison of meter readings with laboratory refractometric values showed a maximum mean arithmetic deviation of ± 0.5°Bx, and the method is considered suitable also for *B*- and *C*-strikes.

Supplement to energy saving by more frequent changing of the knives in centrifugal beet slicers

K. Buck. *Gaz. Cukr.*, 1988, **96**, 201 - 203 *(Polish)*.

Halving the time from 8 to 4 hr before beet slicer knives are reground was found to give a considerable reduction in power consumption by a 16-frame, 1400-mm diameter beet slicer operating at constant speed; it also ensured cossettes of consistently high quality. However, adoption of this approach necessitates doubling the number of sharp knives available, so that the decision should be left to the individual factory. (See also Buck: *I.S.J.*, 1988, **90**, 64A.)

Results from start-up of the effluent treatment plant at Wroclaw sugar factory

K. Kaminski. *Gaz. Cukr.*, 1988, **96**, 203 - 204 *(Polish)*.

The performance of the UASB (Upflow Anaerobic Sludge Blanket) system at Wroclaw is discussed. At a throughput of 96.7 - 103.1 m^3/hr, BOD_5 was reduced by 99.5 - 99.9%, energy consumption was 2 kWh/m^3, the fermentation time was 12.4 - 13.2 hr and the subsequent activated sludge process lasted 30.7 - 32.7 hr. The maximum amount of effluent that can be treated is 129% on beet, entailing the possible use of closed-circuit recycling.

Neutralizing sugar factory waste water together with domestic sewage from towns and housing estates

T. Wolski and B. Polec. *Gaz. Cukr.*, 1988, **96**, 211 - 217 *(Polish)*.

Laboratory tests were conducted on anaerobic fermentation of sugar factory effluent followed by admixing of domestic sewage and activated sludge treatment of the 1:1 mixture. Results, discussed in detail, indicated up to 99.1% reduction of BOD_5 and up to 97.3% reduction of COD.

New possibilities of chemical protection of stored sugar beet. II. Testing the preventive and fungicidal properties of carbamate- and sulphur-based preparations

J. Zahradnicek *et al. Listy Cukr.*, 1989, **105**, 25 - 36 *(Czech)*.

Details are given of laboratory experiments and of small-scale tests conducted in 1985/87 at six sugar factories on 20 chemicals for prevention of stored beet deterioration caused by disease and respiration. The daily beet and sugar losses and inversion rates are tabulated.

Advances and prospects in technical sugar crystallization

D. Schliephake. *Zuckerind.*, 1989, **114**, 193 - 202 *(German, English)*.

Advances made in crystallization in recent years, including development of continuous evapo-crystallization, and the resultant improvements in sugar yield and quality and reductions in energy consumption are discussed. The sugar manufacturing process from thin juice to the final crystal product is divided into three major dewatering stages: evaporation up to thick juice, evaporation and crystallization in the sugar house and removal of residual moisture from the sugar by drying, and the principle of multiple-effect evaporation is extended to crystallization. Comparative heat calculations of five boiling schemes show that the steam consumption of a factory using a three-strike evapo-crystallization scheme to produce standard white sugar can be reduced from 11.20 to 9.23 kWh/kg beet and that of a 4-product factory from 12.85 to 9.80 kWh/kg by twice using the same bled vapour in a cascade system. However, since the vapour in the schemes examined has a pressure of only 0.2 bar, there is risk of air being drawn into the calandria and reducing the heating efficiency.

Intensifying the process of sucrose extraction from beet in an electric field

A. B. Matvienko, M. P. Kupchik, V. V. Mank, I. S. Gulyi and V. A. Shulika. *Izv. Vuzov, Pishch. Tekh.*, 1988, (6), 63 - 65 *(Russian)*.

While pretreatment of the cossettes-juice mixture in an electric field using ion exchange membranes as a preliminary stage in diffusion has been found to increase juice quality, the very presence of the membranes is a hindrance to determination of mass transfer and increases electricity consumption. Electrical pretreatment was therefore carried out in a small experimental unit of 320 kg/hr capacity, using open electrodes without the membranes; 200 V/m was applied for 15 min out of a total diffusion time of 60 min. Results showed that electrical treatment increased the mass transfer coefficient and reduced the colloid, colour and lime salts contents in the juice, so that purity was 3.4 units higher than with conventional diffusion.

Calculation of the optimum temperature conditions during massecuite cooling in crystallizers

P. P. Zagorodnii, V. O. Shtangeev and I. M. Grinchuk. *Izv. Vuzov, Pishch. Tekh.*, 1988, (6), 87 - 90 *(Russian)*.

In calculation of the optimum cooling temperature conditions in massecuite cooling it was assumed that the temperature of the massecuite and the surface area of the sugar crystals remained constant in the passage between sections of the crystallizer and that the final desired temperature was attained by a series of abrupt changes. The requisite equations are presented and their use explained.

Biological treatment of waste water at sugar factories. I. Anaerobic systems

L. Budicek, J. Rejsek, M. Kubin and I. Spoustová. *Listy Cukr.*, 1989, **105**, 58 - 67 *(Czech)*.

After a brief explanation of the principle of anaerobic treatment, a survey with diagrams is presented of various systems used in European beet sugar factories, particularly in Holland and West Germany; they include schemes with mud recycling (the Philipp Müller and Sulzer systems), those with mud beds such as the Biothane process, the anaerobic/aerobic process used at Lehrte Zucker AG, the Sulzer Anodek two-stage scheme, systems with inert bacterial supports instead of mud (as in a variant of the Anodek process) and the BIMA system using a special reactor as employed at Schladen sugar factory.

Trough feeder for the lime section

A. G. Pedos, O. A. Gulevets, P. G. Kovtun and V. G. Druzhinin. *Sakhar. Svekla*, 1989, (2), 49 *(Russian)*.

A system for feeding lime from kiln to slaking tank consists of a reciprocating horizontal trough, one end of which is attached to a connecting rod linked to a crank shaft operated via a reduction gear from an electric motor, while the other end protrudes (with forward movement) into the slaker. Lime falls under gravity from a hopper into the trough as it moves forward and is dispersed in the slaker as the trough reverses.

Improving the performance of differential jet extractors

A. L. Ignatenkov, I. M. Fedotkin and G. I. Myl'nikov. *Sakhar. Svekla*, 1989, (2), 50 - 51 *(Russian)*.

Experiments with a laboratory-scale model of a unit for sugar extraction from beet fragments demonstrated how improvements could be made in the performance of a full-scale model tested at a sugar factory. A modified form of the laboratory unit consisted of a vertical body housing two pairs of vibratory rods carrying four perforated trays (provided with jets) at regular intervals between the top of the vessel and the level of a solids feed port towards the bottom; vertical corrugated, perforated sheets were mounted between the trays. Comminuted material was carried up on the trays against a flow of hot water, extraction being aided by the vibratory movement of the rods and by the jets. Below the level of the solids feed port, the rods carried another four trays (narrowly separated), the bottom two acting as filtration units. The extracted juice was discharged at the bottom of the vessel, some being recycled to the solids feed hopper to be repumped to the vessel and prevent blockage while the rest was mixed with normal diffusion juice. Results showed that at a throughput of 0.42 kg/min, a juice of 11°Bx and a pulp press water of 1.2°Bx were obtained compared with respective values of 5.7° and 1.56°Bx as obtained with the factory unit. A juice draft of up to 250% was attainable.

Redundancy of a DSD thyristor converter

A. E. Tkachenko. *Sakhar. Svekla*, 1989, (2), 51 - 53 *(Russian)*.

The DSD thyristor-type converter provided for the electric drives of inclined trough-type diffusers made in Poland is controlled by a single micro-circuit board which makes it difficult to determine any faults that may occur. A redundancy scheme was therefore devised in which a second thyristor-type converter is used as back-up for the DSD. Circuit diagrams are presented.

Design for a joint between a (diffuser) scoop wheel and shaft

V. A. Prikhodchenko and A V. Tregub. *Sakhar. Svekla*, 1989, (2), 53 *(Russian)*.

Possible alternatives to the splined hub system fixing the scoop wheel to the shaft in a Polish-built DS-12 diffuser are described; they are intended to solve the problem of considerable loads on the shaft which can damage the joint.

Adjustment and operation of FiLS filters

V. V. Gel'ts and P. V. Naryshkov. *Sakhar. Svekla*, 1989, (2), 53 - 54 *(Russian)*.

Modifications suggested to FiLS filter-thickeners (so as to prevent accumulation of mud on the upper edge of the frames) include installation of a square-sectioned duct over the entire length of the filter with slots in it opposite each frame, and provision of steel sheeting to cover the gaps between the juice feed pipes. The alterations have given positive results and prolonged the period between filter cleaning at two sugar factories.

A scheme for deammoniation and utilization of condensate

V. N. Bazlov, A. N. Kovtun and Z. V. Kholodova. *Sakhar. Svekla*, 1989, (2), 55 - 56 *(Russian)*.

A scheme is described in which condensate at >100°C which is not suitable for use as boiler feedwater is treated in a deammoniating spray evaporator and discharged to a sealing leg from which some is recycled for retreatment while most is passed through a condensate-juice heat exchanger to a header tank; at 65 - 70°C it is mixed with heated raw water and condenser water, treated with SO_2 and (after temperature adjustment) fed to diffusion. Some of the condensate may be used for other purposes where there is a shortfall of untreated condensate suitable only for lime slaking, filter cake sweetening-off, etc.

Raw juice preliming

V. A. Golybin and Yu. I. Zelepukin. *Sakhar. Svekla*, 1989, (2), 57 *(Russian)*.

Raw juice of low pH (5.5 - 5.6) and low purity (81.9 - 82.3) was heated to 58°C and 2nd carbonatation mud added at 5 - 7% by weight of juice, which raised the pH to 6.3 - 6.5 (also reducing foam

formation by decreasing the rate of formation of Ca saccharates). After mixing, the pH was raised to 7.5 - 8.2 by simultaneous carbonatation at 55 - 60°C with addition of lime (0.20 - 0.25% CaO on beet) followed by progressive preliming to pH 10.8 - 11.2 with lime at 0.25 - 0.30% CaO on beet; the object of the precarbonatation was to combat the rapid loss in mud adsorptive properties with gradual rise in pH during the progressive preliming. The juice was then treated by conventional hot and cold fractional liming, 1st carbonatation, supplementary liming and 2nd carbonatation. By comparison with traditional processing, the experimental scheme improved 1st carbonatation juice settling and filtration, reduced 2nd carbonatation juice colour and lime salts content and raised its purity.

Waste water treatment by electrocoagulation

V. V. Stetsenko, V. V. Sakhnenko and V. M. Zaitseva. *Sakhar. Svekla*, 1989, (2), 58 - 59 *(Russian)*.

The tests conducted earlier[1] were scaled-up to throughputs of 0.5 and 0.675 m^3/hr of Class III waste water, corresponding to retention times of 5.5 and 4.0 min; application of an optimum current density of 80 - 90 A/m^2 to the electrodes reduced the saponin content from 140 - 160 to 10 - 20 mg/litre and the organic impurities from 1200 - 1400 to 700 mg/litre, thus almost entirely preventing foam formation and improving treatment in an oxygenation tank. Methods are suggested for recovering saponin from the mud (which constitutes 8 - 10% of the initial water v/v).

Application of programmable microcalculators to calculate unknown sugar losses in the diffuser

B. A. Kutsenko and M. A. Fedorov. *Pishch. Prom.*, 1988, (4), 54 - 55; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (7), Abs. 7 R1505.

