INTERNATIONAL SUGAR JOURNAL

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Residual sugar in lime cake	0.2–0.5 %	1 %

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Filter area
0.8–32 m²

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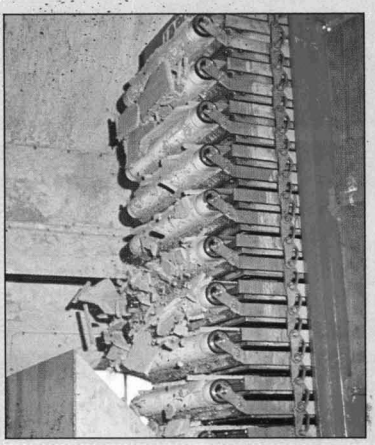
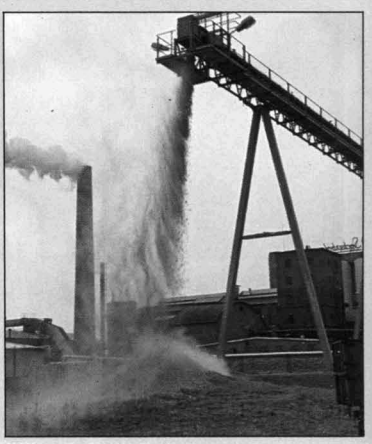
Filter area
35–200 m²





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Notes and comments

Australian working party recommendations

The Savage Committee was set up to prepare a plan for the sugar industry in Australia which would enable it to cope effectively and competitively with changing market situations. It presented its report in August and made a number of recommendations. It proposed that the existing system of assignments and peaks be replaced by a system of "Peak entitlements to No. 1 pool" which would be divisible and freely transferable in whole or in part between and within mill areas. This would allow individual growers to buy and sell their entitlement and move out of cane growing if they chose; it would also remove the incentive to grow "over-peak" cane so as to earn future entitlement, and the need for peak reviews would cease.

The committee recommended ending the formula-based approach to cane pricing, which shares revenue between growers and millers, and its replacement with a new negotiation mechanism which reflects local conditions, variations between seasons and the benefits from restructuring of the industry; any disputes should be settled under civil arbitration. The miller would pay different prices for similar quality cane depending on distance transported, reliability of supply from a particular grower, etc., and the growers would be able to negotiate directly with the mill and, if he were able to agree a contract, could supply to whichever mill he chose.

Local Sugar Cane Boards should be set up with membership agreed by millers and growers and under independent chairmen; these would prepare draft awards including all basic conditions associated with delivery of cane to the factories, and grower-miller contracts would be negotiated on a basis of this award, with provision for arbitration in the event of a dispute. A Sugar Industry Authority would be established under Queensland state legislation to serve as the single statutory body for the sugar industry.

The committee proposes that the Federal and State governments provide support for both cane growers and millers when the No. 1 Pool price is lower than set levels for the 1985, 1986 and 1987 seasons. Trade unions should be consulted at an early stage in proposals to restructure the industry, and research should be rationalized with agricultural research carried out by the BSES (which would also absorb the functions of the Pest and Disease Control Board), and processing research handled by the SRI, albeit with formalized cooperation between the two bodies. Other recommendations are for the removal of the tariff on imported cane harvesters and replacement of the present cane testing service with a mill analysis audit system employing automated equipment.

In September the Federal Prime Minister announced an A$ 150 million income support package for the industry but he imposed two conditions before the package could be implemented[1]. One was that the state governments should contribute additional funds for the scheme and the other was that the sugar industry should agree to a significantly greater degree of consultation. The NSW cabinet has approved participation to extent of A$ 12 million, but the Queensland government is intransigent, refusing to contribute anything to the subsidy and claiming that the Labor government of Mr. Hawke is taunting the Queensland government which is ruled by the National Party. The Queensland Premier says that income support is entirely the Federal government's responsibility because it raises taxes from the industry. The Federal government, on the other hand, argues that since sugar cane is grown almost entirely in Queensland and the industry has been structured and regulated by the State government for more than 60 years, the latter has an obligation to contribute to the subsidy.

Sugar producers themselves have mixed feelings about the strings attached to the income support; they want the subsidy badly but many are averse to losing the protection they enjoy from existing regulations. The Queensland Cane Growers Council challenged the Federal government to identify the financial benefits that deregulation would bring, and this annoyed the Federal Minister for Primary Industry who replied that the Federal government would not put taxpayers' money into an industry that is not prepared to repay the investment by restructuring and making itself more efficient.

While the squabble goes on, more and more growers are falling deeper in debt and the Committee's program includes provision for relief of interest on loans to improve farms and support incomes which have fallen short of basic needs. Interest subsidy, income support and deregulation are, however, not watertight guarantees for a lasting recovery of the Australian sugar industry, which remains vulnerable to low prices on the world sugar market where it, unlike most other sugar industries, sells the majority of its export sugar.

World sugar prices

A late improvement in the weather gave the likelihood of higher sugar output from the European beet crops being processed and as a consequence the world prices of raw and white sugar tended to slide during the early part of October; the LDP and LDP(W) fell from $136 and $175, respectively, to minima of $125 and $164.50 on October 21. Thereafter, reports of damage to Brazilian sugar crops by drought, and that caused to Lousiana cane by Hurricane Juan strengthened the market, as did purchases by India and China. The LDP reached $140 per

1 *Financial Times*, November 7, 1985.

tonne by October 30 while the LDP(W) reached $174.50, although both fell back slightly, to $138 and $171.50, on October 31 before resuming their climb in November.