Unknown losses in diffusion can be determined from the increase in reducing matter and from the quantity of acids (in terms of lactic acid) formed by microbial and fermentatative degradation of sucrose. Formulae are presented for calculation of these losses using microcalculators as well as a computer program, instructions for its use and a worked example.

Factory trials of a microprocessor system of vacuum pan automation

K. F. Gerbut, A. F. Kravchuk, V. A. Karpenko, A. K. Sushchenko and V. P. Rudnev. *Pishch. Prom.*, 1988, (4), 55 - 58; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (7), Abs. 7 R1504.

The D5 microprocessor system of automatic boiling control developed by DDS was installed at Yagotin sugar factory and tested on *A*-massecuite boiling during the 1986/87 campaign. The system proved reliable over the range of factory temperatures, and the sugar obtained had a stable granulometric composition, allowed water drinks to be fully omitted and reduced the length of the boiling cycle. Since the system provides information on the state of the process in various forms, this information can be split up into categories of importance. The microscope built into the pan gives more precise visual information on all stages of the boiling process.

Disinfectants and the quality of 2nd carbonatation juice

V. S. Shterman, E. V. Ivchenko and M. S. Zhigalov. *Pishch. Prom.*, 1989, (1), 67 - 68; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (8), Abs. R 1545.

Results are presented of investigations into the effect of disinfectants (formalin, trialkylbenzylammonium chloride, Ca bisulphite and H_2O_2) on the quality of 2nd carbonatation juice. It was found that formalin has a negative effect on the technological properties of the purified juice, while addition of Ca bisulphite causes a noticeable fall in the juice colour and has a positive effect on its technological properties. Hydrogen peroxide has the merit of being degraded to oxygen and water so that it does not cause extra non-sugars to enter the juice, but its cost is significantly higher than that of the other disinfectants.

Change in the quality of beet following brief storage in the field and in factory silos

G. Vaccari, G. Mantovani, G. Sgualdino, M. Bentini and G. Baraldi. *Ind. Sacc. Ital.*, 1989, **82**, 7 - 15 *(Italian)*.

Mechanically harvested beets, from a hilly region of Italy and having a greater incidence of damage than normally because of the sharp gradients of the fields in which they grew, were stored for up to 4 days in field clamps and in factory piles at maximum temperatures of 32 - 34°C, minimum temperatures of 19 - 21°C, maximum R.H. of 85 - 90% and minimum R.H. of 58 - 70%. In addition to the physical condition of the beets (root diameter distribution, topping level and distal and lateral fracture), changes in pol, dry solids, weight, purity, sucrose, reducing sugars, glutamine, Ca^{++}, Mg^{++}, Na^+, K^+, Cl^-, SO_4^{--}, PO_4^{---} and organic acids were determined. Inconsistency was noted in pol readings when these were related to the beet brei, and the measurements acquired significance only when related to the dry solids content in the beet. Analytical data obtained from hot extraction juice were found to be of particular significance as an aid in determining losses and non-sugars formation.

From a visit to French sugar factories

J. Grzejda, W. Goralczyk, W. Matuszek and J. Kubarski. *Gaz. Cukr.*, 1989, 97, 7 - 11 *(Polish)*.

Brief accounts are given of equipment and processes at five factories (Villenoy, Roye, Marle, Seclin and Lillers) visited by a Polish delegation as well as of the work and organization of the Institut de

1 Sakhnenko & Stetsenko: *I.S.J.*, 1987, 89, 102A.

Recherches de l'Industrie Sucrière and Groupement Technique de Sucreries, plus new ideas in measurement of massecuite supersaturation in batch pans and microcomputer control of evaporation.

Trial with "wet microsphere" beds in an anaerobic fermentation tank

K. Marciniak. *Gaz. Cukr.*, 1989, **97**, 16 - 17 *(Polish)*.

In tests in November/December 1987 at Melno sugar factory moist "microspheres" (a waste product of unstated composition and particle size from a local power station) were poured onto waste water in an anaerobic tank to form a surface layer at least 4 - 5 cm thick with the aim of preventing heat loss from the water to the atmosphere and to insulate the accumulated solids against atmospheric oxygen. Results showed a fall in temperature of only 2 - 5°C to 14 - 15°C (with one case of a 1°C fall) against 6 - 14°C in the corresponding period of the previous year. A reduction of only 60 - 80% in the solids was attributed to the lack of aerobic pretreatment.

Some aspects of the effects of various quantities in pure and technical lime-sugar solutions. II. Influences on the rate of carbon dioxide absorption

E. Sarka. *Listy Cukr.*, 1989, **105**, 77 - 85 *(Czech)*.

Factors affecting the rate of CO_2 absorption under 1st carbonatation conditions were examined. While the specific area of the phase interface, CO_2 diffusivity and the total hydration rate constant of the gas had major effects on absorption, these factors were in turn influenced by (i) the juice level in the carbonatation vessel and the CO_2 content in the gas which, under conditions of perfect mixing, affected the partial pressure of the gas and hence its solubility, and (ii) alkalinity, Brix, pol, purity, and saponin, pectin and reducing matter contents, increases in which caused an increase in absorption, which was only slightly affected by the quantities of inorganic matter and protein.

Reducing heat consumption in sugar factories

O. Böhm. *Listy Cukr.*, 1989, **105**, 85 - 91 *(Czech)*.

Thermal energy consumption in sugar factories is discussed and means of reducing it discussed (with 76 references to the literature), starting with the beet (the sugar content in which should be maximized and the amount of extraneous matter reduced) and then examining each factory process from diffusion to boiling as well as boiler operation, juice heating, use of automatic controls, vapour recompression, massecuite stirrers, etc.

The effect of pH on change in sugar solution colloids

V. A. Loseva and N. G. Kul'neva. *Dokl. Voronezh. Tekhnol. Inst.*, 1988, 6 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (9), Abs. 9 R1459.

The effect of pH on the kinetics of colloids formation in sugar solutions during prolonged heating was studied. The 0.5M sucrose solutions investigated were prepared in buffer media at pH 6.0, 7.0 and 8.5 and in twice-distilled water. The solutions were heated at 80°C for 100 hr. It was found that in both buffer and non-buffered media, the relationship between colloid formation and pH was expressed by a curve with maxima. The greatest amount of colloidal material formed at pH 7.0 after 20 and 60 hr heating, at pH 6.0 after 20 hr and at pH 8.5 after 10 hr. At all pH levels, increase in the colloidal fraction was accompanied by enlargement of the particles, reflecting both the continuity of particle formation and the reversibility of their destruction.

Supplement to operational tests on the WL prototype pulp press

K. Buck. *Gaz. Cukr.*, 1989, **97**, 25 - 28 *(Polish)*.

Trials were conducted at Przeworsk sugar factory by the manufacturers (ZUP Nysa) and by the Institute for the Sugar Industry (IPC) on the twin-spindle WL horizontal pulp press described earlier[2]. In the ZUP Nysa tests, the dry solids content was raised from an average of 9.8% to 18.0 and 21.0% at speeds of 2.35 - 4.57 and 4.05 - 4.63 rpm, respectively. In the IPC tests, speeds in the range 1.04 - 6.2, 6.2 - 11.0 and 8.5 - 9.16 rpm raised the average dry solids content from 9.0, 8.9 and 11.4% to 23, 16 and 18.5%, respectively. The results and conclusions to be drawn from them are discussed.

The course of cossettes extraction in the diffuser

P. Slugocki. *Gz. Cukr.*, 1989, **97**, 29 - 30 *(Polish)*.

The theory of diffusion is discussed and a mathematical model described which is written in Fortran IV and is based on investigations of the process in a trough-type diffuser at Chelmza factory. A worked example is presented and possible applications of the model, using a computer, are listed.

Total pressure loss in sugar beet (pile) ventilation units

B. Senge, E. Manzke and P. V. Schmidt. *Lebensmittelind.*, 1989, **36**, 72 - 76 *(German)*.

To maintain a beet storage pile temperature of about 0°C, the East German standard for forced ventilation stipulates an air flow rate of 35 m^3/tonne/hr for beets cleaned when dry and 50 m^3/tonne/hr for beets cleaned when wet; an increase in the rate to 80 - 120 m^3/tonne/hr has been shown to have an increasing positive economic effect, but to achieve higher rates would necessitate reducing pressure loss. Total pressure loss in the air feed is composed of a loss (i) between the ventilator and air duct, (ii) throughout the duct, including bends, (iii) at the exit from the duct, and (iv) possible suction loss at the grid of the feed nozzle. Examination of the problem

2 Buck: *I.S.J.*, 1988, **90**, 14A.

led to the conclusion that the layout of the ventilation system had greatest effect and that improvements could be achieved by using open concrete ducts with the ventilators placed in parallel at the end of a pile rather than at the long side. At Anklam sugar factory, this arrangement allowed an increase in air flow from 63 to 80 m^3/tonne/hr without increase in electricity consumption.

On the 1988 campaign and new technological developments

K. Buchholz and D. Schliephake. *Zuckerind.*, 1989, 114, 275 - 290 *(German).*

After a brief historical account of the Institut für landwirtschaftliche Technologie und Zuckerindustrie an der Technischen Universität Braunschweig and of research conducted there, the construction of new laboratories is mentioned; work is to be expanded in the fields of carbohydrate chemistry and biotechnology, and recent advances made are indicated. General data from the 1988 campaign precede discussions of specific aspects, including: the use of aluminium sulphate as clarifying agent in place of lead subacetate for sugar determination in beet brei; diffusion under alkaline conditions (which gave a higher pulp dry solids content but also lower juice purities than with normal diffusion, while problems arose in association with undissolved lime); preliming trials which pointed to possible ways of optimizing the process; investigations of lime consumption in juice purification, particularly the question of using 85% CaO on juice non-sugars or 70% CaO (which causes increased colour, filtration coefficient, hardness and hence evaporator scale formation); and environmental protection, particularly the formation and emission of ammonia and the removal of organic acids from flue gases. Subjects of general interest in the fields of heat and process technology were examined in greater detail:

Results from measurements on wet scrubbers of varying construction and means of operation: Measurements of emission in flue gases after scrubbing showed that a jet-type scrubber was best in removal of sulphur oxides and organic substances (72% and 74%, respectively), while a venturi-type scrubber followed by a spray-type scrubber in a factory using powdered lignite as fuel was best in dust elimination (92%); a straight venturi-type scrubber gave poorest performance.

Behaviour of beet cell tissue in relation to intro-diffusion of dissolved substances: Diffusive dewatering is a newly developed process made up of two physical processes, namely removal of water from the cossette and concentration of the dissolved solids (sugar) by its back-diffusion into the cossette; model tests showed a reversible swelling and shrinkage of a cossette as function of the concentration of back-diffused sugar or NaCl. Both dehydration of the interlamellae and the build-up of an unsteady osmotic pressure gradient contribute to the contraction and swelling; the convective discharge of the cossette contents under the effect of increase in inner pressure causes the diffusive dewatering to accelerate with increase in the dry solids content, while calculation of the back-diffusion velocity has revealed transport coefficients that differ with time.

Crystal footing work: Since operation of a pan with pretreated slurry is often used instead of massecuite cooling in the production of crystal footing magma, the two systems were operated in parallel with identical syrup and slurry feeds; measurements showed that cooling gave a better product with a lower ash content and only 19% conglomerates as against 62% in the pretreated slurry system, while the average crystal size was the same in both schemes. Since crystals at the surface of a droplet of polypropyleneglycol (PPG), used as dispersion agent in seed slurry, formed conglomerates and thus gave an inferior crystal sugar product by comparison with that obtained using sugar-saturated glycerol, it is recommended to use the latter.

Continuous crystallization: At Offenau, four pans provided with massecuite stirrers were linked in a cascade for continuous low-grade boiling at a massecuite throughput of 35 tonnes/hr; the first three pans operated at a steam pressure of 0.6 bar without any problems, while a pressure of 1 bar was needed in the last pan. At Brühl, satisfactory crystal quality resulted from tests in which four pans having stirrers above the calandria were linked in series for continuous white sugar boiling. An evapo-crystallization tower at Schladen used steam at 0.6 bar to produce white sugar 2 from 60 tonnes of magma per hr against a design capacity of 85 tonnes/hr. A multitasking simulation system (in which a number of computer programs operate simultaneously) was used to provide measurements from which a continuous Brix curve was instantaneously calculated for an evapo-crystallization tower; comparison of the curve with one produced by a refractometer installed in the curved rim below the calandria (as against the base of the pan in unsuccessful tests conducted in the previous campaign) showed general agreement but with occasional deviations attributed to fluctuations in homogeneity at one measuring point. Boiling with vapour at less than 1 bar has proved to give unsatisfactory results because of the much greater intrusion of air as an incondensable gas.

Benefit of the MET in the sugar house: The Multistage Ebullism Tank (MET) used as continuous crystallizer at Schleswig sugar factory increased by 1.24% on beet the raw sugar quantity and, since the raw sugar was melted to produce white sugar 1, reduced the amount of massecuite processed in the white sugar house by about 11%; however, to compensate for the higher raw sugar output at lower purity, syrup of higher purity must be fed direct to the low-grade massecuite. The system is of no advantage in respect of energy consumption (even where it is used for refined sugar) and the formation of fines (unavoidable because of the nature of the process) has caused separation problems in the centrifugals.

Sugar refining

Application of heterogeneous cation exchange resins of varying nature as catalysts for sugar syrup inversion

V. S. Pavlenko, G. V. Krichevskaya, L. S. Ivanova and S. A. Brenman. *Pishch. Prom.*, 1988, (4), 41 - 43; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (7), Abs. 7 R1512.

Soviet cation exchange resins of varying nature were used to catalyse sucrose hydrolysis at Krasnopresnensk refinery. It was found that the degree of inversion of the syrups depended substantially on the nature of the resin and could be increased by adjusting the time of contact between the resin and syrup and increasing the amount of resin used. The quantity of anion exchange resin used for neutralization was governed by the extent of the inversion process; the lower the pH of the inverted syrup, the greater was the amount of anion exchanger consumed.

Improvement in twin-drum granulators

S. I. Temper, G. B. Sokol and V. S. Kosmatskii. *Sakhar. Svekla*, 1989, (2), 54 - 55 *(Russian)*.

Considerable crystal damage has been found in small-diameter twin-drum units (the first drum intended for drying and the second for cooling) typically installed in Soviet sugar factories built in the 1950's, while considerable entrainment losses have occurred with high air flow rates used in an effort to increase throughput. Operating the drums in parallel (each acting as dryer and cooler with air fed to both units through a common heater) provided the answer to the problem, and at Borshchev factory a total throughput of 22 tonnes/hr of refined sugar was achieved at a final moisture content of 0.08% and a final temperature of 35°C (compared with initial levels of 0.09% and 48°C, respectively); the level of crystal abrasion was reduced from 40 - 45% to 20 - 22%.

The composition of Class III waste water

N. A. Savdun, N. I. Yakimenko, V. N. Skalozub, G. M. Solovets and A. A. Kirilenko. *Sakhar. Svekla*, 1989, (2), 60 - 62 *(Russian)*.

The physico-chemical properties of Class III waste water from Soviet refineries and the quantities of impurities in it are governed by the liquor decolorization process used: treatment with (i) AV-17-2P anion exchange resin, (ii) powdered carbon or (iii) AGS-4 granular carbon. The effects of the three processes on waste water composition are discussed with the aid of tables showing the quantity of water % refined sugar, temperature, suspended solids content, pH, calcination losses, chloride, sulphate and total nitrogen contents, COD and BOD. The waste waters have descending levels of COD and BOD in the order in which they are given above.

Demonstration of an advanced liquid treatment system. Amstar Sugar Corporation's reverse osmosis project. II. Pilot operation

K. W. Lee, G. Keblish and C. C. Chou. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 22 pp.

The results are discussed of a test on char waste water treatment at Brooklyn refinery where the costs of discharging effluent to municipal sewer systems are rising. The system consisted of a cartridge pre-filter, heat exchanger, high-pressure pump and a reverse osmosis unit containing eight spirally wound polyamide membranes 40 in long × 4 in diameter. Average operating pressure was 240 psig and feed temperature 59°C (compared with a designed 63°C). Because of excessive Ca sulphate and carbonate levels, 6 ppm polyacrylic acid was added to the feed as anti-scale agent. Concentrate was recycled to the feed stream. Results showed a rapid fall in permeate flow rate during the first 100 hr (out of a total of 382 hr) and a sugars content in the permeate that was too high (>10 ppm) to allow its use as boiler feed water, although there was considerable reduction in the Ca and Mg contents, a 96.8% fall in total dissolved solids, 95.4% reduction in conductivity, 95.5% decrease in the ash content and 98% fall in total sugars. Details are given of membrane regeneration tests, and the economics of the scheme are analysed. (See also Chou & Weber: *I.S.J.*, 1989, **91**, 71 - 78.)

Non-sugars: dirt, contamination and extraneous matter in raw, semi-refined and refined sugar

D. S. Martin and J. E. Somner. *Paper presented to Sugar Ind. Tech. Conf.*, 1989, 8 pp.

Impurities in sugar are classified under: continuous soluble, invisible substances such as agricultural and other chemicals; continuous insoluble, visible contaminants such as turbidity and particles of foreign matter; and discontinuous, insoluble visible bodies such as pieces of glass, metal, etc. Detection of these, the need to maintain suitable standards through quality control and nutritional considerations are discussed and some case studies outlined. The point is made that methods for measurement of pol, copper, particle size, micro-organisms, turbidity and insoluble matter are still only tentative.

Terminology for process control in refining of cane raw sugar

E. Gutknecht. *Lebensmittelind.*, 1989, **36**, 76 - 77 *(German)*.

In the East German sugar industry, there are fewer definitions, symbols and standard terms available for chemical control in cane sugar refining than for beet sugar manufacture and refining. Additions and changes suggested by the author to meet the needs of an increase in cane sugar refining include purity, impurity, reducing matter content, total sugar content, sugars content, non-sucrose and non-sugars contents and insoluble non-sucrose content; the concepts are explained and appropriate symbols listed for use in formulae.

Starch based sweeteners

Porous iron as support for immobilized enzymes

M. Kminkova, A. Proskova, J. Kucera and M. Dedek. *Prum. Potravin.*, 1988, **39**, (6), 321 - 324; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (1), Abs. 1 R1481.

Results are given of investigations on the use of porous iron (produced by powder metallurgy) as support for immobilization of glucose oxidase and glucoamylase by direct adsorption and by bonding glucoamylase via glutaraldehyde with egg white adsorbed on the support. The porous iron proved to be unsuitable directly as support because of increase in the iron ion content in the solution, but coating its particles with a polymer permitted its use, but only in applications where its magnetic properties were important.

Immobilization of cells with glucose isomerase on collagen. Properties of the complex

A. Krakowiak. *Acta Alimen. Pol.*, 1987, **13**, (4), 359 - 368; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (1), Abs. 1 R1482.

Cells of *Actinoplanes missouriensis* containing glucose isomerase (GI) were immobilized on collagen. Glutaraldehyde (optimum concentration 0.5%) was used for intramolecular bonding of GI with the carrier and for polymerization of the collagen. Under these conditions, the collagen membrane remained stable and insoluble with incubation in water at 80°C for 80 hr, and negligible loss of GI activity was observed. Comparison of the optimum parameters under which the immobilized and free GI performed showed that the optimum temperature was higher at 73°C for the former than for the latter (65°C), while the respective optimum pH values were 7.5 and 7.8. The immobilized GI was more stable at high temperatures than the free enzyme, and at 90°C loss of activity was 22% and 55%, respectively. In investigation of continuous glucose isomerization with the immobilized GI, the residence time of the substrate in the reaction vessel had considerable effect on the degree of isomerization and vessel productivity, optimum levels of both being achieved with 1 minute's retention. After 400 hr operation, GI activity fell by 23%, the degree of isomerization was 20% and productivity was approx. 32 mg fructose/litre/min. Injection of air together with the substrate caused a 30% fall in GI activity after 60 hr because of the formation of a large number of bubbles.

Means of shortening the time for glucose hydrate crystallization

I. N. Nesterova, V. S. Shterman, M. S. Zhigalov and K. A. Kairova. *Pishch. Prom.*, 1988, (11), 23 - 24; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (5), Abs. 5 R1591.

The bulk crystallization rate of glucose hydrate was studied as a function of temperature and dextrose equivalent (DE) under conditions close to those of industrial crystallization. The arrangement and operation of the experimental unit employed are described. It was found that a reduction in the crystallization time necessitated conducting the process at temperatures approximating that (48 - 50°C) at which the monohydrate changes to the anhydride form at maximum possible DE values.

New isomerization technology for high fructose syrup production

R. L. Antrim, N. E. Lloyd and A. L. Auterinen. *Starch/Stärke*, 1989, **41**, 155 - 159.

While cross-linked, cell-based isomerases used in conventional immobilized systems are discarded after inactivation, in a new technique (on-column loading) the enzyme is gradually added to the column during glucose isomerization to fructose, so that productivity can be maintained constant throughout the process or the capacity altered if and when required. The process uses the granular DEAE-cellulose carrier described earlier[1] and a soluble glucose isomerase concentrate having an activity of 3500 - 4500 GIU/g which, when immobilized, has a half-life of 1800 - 1900 hr. Magnesium and bisulphite at 1.5 and 2.0 mmoles/litre are used as enzyme activators. The glucose should have a minimum concentration of 94%, a total dry solids content of 40 - 50%, a conductivity of <40 S/cm, a Ca content of <1.5 ppm and contain no measurable oxygen, while recommended operating conditions include a pH range of 7.2 - 8.2 (preferably 7.6 - 7.8) and a temperature range of 54 - 62°C (preferably 57°C); under optimum conditions, approx. 133 million units of isomerase concentrate will yield 1000 tonnes of 42% HFS. Advantages of the new system are discussed and its use in a US fructose plant described.

The taste of excellence

S. Tedbury. *Tate & Lyle Times*, 1989, (52), 4 - 7.

An account is given of the activities of A.E.Staley Manufacturing (a member of the Tate & Lyle Group) in the manufacture of dextrose and glucose syrup, HFS and Krystar (a crystal product).

Amylum - a century of service

Anon. *Tate & Lyle Times*, 1989, (52), 8 - 10.

Amylum NV, located at Aalst in Belgium, is the main operating unit in CST (Cereal Science & Technology), two thirds of which is owned by the Tate & Lyle Group. Information is given on wet milling of wheat at Amylum NV which from the starch produces glucose and glucose syrups, crystal and liquid dextrose, HFS and maltodextrin.

Technology refined

Anon. *Tate & Lyle Times*, 1989, (52), 11 - 13.

The activities at Tunnel Refineries Ltd. in London are described, including the production of various glucose syrups from maize starch.

1 Antrim & Auterinen: *I.S.J.*, 1986, **88**, 130A.

Laboratory studies

Direct *vs.* double polarization for the estimation of sucrose in gur and cane juices

K. P. Sharma and S. K. Batta. *Bharatiya Sugar*, 1989, **14**, (4), 57, 59 - 60.

Comparison of the two polarimetric procedures showed that double polarization gave generally lower but more reliable values than the direct method and gave a better indication of post-harvest deterioration of cane. Addition of sorbic acid to gur samples did not increase the pol reading when the double method was used.

A study of the kinetics of sucrose hydrolysis by an optical method

T. Ya. Chernyakova and N. A. Arkhipovich. *Dokl. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1988, 9 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (5), Abs. 5 R1581.

Sucrose hydrolysis in an acid medium was studied in the temperature range 50 - 90°C. Polarimetry was used to determine the reaction rate constants at varying pH levels. A method for calculating the final pol of the hydrolysis products is proposed which takes into account the effect of temperature on the specific optical rotation of fructose. The temperature coefficients of the hydrolysis reaction have been calculated and shown to accord with Van't Hoff's law. On the basis of the results obtained it is recommended to use polarimetry to determine sucrose hydrolysis rate constants at temperatures greater than 20°C.

A study of polysaccharides in the sugar factory

J. Copikova, D. Novotny, F. Kvasnicka and P. Kadlec. *Listy Cukr.*, 1989, **105**, 44 - 48 *(Czech)*.

Polysaccharides were isolated from beet, raw juice and molasses, separated chromatographically on a column of Separon Hema 1000 hydroxyethylmethacrylate and their molar concentrations and polydispersity calculated. Monosaccharides resulting from acid hydrolysis were determined by ion exchange chromatography and the content of each converted to that of the corresponding original polysaccharide. The values for pectin, galactan, dextran, xylan and araban are tabulated, demonstrating the dominance of pectin in beet (2.13% on dry solids), followed by araban (0.44%), xylan (0.15%) and galactan (0.07%); raw juice contained 0.47% araban, 0.33% pectin, 0.30% dextran + galactan and 0.26% xylan, while molasses contained 0.10% dextran, 0.08% araban, 0.05% xylan and 0.03% pectin.

Spectrophotometric flow-injection determination of sucrose and total reducing sugars in sugar cane juice and molasses

I. L. Mattos, E. A. G. Zagatto and A. O. Jacintho. *Anal. Chim. Acta*, 1988, **214**, (1/2), 247 - 257; through *Anal. Abs.*, 1989, **51**, Abs. 4F17.

Samples of cane juice or molasses were injected into the carrier stream (water at 1 ml/min) which was then mixed with 1M HCl in a 250-cm PTFE (polytetrafluoroethylene) coil for hydrolysis of sucrose. This solution was then merged with 3M NaOH-1% potassium ferricyanide reagent solution in a 580-cm PTFE coil, the solution was debubbled and 0.1% 1,10-phenanthroline-0.5M acetic acid-0.1M citric acid-30 mg/litre of Fe(III) added. The solution was passed through a 20-cm polyethylene coil and the absorbance measured at 512 nm. The sampling rate for determination of sucrose and total reducing sugars was 40/hr. The sampling rate was almost doubled when only reducing sugars were determined and a simplified flow system could be used. The coefficients of variation for determination of sucrose and total reducing sugars in cane juice were 0.47% and 0.38%, respectively, and in molasses 0.54% and 0.44%, respectively. Results generally agreed well with those from classical methods.

Optimization of the viscosity of saturated sucrose solutions in the presence of non-sugars at 30° and 40°C

I. P. Orobinskii, Yu. S. Serbulov and A. P. Boldyrev. *Dokl. Voronezh. Tekhnol. Inst.*, 1988, 7 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (8), Abs. 8 R1543.

The effect of the temperature and concentration of alkali metal sulphites and carbonates on the viscosity of saturated sucrose solutions was investigated. Mathematical methods were applied to planning of the experiment and processing of the results with the aim of selecting the optimum temperature and concentration of a given non-sugar at which the sucrose solution viscosity was minimum. At constant temperature and concentration the viscosity will be lower when potassium sulphite is added.

Inter-laboratory analyses

J. P. Ducatillon and J. P. Lescure. *Sucr. Franç.*, 1989, **130**, 103 - 115 *(French)*.

54 laboratories made collaborative analyses of: (i) syrup and molasses for pol, Brix and purity; (ii) white sugar under the EEC points system for appearance, colour and ash; (iii) white sugar for SO_2; (iv) white sugar properties; (v) white sugar granulometry; and (vi) juice and syrup for iron, calcium and silicon. The results and conclusions drawn from them are discussed.

Research and development of biosensors. A review

F. Scheller *et al. Analyst*, 1989, **114**, 653 - 662.

A survey, with 74 references to the literature, is presented of types and applications of biosensors, including the oxidase-based amperometric enzyme electrode. Details are given of commercially available enzyme electrode-based analysers and the analytical characteristics of biospecific electrodes. Substrates that can be measured with biosensors include sucrose, fructose and glucose; application in fermentation is among the fields described.

By-products

The future of the industry: by-products, efficiency and propaganda

G. L. Aleman. *Proc. Inter-American Sugar Cane Seminar*, 1987, 118 - 122.

The future of the cane sugar industry and its competition with the corn syrup industry are discussed, with examination of the by-products utilization potential, sugar factory efficiency, the use of automation and the need to defend sugar against adverse propaganda.

The updating of our sugar industry concerning energy and by-products. II

J. Fernandez. *Proc. Inter-American Sugar Cane Seminar*, 1987, 125 - 127.

By-products obtainable from the cane plant, enzymatic treatment of bagasse to yield glucose and fuel alcohol manufacture from glucose and lignin are discussed and the possible advantages of producing liquid sugar and pasteurized cane juice (the latter for sale in cartons) indicated. Growing corn rich in amino-acids of dietary importance is also advocated as an alternative to sugar cane in Florida.

Perspectives in Mexico for the initation of a fuel alcohol program

C. S. Peck. *Proc. Inter-American Sugar Cane Seminar*, 1987, 133 - 139.

A proposed program for the use as motor fuel of ethanol (manufactured from cane molasses) in a 1:10 alcohol: gasoline mixture is outlined; the economics are examined, including those of dehydration of the alcohol from 96°G.L. (as normally produced in Mexican sugar factories) to 99.5°G.L.

The production of alcohol in Costa Rica as an alternative strategy

A. Ruiz. *Proc. Inter-American Sugar Cane Seminar*, 1987, 140 - 143.

Reasons for the decision to produce ethanol in Costa Rica are discussed and earlier experience in the use of alcohol manufactured at a sugar-alcohol complex constructed in the 1970's at Central Azucarera Tempisque (CATSA) is described. Under a new program implemented in 1985, a second distillery was built at Cañas, Guanacaste (operated by Taboga S.A., a sugar producer of long-standing); the two distilleries have a production capacity of almost 40 million litres in a 100-day cane season. A dehydrating plant and a storage installation were installed at Punta Morales with the intention of treating dehydrated alcohol bought on the international market and exporting it, particularly to the USA. All the gasoline used as motor fuel in Puerto Rico is in a 10:1 blend with alcohol.

Biogas from alcohol distillery waste

D. A. Butterfield, W. A. Mellowes and S. Thomas. *Proc. Inter-American Sugar Cane Seminar*, 1987, 144 - 148.

Results of tests on the use of an upflow anaerobic sludge blanket (UASB) reactor for the treatment of vinasse at two molasses alcohol distilleries in Trinidad and Tobago are reported. In one trial, the plant was operated for 40 days at 27°C and hydraulic retention times (HRT) corresponding to organic loading rates of 38.7, 28.0 and 22.4 kg COD/m^3/day; in another test run during 55 days at 37°C, the HRT corresponded to 82.0, 27.3 and 16.2 kg COD/m^3/day. The results showed a COD reduction (ranging from 47.9 to 61.9% at 27°C and from 49.9 to 75.9% at 37°C) which was considered generally too low, while the gas production rate and hence methane yield were quite low by comparison with theoretical values. Thus, although the UASB system may be used for high loading rates, improvements in performance will require different operating conditions and design modifications.

IMPA's research activities on sugar cane by-products utilization

L. E. Zedillo. *Proc. Inter-American Sugar Cane Seminar*, 1987, 151 - 171.

An account is given of the work of IMPA (Instituto para el Mejoramiento de la Producción de Azúcar), a research organization set up in Mexico in 1949 to find ways of improving sugar production and which recently extended its activities in the field of by-products utilization. Brief descriptions are given of projects on utilization of vinasse, filter cake, bagasse and molasses as well as effluent treatment and alternative uses of sucrose, and the approach adopted by IMPA to establishment of research priorities in view of the wide range of cane by-products is analysed. Cane by-products utilization research conducted by other organizations in Mexico is also summarized.

Sugar cane: development and evolution of the sucrochemistry and the paper complex in a Peruvian micro-region

S. Leyva and V. Sagastegui. *Proc. Inter-American Sugar Cane Seminar*, 1987, 172 - 188.

The micro-region described includes some 7000 ha of canefields from which refined and various other types of sugar are produced. The Paramonga complex includes a sugar factory, a molasses alcohol distillery, an installation for PVC manufacture from ethanol via ethylene, a bagasse paper plant and an electrolysis plant which supplies the various chemicals needed for paper manufacture. The installations are interconnected by pipelines. Details are given of the processes used.

A system to use cane as biomass for sugar, alcohol, fertilizer and fibre

J. A. Casey. *Proc. Inter-American Sugar Cane Seminar*, 1987, 205 - 219.

Details are given of a system for the production of white sugar, fuel alcohol, bagasse fibre (for use as fuel or for paper, board or charcoal manufacture)

and fertilizer which includes the use of all the solid waste (filter cake, boiler ash, cane trash and bagasse pith) plus almost all the vinasse for the production of a compost. The equipment used is indicated and the economics analysed.

Potential sources for ethanol production in Trinidad and Tobago

W. A. Mellowes and R. E. R. Lewis. *Proc. Inter-American Sugar Cane Seminar*, 1987, 250 - 266.

Potential raw materials for ethanol manufacture in Trinidad and Tobago are surveyed, including cane tops and trash, bagasse, molasses, fruit, vegetables, yeast, grasses, starch-containing plants and cellulosic material such as wood, waste paper, agricultural residues, etc. Ethanol yields from the various sources are indicated and the possibility suggested of combining molasses with some of the other substrates.

Modelling the world prices of molasses and ethanol

J. Fry. *Proc. Inter-American Sugar Cane Seminar*, 1987, 280 - 292.

Models developed for analysis of molasses and ethanol prices are described and the relationships between price and the principal factors governing the respective markets discussed.

The use of final molasses as a preservative in animal feeds

C. K. Laurie. *Proc. Inter-American Sugar Cane Seminar*, 1987, 293 - 300.

While powdered yeast has been widely used as preservative in animal fodder, there is evidence of partial denaturing of proteins and destruction of amino-acids during desiccation. In experiments on the use of cane molasses as yeast cell deactivator, a slurry of living yeast cells was combined with molasses at 27% and 73% (dry matter), respectively; complete deactivation of the yeast resulted from the high osmotic pressure, while the bactericidal effect of the molasses allowed the mixture to be stored for over a year without deterioration. In a pig feeding trial, the mixture (containing 14% crude protein and 81% total digestible nutrients) gave adequate daily weight gains, while the production cost of the ration was only 50 - 60% of that for conventional pelleted rations used in Barbados. Laboratory experiments also showed that molasses mixed with minced animal and fish offals also acted as preservative and allowed them to be used as protein/energy bases in non-ruminant feeds.

Ammoniation of sugar cane bagasse and cane tops - the effect of time, temperature, moisture content and level of NH_3 on digestibility

C. K. Sankat and B. Lauckner. *Proc. Inter-American Sugar Cane Seminar*, 1987, 301 - 312.

Although *in vitro* experiments showed that ammonia treatment improved the digestibility of cane tops and bagasse, the effect was not as good as that given by NaOH treatment, particularly in the case of bagasse. At an optimum of 6% (on dry matter) ammonia addition and a temperature of 90°C, 72 hr was needed for completion of the process; treatment at an ambient 30°C gave a poorer rate and degree of improvement than at 60° or 90°C, while treatment time increased with a decrease in temperature. Moisture content of the cane tops (15, 30 and 50%) had no effect on digestibility improvement, while improvement increased with bagasse moisture content, although results obtained with bagasse treatment at 30°C indicated the possibility that a reduction in moisture content could even be marginally beneficial.

The intake and digestibility of untreated, NaOH- and NH_3-treated bagasse in complete, processed and unprocessed rations by sheep

C. K. Sankat, R. H. Singh, P. O. Osuji and B. Lauckner. *Proc. Inter-American Sugar Cane Seminar*, 1987, 313 - 320.

NaOH proved better than anhydrous ammonia in improving the digestibility and dry matter intake of ground bagasse incorporated with molasses in sheep rations at respective levels of 37% and 40%. However, grinding of the bagasse appeared to be unjustified when alkali treatment was not used.

High-test molasses and torula yeast as substitutes for conventional diets for fattening pigs. I. Performance from 30 to 60 live weight

V. Figueroa, A. Maylín, J. Ly and M. Pérez. *Cuban J. Agric. Sci.*, 1988, **22**, 285 - 291.

Trials in which castrated male pigs of 30 kg live weight were fed on rations containing high-test molasses or maize plus torula yeast (the amount of yeast with the molasses being approximately double that with the maize) showed that the performance of the pigs (as determined at a slaughter weight of 60 kg) was not affected by replacing the cereal with the high-test molasses.

Effect of cutting age and final molasses levels on the quality of coast cross Bermuda grass (*Cynodon dactylon* L. Pers.) silage

G. H. Domínguez and C. Hardy. *Cuban J. Agric. Sci.*, 1988, **22**, 311 - 316.

While addition of 1 or 2% final molasses to Bermuda grass silage improved the pH where the grass had been harvested at an age of 54 days, it did not have the same effect with younger grass (harvested at 37 days) which was of better quality than the older grass and therefore recommended without the molasses addition.

Reassessment and improvement of continuous cultivation of yeast

C. H. Lin, L. H. Wang, Y. C. Kuo and C. Y. Chang. *Taiwan Sugar*, 1988, **35**, (6), 19 - 22.

See *I.S.J.*, 1989, **91**, 88A.

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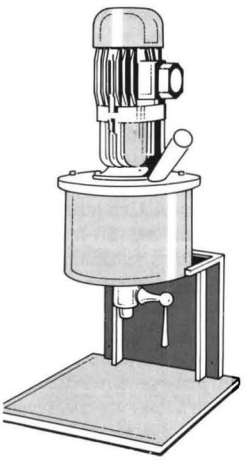

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1. Report of Crystallographic Laboratory University of Utrecht, Holland.

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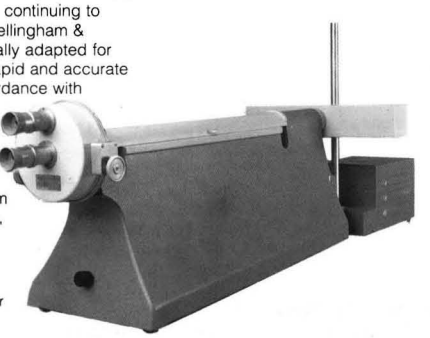

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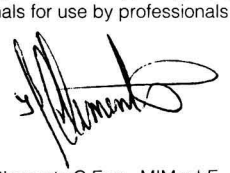

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2 E. Hugot - Handbook of Cane Sugar Engineering. 1960. p. 517

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In Brazil, Leibig[3] has developed a "low pressure extraction system". This is an improvement on conventional diffusion; the separation efficiency is improved by the use of perforated drums operating at low pressure. The drums are set such that the cane mat is compressed to its no-void volume, thus expelling juice without allowing the ingress of air. But stage efficiency in the LPE system is only slightly in excess of 50%. It uses 9 stages, instead of 12 - 18 in conventional diffusers. Later we shall demonstrate that 4 stages should be enough.

In order to improve stage efficiency we must move to the hydrodynamic mixture concept. In other words, we must not end up with a solid mass, when we are trying to mix two liquids. In a diffuser, even when the mass of the liquid phase is twelve times that of the fibre (12 × f, as in John Payne's displacement concept), we still have a hydrostatic system without any significant agitation of the mixture.

In modern diffusers, vertical screws are used to stir the bagasse bed but this is done more to improve percolation, to prevent flooding, than for improvement of stage efficiency.

The hydrodynamic extraction process

In order to illustrate what we mean by the hydrodynamic process, we will compare it with the procedure used in the laboratory for the determination of pol in cane by direct analysis. This procedure consists in making a mixture of cane with water (15 × f) which will thus contain 5% of fibre. When this mixture is treated in a high-speed wet disintegrator, we have a stage efficiency of 100%, since we assume that all the pol originally in the solid is now in a homogeneous solution.

On an industrial scale we could not afford to add so much water because of the evaporation load it would create. We therefore have to resort to recycling of the imbibition, and the recycling rate has to be such that the fibre content of the slurry is never more than 7%. This slurry, then, has the hydrodynamic properties of a liquid. In other words, we should be able to pump it.

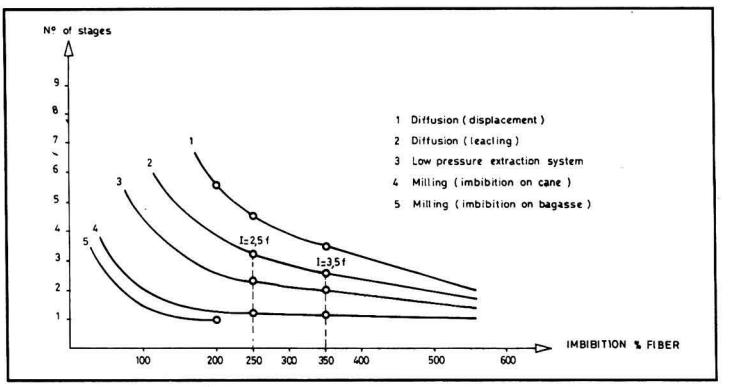


Fig. 3A. Number of stages *versus* imbibition rate for 95% extraction

The idea of pumping bagasse was first given to me by Dr. Douwes Dekker during the 1962 Congress of ISSCT in Mauritius. Ten years later, John Farmer was pumping a slurry of shredded cane in his "high extractor". The last industrial use of such a process was when a slurry of bagasse was pumped at Quartier Français sugar factory in Réunion from 1975 to 1977 when using the FCB-Rivière patented process. This is the most efficient way of obtaining a homogeneous mixture of the extractable juice and the imbibition liquid.

Number of stages

The number of stages needed, assuming 100% stage efficiency, depends mainly on imbibition rate and separation efficiency. The effect of these two parameters is best shown by making use of the Ponchon Savarit diagram. Figure 1A shows that, to dilute the extractable juice of No. 1 mill bagasse to the desired final bagasse *in one stage*, the imbibition rate to be used is 2.5 × f for a final dilution to 7°Brix, giving 95% extraction after dewatering, or 6.8 × f for a final dilution to 3°Brix, giving an extraction rate of 98% after dewatering.

Figure 1B shows the theoretical number of stages to be used to achieve 98% extraction using 2.5 × f as the imbibition rate in conventional milling, that is to say, with imbibition applied to No. 1 mill bagasse.

Figure 2A shows that, to dilute the extractable juice in cane in one operation to the desired final Brix, assuming 100% efficiency of mixing, the imbibition rate to be used would be 11 × f for a final Brix of 7° or 25 × f for a final Brix of 3°, giving 98% extraction after dewatering in a conventional mill.

Figure 2B refers to a milling process with imbibition applied on cane, in front of the first mill. The Ponchon Savarit diagram shows that, in this case, assuming a stage efficiency of 100% and an imbibition rate of 2.5 × f, the number of stages to be used would be 2 for 95% extraction or 3 for 98% extraction.

Figure 2C is the Ponchon-Savarit diagram for a diffuser; if the juice content of the cane mat is 6 × f (leaching) and the imbibition rate 2.5 × f, 6 to 7 stages are theoretically needed to achieve a final Brix of 3°, giving 98% extraction after dewatering. If the juice content of the cane mat is 12 × f (displacement process), then the number of stages theoretically needed would be 15.

Figure 3A gives the theoretical number of stages to be used in the various processes depending on the imbibition rate, for a target extraction of 95%. Figure 3B gives the same information for 98% extraction. The number of

3 *Zuckerind.*, 1987, 112, 966 - 970.

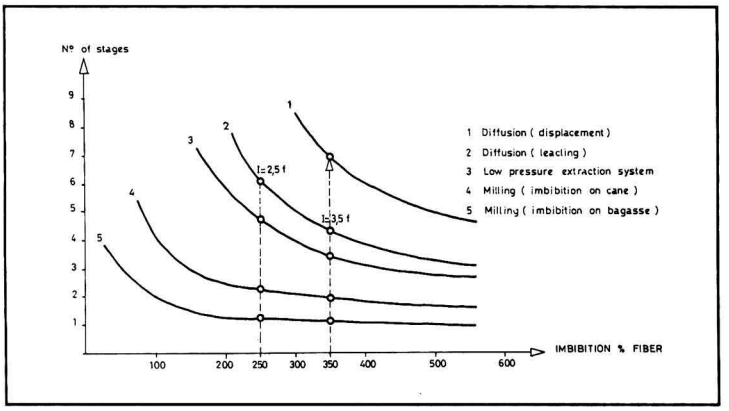


Fig. 3B. Number of stages *versus* imbibition rate for 98% extraction

stages predicted by the use of the Ponchon-Savarit diagram is theoretical; that is to say, the stage efficiency is assumed to be 100%. But what can we expect in practice?

Practical stage efficiency

At Quartier Français factory in 1981 a pilot plant (Figure 4) was designed to simulate hydrodynamic washing of shredded cane, using diluted juice successively from No. 2, No. 3, No. 4 and No. 5 mills, and finally water.

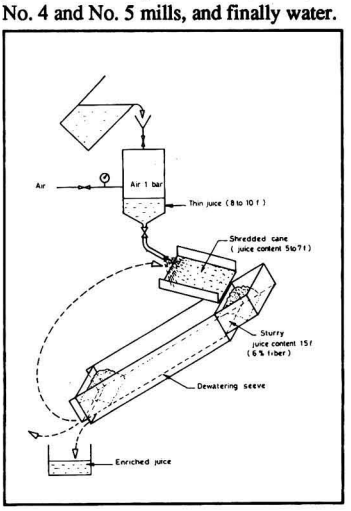


Fig. 4. Hydrodynamic cane lixiviation pilot plant at Quartier Français, 1981

The juice in cane was diluted to a final residual juice of below 3.5°Brix after five stages only. After dewatering in a static hydraulic press to a final moisture content of 55%, a pol extraction of 97% was obtained. So the stage efficiency must have been close to 100%.

This hydrodynamic process was patented in 1982 and it was of interest to determine what would be the stage efficiency in an industrial hydrodynamic extraction system. The Quartier Français factory was closed down at the end of the 1982 crop, however, and we had to wait until the end of the 1986 crop to carry out experiments on cane lixiviation on an industrial scale at Beaufonds factory.

For 24 hours (the last day of the 1986 season), the 1st mill was by-passed and the shredded cane sent to the bagasse lixiviation cell in which No. 3 mill juice was applied as in normal bagasse imbibition (Figure 5). Recycling of the juice was used to lower the fibre content of the mixture. The drop in Brix through this cane lixiviation stage was 84% of the achievable drop; stage efficiency was therefore 84%.

Second industrial scale experimentation (cane imbibition)

In Beaufonds sugar factory, during the whole 1988 crop, No. 2 mill juice was recirculated in front of the No. 1 mill. Cane imbibition was therefore performed in a countercurrent pattern (Figure 6). Although the process was far from being hydrodynamic (imbibition using No. 2 mill juice was applied in the conventional manner, on top of the Donnelly chute), the stage efficiency was 74%, as compared with an efficiency of 35% for the following bagasse imbibition stage.

Conclusion

On an industrial scale, a stage efficiency of at least 80% can be expected from a fully hydrodynamic process. The target dilution to 3°Brix of residual juice in cane will therefore need 7 to 8 stages (6/0.8). Four hydrodynamic cane lixiviation cells will be installed at Beaufonds in 1989 in front of the first mill and will be followed by three cane imbibition stages. Three mills only will be used, with two bagasse imbibition cells. The predicted overall extraction is 98%.

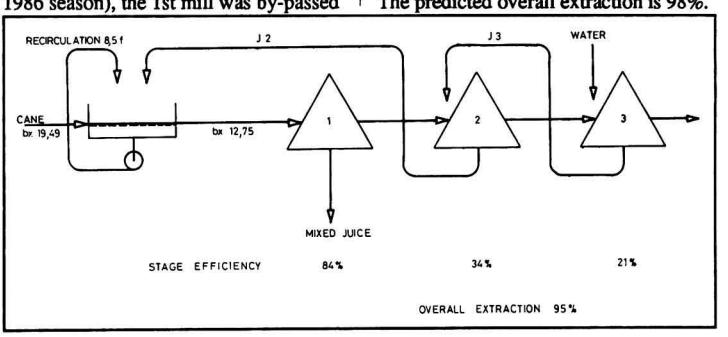


Fig. 5. Flow diagram of three-mill tandem at Beaufonds, 1986 with one cane lixiviation stage and two bagasse imbibition stages

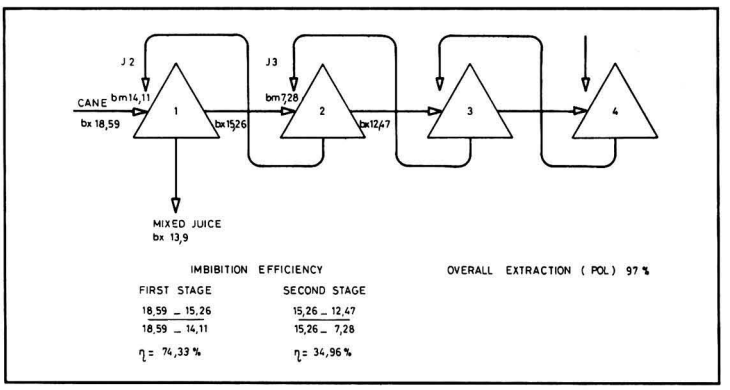


Fig. 6. Flow diagram of four-mill tandem at Beaufonds, 1988, with one cane imbibition and three bagasse imbibition stages

It had been hoped that the results of this industrial scale experiment would be available for distribution and discussion at the 1989 ISSCT meeting in Brazil but this was not to be, and the results will be published at a later date.

Summary

Milling and diffusion are both multistage countercurrent extraction processes. As shown by the author[4] in 1976, both processes use about twice as many stages as would be required if the mix-ing of the extractable juice with the imbibition juice was 100% efficient. In the case of milling, this is because, after being compressed, the bagasse on re-expanding fills up with air, thus hindering the penetration of the imbibition liquid. In the case of diffusion it is because the solid phase is static with respect to the liquid phase. Imbibition should be applied on cane, not on bagasse, and the mixture of shredded cane and imbibition juice should be fluid so that it can be agitated in a hydrodynamic process.

4 "Must we abandon mills". *Paper presented to Mauritius sugar conference*, 1976.

Facts and figures

Indonesian sugar production and imports[1]

Gunung Madu Plantations, on the southern tip of Sumatra, is one of the largest sugar factories in the Southern Hemisphere after Brazilian plants. It now crushes 12,000 tonnes of cane daily from an area of 21,000 hectares. Its growth is part of an expansion whereby Indonesia is fast approaching self-sufficiency in sugar and has produced its largest ever sugar cane crop this year. Nevertheless, the estimate for Indonesian imports in 1989 has been further raised to 621,000 tonnes, against 180,000 tonnes in 1988 and a forecast of 282,000 tonnes for 1990, according to the Indonesian Sugar Council[2].

Continuing sugar shortages in China[3]

China's Ministry of Agriculture said in its newsletter that the country will be on average 2.3 million tonnes short of sugar every year until at least the year 2000. It estimated domestic demand in 2000 at 13.56 million tonnes, white value, and supply at 11 million tonnes, up from 11.03 and 8.5 million tonnes, respectively, in 1995 and 8.32 and 6.5 million tonnes in 1990. Annual per caput consumption is forecast to rise to 10.6 kg by 2000 from 9.2 kg in 1995 and 7.4 kg in 1990.

Italian sugar industry rationalization proposal[4]

The Italian Minister of Agriculture has proposed that, of the seven sugar factories in the southern part of the country, four – Latina, Foggia Incoronato, Potenza and Strongoli – should be closed. The factories at Termoli, Rignano Garganico and Rendina would process all the beet in the region. An alternative would be for the closed factories to engage in refining of temporarily imported raw sugar, or the production of yeast and alcohol. Restructuring in northern Italy would involve the closure of the factory at San Pietro in Casale and expansion of that at Pontelagoscuro.

Congo sugar industry diversification[5]

The sugar industry of the Congo Republic is to diversify into production of jam, biscuits and livestock feed by processing molasses, according to the head of the State Sugar Corporation. A distillery project was started in 1988. Raw sugar production is expected to reach 35,000 tonnes from 370,000 tonnes of cane, against 31,000 tonnes in 1988. More than half of the output was exported to the EEC and US.

Egypt sugar imports, 1988[6]

	1988	1987
	tonnes, raw value	
Brazil	133,000	28,000
Cuba	50,000	77,000
Czechoslovakia	0	28,000
EEC	528,000	405,000
Germany, East	36,000	41,000
Guatemala	13,000	0
Mexico	15,000	0
Poland	42,000	61,000
Sweden	10,000	0
Thailand	0	16,000
USA	0	13,000
USSR	24,000	0
	851,000	669,000

1 *Australian Canegrower*, 1989, **11**, (12), 3.
2 *Reuter Sugar Newsletter*, July 26, 1989.
3 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 448.
4 *Ind. Sacc. Ital.*, 1989, **82**, 160.
5 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 463.
6 *I.S.O. Stat. Bull.*, 1989, **48**, (8), 2.6.

The performance of a cane shredder fitted with feed rolls

By R. I. Letizia and E. E. McDougall
(Mackay Sugar Cooperative Association Ltd., Racecourse Mill, Queensland, Australia)

Introduction

For the 1987 crushing season, Racecourse sugar factory installed several major items of plant, including a 2.75 m wide cane shredder. The shredder was part of a $Aus 14 million expansion program to rebuild the marshalling yards and cane receivals station on the southern side of the Peak Downs Highway and to construct a new cane preparation station and number one mill beside the existing milling train.

Design parameters

The following design criteria were specified for the shredder:

(a) Crushing rate of 750 tonnes cane per hour with minimum consumed power of 8 kW/tch.

(b) Minimum preparation of 90% P.O.C.

(c) Heavy 26 kg forged steel hammers with hammer tip speed of 95 m/sec.

(d) Tungsten carbide hammer tips and tramp iron magnet.

(e) Feeder rolls to obtain maximum angle of wrap of grid, eliminate chokes with worn hammer tips, and achieve a more uniform feed to the shredder.

(f) Feeder rolls configuration such that no cane passes between the rolls when they are stationary.

(g) Tall feed chute with feed level controls.

(h) Ability to remove shredder rotor with overhead crane without dismantling chute and feeder rolls.

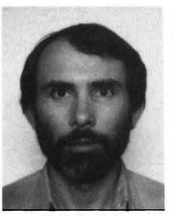
(i) Prepared cane to discharge onto conveyor belt with minimum centre distance between shredder and No. 1 mill.

(g) Design to minimize maintenance and facilitate hammer removal and handling.

Description of plant

Cane carrier and conveyor

The design and operation of the



R. I. Letizia

E. E. McDougall

receivals station has been described by Stuart & McEachran[1]. The cane is fed with the assistance of a kicker from a 1.98 m wide slat conveyor onto a 1.83 m wide conveyor belt which transports the cane 180 metres across the highway. This conveyor, which is fitted with a belt weigher for determining cane rate, discharges onto a tramp iron magnet at the top of the shredder chute. The electromagnet is 1.98 m wide with a stepped face plate made from 12 mm manganese steel, of single pole construction, oil cooled and rated at 11 kW when hot.

Shredder chute and feed rolls

Figure 1 is a cross sectional elevation of the shredder, feed chute and feed rolls. The shredder feed chute is 8.0 m high and slopes at 60 degrees. It delivers billet cane to two spikey-toothed rollers which are driven independently by 45 kW motors, through eddy-current couplings and shaft-mounted reduction units. The feed rolls have a base cylinder diameter of 900 mm, with 250 mm high spikey teeth and have a maximum peripheral speed at the base cylinder of 30.5 m/min. The rolls have independent drives to allow for roll setting adjustment, and the teeth on one roll are displaced longitudinally with respect to the other roll so that the teeth do not mesh. Data on feeding billet cane with spikey tooth rolls were not available when the shredder feeder was designed. The feeder that was installed at Pioneer mill, as described by Millet & Wellington[2], was designed to meter cane into the shredder and not be a force feeder.

It was assumed that the cane density in the shredder chute would be similar to that in a cane bin (about 350 kg/m³). With a suitably wide feeder setting, a similar compaction (representing a compression ratio of about 0.3) should be possible in the nip between the rolls. The power requirements for such a low compression ratio were considered to be small and extrapolation of the results from Sugar Research Institute's experimental shredder feeder[3] predicted a power requirement of 72 kW at 750 tch. Consequently a total of 90 kW (2 × 45 kW) was installed

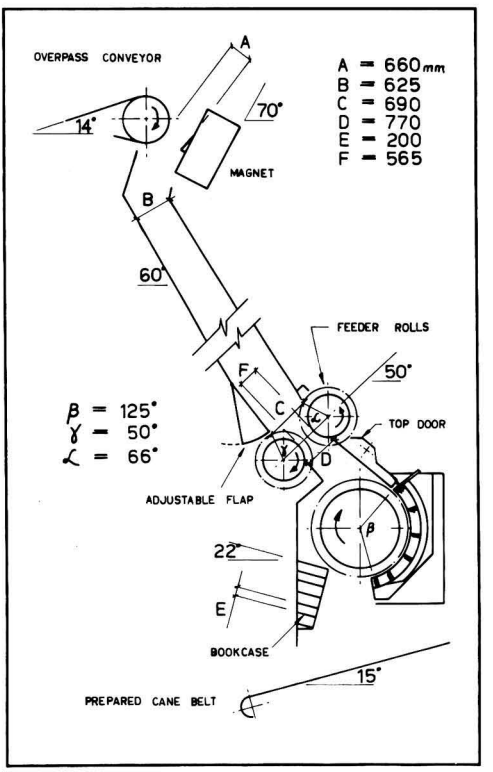


Fig. 1. Cross sectional elevation of shredder

1 *Proc. Australian Soc. Sugar Cane Tech.*, 88, 63 - 68.
2 *ibid.*, 1986, 303 - 307.
3 Cullen: Private correspondence, 1982.

and the feed rolls were set at 485 mm between base cylinders, with the feed chute 860 mm deep at the bottom.

Shredder

Apart from the feed rolls, the shredder is basically of conventional design. It is driven by a 7000 kW multi-stage impulse turbine through a double helical gearbox. The nominal operating speed of the shredder is 857 rpm, with a swept diameter of 2.13 m. The rotor carries 12 staggered rows of hammers with non-indexable tungsten carbide tips: a total of 162 hammers. The grid is of pocketed design with an angle of wrap of 125 degrees.

Access to the shredder rotor for hammer maintenance is obtained by raising the top door as shown in Figure 2. To reduce manual handling of the heavy hammers, a lifting rack is used to lower the hammers into the shredder one row at a time. Removal and replacement of the hammer pivot bars are facilitated with the use of a hydraulic ram.

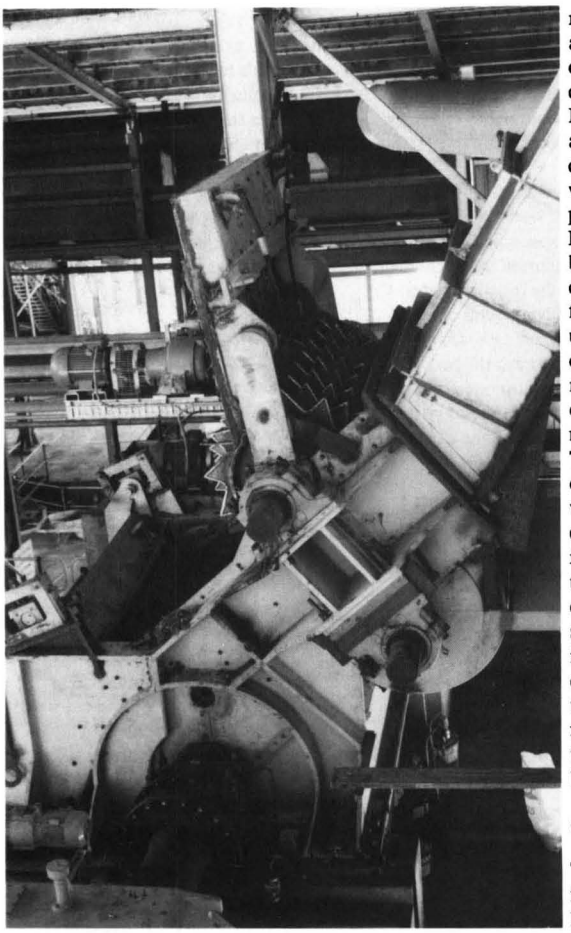


Fig. 2. Shredder with shroud removed from top feed roll and top door raised to allow access to rotor

The shredder is mounted 5 metres above floor level on a reinforced concrete pedestal. It discharges onto a 3 metre wide conveyor belt which transports prepared cane to No. 1 mill. This belt has a concave radius rising from 15 degrees under the shredder to a maximum of 21 degrees at the number one mill. The shredder discharge is fitted with a "bookcase". The latter is designed so that any metal expelled from the shredder will impinge on the cane packed into the bookcase and not be driven into the prepared cane belt.

Control

The milling train, from the cane unloading station to No. 6 mill, is under the control of a Bailey Controls Network 90 distributed control system. The milling train runs under automatic control with the Network 90 performing both loop and sequence control in a manner similar to that at Fairymead mill as described by Troiani & McLucas[4].

With the cane carrier, overpass conveyor, feed rolls and prepared cane belt all installed with variable speed drives and the ease of reconfiguring the Network 90, it is a relatively simple matter to experiment with different control strategies. The control scheme that was used for most of the season was the following:

(a) No. 1 mill is set at a fixed speed.

(b) The shredder feed rolls are controlled from No. 1 mill chute level via a two-term control loop and the prepared cane belt speed is set in a direct ratio to feeder speed.

(c) The cane carrier speed is controlled from shredder chute level via a two-term control loop and the overpass conveyor speed is set in direct ratio to carrier speed.

The level of billet cane in the shredder chute is detected by six Bell Instruments Model BAL-13-0-2 capacitance transducers spaced at 800 mm intervals up the side of the chute. These level transducers have been used successfully for several years in the bottom of the cane carrier for controlling the tipping cycle.

Operation and performance

Shredder

Several problems relating to vibration were experienced. The nominal speed of the shredder, 857 cycles/min or 14.3 Hz, coincides with the natural frequency of vibration of the spring-mounted turbine emergency stop valve and its associated pipe-work. At 857 rpm and with a set of worn hammer tips, the velocity of the stop valve in the vertical direction was 30 mm/sec. It was found that, by running the shredder at 720 r/min, the vibration of the valve could be reduced to an acceptable level

4 *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 141 - 148.

of 3 mm/sec. This problem has yet to be resolved with the turbine manufacturer.

The shredder was originally designed to operate with eight complete rows of 27 hammers each. However, the vibration with this configuration was quite severe particularly on the grid. The present configuration of 12 staggered rows runs more smoothly and quietly [87 dB(A) at floor level] albeit at the expense of preparation. The average P.O.C. figure for the season was a disappointing 89.7%. This can be attributed to the low operating speed of 720 rpm and an average power consumption of 3000 kW. Cane preparation of greater than 90% P.O.C. should be easily achieved at an operating speed of 857 rpm and an input power of over 4000 kW.

Problems were also experienced with the shredder surging. The shredder and/or conveyor belt had a tendency to wrap up the prepared cane into what looked like rolls of carpet which would then travel up the prepared cane belt, followed by a gap. This problem was particularly severe until extra "shelves" were added to the bookcase to reduce the distance between shelves from 400 mm to 200 mm. It is possible that a lump of prepared cane is forming in the top of the bookcase just below the arc of the hammers with cane accumulating in the shelf until the lump is large enough to fall away onto the belt. Long-fibred canes appear to be more susceptible to the problem than short-fibred canes, which generally discharge onto the belt in a continuous blanket.

Hammer tips

The use of a tramp iron magnet and tungsten carbide hammer tips has proved very successful in reducing hammer maintenance. Seco Titan B45 tips (Figure 3) with a hardness of 1130 HV were used initially and achieved an operating life of 360,000 tonnes of cane or six weeks crushing. The harder CM grade (1400 HV) is now being tested. On average, four tips are smashed every week from the passage of tramp iron through the shredder. No problems with shredder chokes were experienced even after two weeks of continuous crushing with a set of very worn hammer tips.

Shredder feeder

The shredder feed rolls were initially run at full speed, so that no build-up of cane occurred in the chute or in the nip between the rolls while the rest of the new equipment was commissioned. However, when cane was allowed to bridge between the two rollers, the two eddy-current couplings stalled and the feed chute had to be dug out. The combined stall torque of both feed rolls is about 120 kNm. It was also noted that the bottom feed roll was exerting considerably more torque than the top roll and stalled first.

The bottom feed roll was subsequently lowered by 80 mm, increasing the set opening between the base cylinders to 565 mm. An adjustable flap was also installed in the bottom of the feed chute so that contact angle on the bottom roll could be reduced to 50 degrees and the feed chute depth reduced to 690 mm. The contact angle on the top roll remained at 66 degrees. With this configuration, as shown in Figure 1, the feeder rolls still required a maximum total starting torque of 100 kNm with a full chute. However, under steady state operation, at a crushing rate of 480 tch, the total power consumed by both feed rolls rarely exceeded 20 kW, which corresponds to a torque of about 40 kNm. Typically, about two thirds of the power was supplied by the bottom roll. At an average roll speed of 4.5 rpm and a net escribed volume (total volume less volume of teeth) of 5 m^3 per revolution, the average density of cane between the rolls was 355 kg/m^3 of cane. No expression of juice was evident.

Shredder chute level control

Good control over the level in the shredder feed chute proved rather difficult to achieve. The problem was caused by the angle of inclination of the feed chute and the erratic way the billet cane moved down the chute. It was found that the angle of 60 degrees was not steep enough to produce a continuous flow. The billet cane would build up along the bottom of the chute, then avalanche down the chute in a series of cascades. Consequently, it was necessary to smooth the chute level signal mathematically to obtain an "average level" input to the controller and to maintain a reasonably continuous output signal to the cane carrier and overpass conveyor. The capacitive level transducers appear to be satisfactory for detecting billet cane in a chute, although maintaining the correct sensitivity can be a problem.

Figure 4 contains two histograms of the shredder chute and No. 1 mill chute levels for a 26 hour period. These histograms, which indicate the percentage of time the chute height was in a

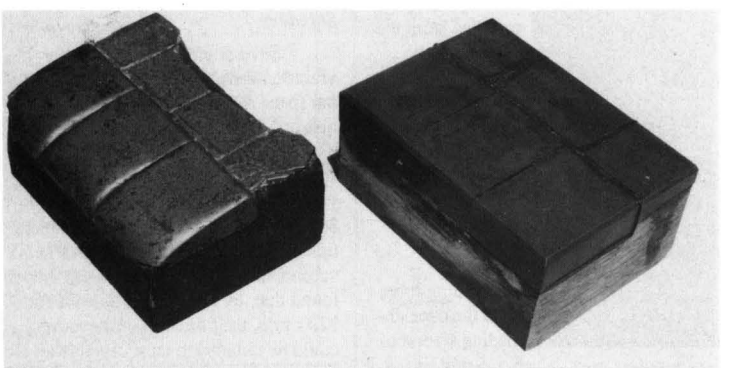


Fig. 3. Tungsten carbide hammer tips showing wear after 360,000 tonnes of cane

certain range, were obtained by statistical analysis of data recorded by the Network 90's archiving system.

The large variation in the shredder chute level is due to the control difficulties discussed above and an attempt to use the chute as a surge hopper. On the other hand, the control scheme implemented for No. 1 mill is designed to maintain the chute level as close as possible to the set-point of 55% to obtain a constant feed compaction in the hopper.

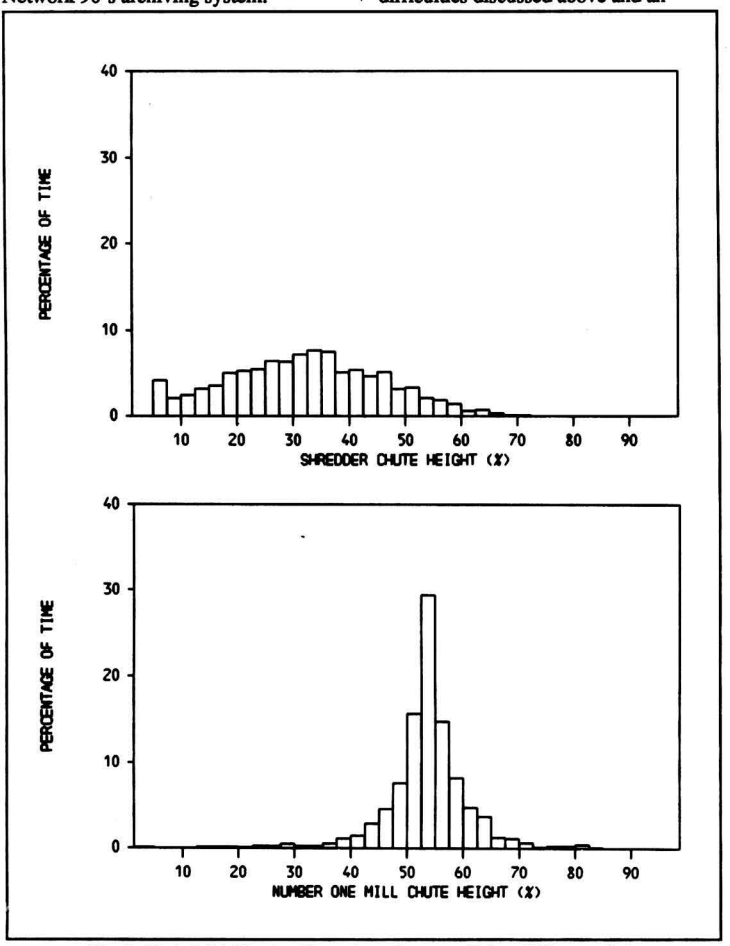


Fig. 4. Chute height for shredder and number one mill for a 26 hour period

Figure 4 shows the success of this scheme, which was also reflected in the smooth running of the rest of the milling train.

Conclusions

The Racecourse shredder has demonstrated that spikey tooth feeders can be used successfully to control the flow of billet cane through a shredder and allow the use of a large angle of grid wrap without chokes. It is believed that a crushing rate of 750 tch should be attainable with a cane preparation of greater than 90% P.O.C. The use of a tramp iron magnet and tungsten carbide hammer tips has proved successful in reducing hammer maintenance.

While good control over the level of cane in the shredder feed chute was not achieved, it did not adversely affect the No. 1 mill chute level control. An improvement in the shredder chute level control may be possible by increasing the angle of inclination of the chute.

Acknowledgements

The authors wish to thank the management and staff of Racecourse mill for their encouragement and assistance with this project. Thanks are due also to Brian Edwards, of Sugar Research Institute, for the statistical analysis of the milling train performance data.

Bagasse pulp feasibility study in Hawaii[1]

In the event of positive results from a feasibility study being undertaken by a Japanese firm, Hawaii may set up its first pulp plant. A Hawaiian sugar company recently ordered the study, which is based on the use of bagasse as raw material for the plant. According to in-itial estimates, the factory could produce nearly 50,000 tonnes annually of commercial bagasse pulp. The plant would be located at the Puunene Mill on Maui which, with its 14,500 hectares, is the largest sugar producer in Hawaii. At present the company uses most of its bagasse to generate electricity and sells its surplus for poultry litter and plant fertilizer. The company points out that diversification to pulp production would make it possible to capitalize the increased value of the bagasse for paper production.

New sugar factories in India[2]

Five more sugar factories are to be set up in the Punjab next year. The Secretary of Cooperatives in the state said that four factories (Ajnala, Budhlada, Faridkot and Jagraon) are to start production by the end of this year, raising the total number of cooperatives in the state to 17.

1 *GEPLACEA Bull.*, 1989, **6**, (9), Sugar Inf.-2.
2 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 464.

World sugar production estimates, 1989/90[1]

	1989/90	1988/89
	tonnes, raw value	
BEET SUGAR		
Belgium	990,000	1,005,000
Denmark	538,000	549,000
France	4,075,000	4,424,000
Germany, West	3,150,000	3,000,000
Greece	380,000	235,000
Holland	1,195,000	1,075,000
Ireland	212,000	212,000
Italy	1,780,000	1,606,000
Portugal	2,000	1,000
Spain	1,050,000	1,290,000
UK	1,360,000	1,417,000
EEC	*14,732,000*	*14,814,000*
Austria	468,000	357,000
Finland	144,000	145,000
Sweden	400,000	395,000
Switzerland	145,000	150,000
Turkey	1,575,000	1,414,000
Yugoslavia	885,000	653,000
W. Europe	*18,349,000*	*17,928,000*
Albania	45,000	45,000
Bulgaria	95,000	75,000
Czechoslovakia	855,000	660,000
Germany, East	605,000	550,000
Hungary	560,000	518,000
Poland	1,850,000	1,824,000
Rumania	560,000	450,000
USSR	9,400,000	8,913,000
E. Europe	*13,970,000*	*13,035,000*
Algeria	11,000	11,000
Egypt	105,000	102,000
Morocco	395,000	408,000
Tunisia	25,000	27,000
Africa	*536,000*	*548,000*
Canada	109,000	113,000
USA	3,355,000	3,186,000
N. America	*3,464,000*	*3,299,000*
Chile	435,000	451,000
Uruguay	25,000	22,000
S. America	*460,000*	*473,000*
Afghanistan	1,000	2,000
China	920,000	1,140,000
Iran	442,000	509,000
Iraq	20,000	20,000
Japan	707,000	705,000
Pakistan	45,000	38,000
Syria	15,000	22,000
Asia	*2,150,000*	*2,436,000*
World Beet	38,929,000	37,719,000

	1989/90	1988/89
	tonnes, raw value	
CANE SUGAR		
Spain	16,000	16,000
Europe	*16,000*	*16,000*
Angola	25,000	12,000
Burkino Faso	27,000	22,000
Cameroun	80,000	80,000
Chad	25,000	27,000
Congo	35,000	31,000
Egypt	913,000	875,000
Ethiopia	190,000	195,000
Gabon	15,000	15,000
Guinea	20,000	15,000
Ivory Coast	155,000	158,000
Kenya	449,000	428,000
Madagascar	131,000	122,000
Malawi	184,000	178,000
Mali	20,000	20,000
Mauritius	614,000	672,000
Morocco	108,000	119,000
Mozambique	38,000	27,000
Nigeria	65,000	55,000
Réunion	206,000	251,000
Rwanda	5,000	5,000
Senegal	82,000	77,000
Sierra Leone	6,000	6,000
Somalia	50,000	49,000
South Africa	2,550,000	2,470,000
Sudan	413,000	378,000
Swaziland	467,000	465,000
Tanzania	110,000	105,000
Uganda	25,000	20,000
Zaire	75,000	70,000
Zambia	145,000	140,000
Zimbabwe	415,000	470,000
Africa	*7,643,000*	*7,557,000*
Barbados	79,000	66,000
Belize	94,000	96,000
Costa Rica	220,000	224,000
Cuba	7,900,000	8,124,000
Dominican Republic	820,000	735,000
Guadeloupe	81,000	79,000
Guatemala	733,000	705,000
Haiti	50,000	48,000
Honduras	200,000	197,000
Jamaica	235,000	192,000
Martinique	8,000	8,000
Mexico	3,830,000	3,712,000
Nicaragua	250,000	205,000
Panama	110,000	111,000
Puerto Rico	85,000	83,000
St. Kitts	28,000	28,000
El Salvador	228,000	198,000
Trinidad	103,000	101,000

	1989/90	1988/89
	tonnes, raw value	
USA-Hawaii	850,000	813,000
-Mainland	2,295,000	2,241,000
N. & C. America	*18,199,000*	*17,966,000*
Argentina	980,000	1,284,000
Bolivia	185,000	166,000
Brazil	7,430,000	8,582,000
Colombia	1,461,000	1,425,000
Ecuador	325,000	292,000
Guyana	204,000	168,000
Paraguay	120,000	105,000
Peru	590,000	580,000
Uruguay	55,000	51,000
Venezuela	500,000	510,000
S. America	*11,850,000*	*13,163,000*
Bangladesh	145,000	115,000
Burma	45,000	26,000
China	4,450,000	4,157,000
India	10,150,000	9,460,000
Indonesia	2,350,000	2,083,000
Iran	189,000	125,000
Iraq	6,000	7,000
Japan	265,000	279,000
Malaysia	105,000	100,000
Nepal	30,000	30,000
Pakistan	2,0060,000	1,975,000
Philippines	1,700,000	1,590,000
Sri Lanka	38,000	37,000
Taiwan	590,000	664,000
Thailand	3,850,000	4,080,000
Vietnam	460,000	470,000
Asia	*26,433,000*	*25,198,000*
Australia	4,100,000	3,755,000
Fiji	490,000	376,000
Papua New Guinea	37,000	51,000
Oceania	*4,627,000*	*4,182,000*
World Cane	68,768,000	68,082,000
World Sugar	107,697,000	105,801,000

* * *

Argentina cane crop reduction[2]

Following drought in Argentina[3], the Ministry of Agriculture forecasts the sugar cane crop in 1989/90 to reach 10,780,000 short tons, down 22.7% from the 13,939,000 tons of 1988/89 and 26% below the 14,486,000 tons average of the preceding five years.

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 455 - 457.
2 *Czarnikow-Rionda Rpt.*, September 14, 1989.
3 See *I.S.J.*, 1989, **91**, 159.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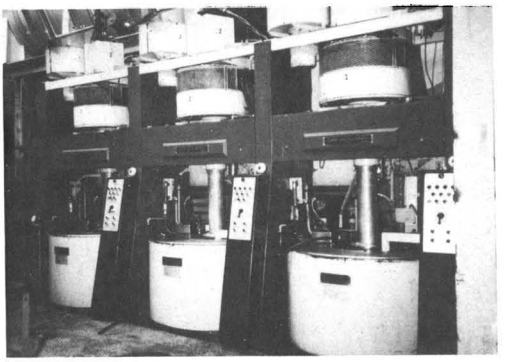

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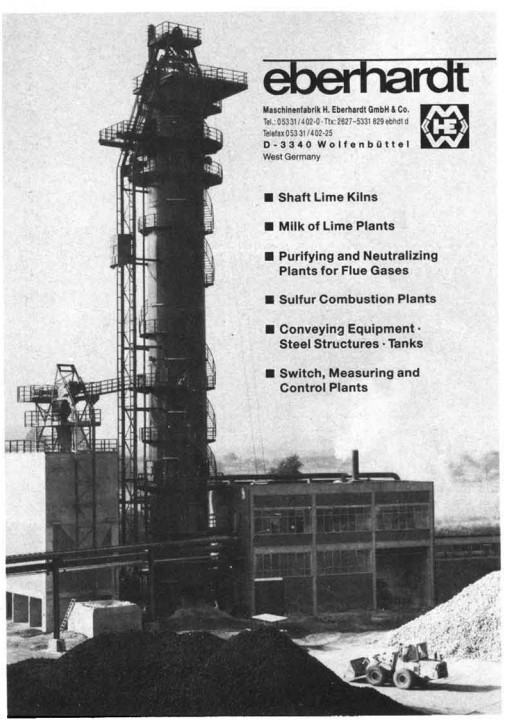

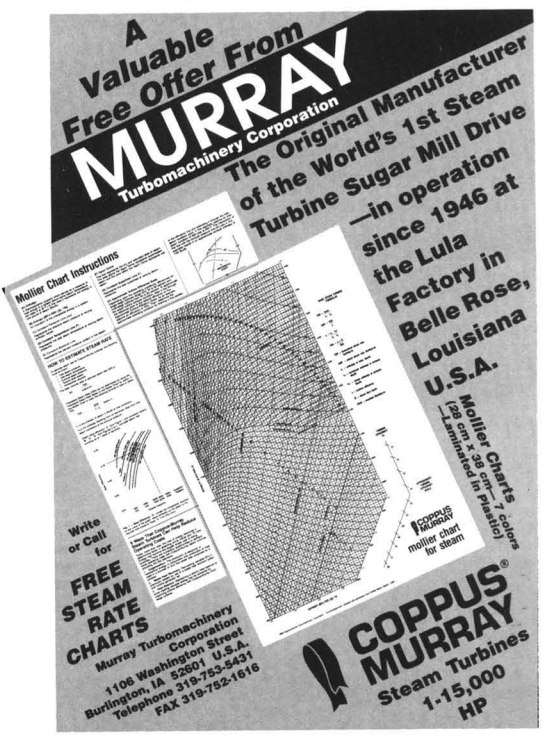

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