Raw and white sugar markets

In an article concerning the changes of recent years in the amounts and destinations for EEC sugar exports (see *I.S.J.*, 1985, **87**, 198), F. O. Licht GmbH recently discussed the nature of such exports to the world market[2].

"There are in effect two sugar markets, a raw sugar market and a white sugar market, and the relationship between these has changed significantly. Until recently, world trade in sugar was based mostly upon raw sugar with a comparatively small margin in white sugar which went mainly to Middle Eastern countries lacking refining capacity of their own, and to certain developing countries which bought white sugar in small quantities. This pattern has changed fairly rapidly; the raw sugar trade now accounts for only about 60% of world gross imports. Much of this consists of raw sugar imported by industrialized countries which operate refineries and sometimes re-export white sugar. Demand in these countries has been falling rapidly in recent years, mainly because of increased competition from substitute sweeteners. This has had a profound effect on the demand for raw sugar.

"The white sugar market consists mainly of sugar refined from beet, grown in industrialized countries and sold mainly to developing countries without a refining industry. However, white sugar is also increasingly supplied by developing countries such as Brazil or toll refiners such as Korea."

Subsequently, Licht has observed[3] that world demand for white sugar sufferered a major setback in 1984/85 in spite of higher Indian demand. White sugar demand fell by more than 1.1 million tonnes against the previous year to 10.2 million tonnes and the fall would have been greater had India not imported significant quantities to bridge the gap between falling domestic production and steeply increasing consumption.

Growing economic difficulties have forced many developing countries to cut back on sugar imports and/or to foster domestic production to save foreign exchange. The war with Iraq may be a factor in the lower demand from Iran. The USSR, Yugoslavia, Mexico, Peru and Indonesia have all increased output and are not likely, therefore, to return to being as large importers as in the past. Licht concludes that all hopes for the white sugar market rest on possible crop shortfalls and on an upturn in the world economy which could increase import demand from developing countries.

"The white sugar market will grow, no doubt; population growth alone will see to that, but the growth rates may be smaller than some people wish to believe."

US alcohol demand and sweetener supplies

The Environmental Protection Agency in the US succeeded in securing legislation whereby the maximum amount of lead in gasoline was reduced from July from 1.1 to 0.5 grams per US gallon. From January 1, 1986, the limit will be reduced again, to 0.1 grams per gallon. The lead is added as tetraethyl lead which acts as an octane enhancer and permits the use of high-compression engines. An alternative is to add alcohol to gasoline and the use of alcohol for this purpose has been stimulated since July and will receive further impetus from next January. The question arises as to the source of this alcohol; the US imposes a prohibitive duty on imported fuel alcohol, and Brazilian suppliers have just had extra "anti-dumping" penalties imposed on their alcohol. The price of alcohol in the US is likely to rise sharply, when it is likely that corn processors will switch from producing HFS to alcohol manufacture — a relatively easy change for them. As a consequence this could allow a significant rise in the demand for sugar if HFS production capacity is not expanded.

Indian sugar imports

India is believed to be seeking a further 100,000-200,000 tonnes of white sugar from the free market which will complete an estimated import requirement for 1985 of two million tonnes[4]. The need for large-scale imports has arisen because of lower output than expected and a rapid increase in consumption. According to the Indian Sugar Mills Association, internal consumption, which was 7.57 million tonnes in 1983/84, is likely to rise to 8.2 million tonnes in the current season and may rise further to 9 million tonnes in 1985/86[5]. Against this, the current season's production may just touch 7 million tonnes.

US Farm Bill amendment defeat

On September 26, the House of Representatives voted down an amendment to lower the loan rate for sugar by one cent per pound in each of the next three years[6]. The amendment had been supported by the USDA and the White House and would have reduced the Market Stabilization Price. It has been opposed by representatives of the domestic sugar-producing states. A similar amendment was to be put to the Senate in October, but even if this were defeated, the unamended Bill is likely to be vetoed by the President; thus a compromise may eventually be reached in due course involving a reduction of something less than one cent.

2 *Int. Sugar Rpt.*, 1985, **117**, 499-500.
3 *ibid.*, 541-542.
4 *ibid.*, 558.
5 *Financial Times*, September 25, 1985.
6 *Dyergram*, 1985, (35), 1-2.

Aspects of automatic sugar boiling at Newark factory

By S. C. H. McCarey and F. Fearnside

(Continued from page 213)

1983 refining run

At this stage the outstanding problems in sugar end operations had been identified as white sugar crystal size and quality and raw pan station capacity. It was recognised that remelting AP sugar, instead of magmatising into raw pans, would enable both these problems to be solved, at least in part, simultaneously. However, remelting direct to standard liquor would probably increase colours and non-sugars recirculation. Therefore, affination of AP sugar was looked at as a solution.

Following a study of the affination proposal, it was concluded that affination would enable many improvements to be made to the sugar end operation.

(1) High green syrup purity and flow could be increased.

(2) Wash syrup purity could be increased, decreasing colour and non-sugars recirculation.

(3) Low green syrup purity could be decreased, despite any increase in high green syrup purity, since raw massecuite purity would be the same as that of high green syrup—using the magma system, raw massecuite purity was about two points higher than that of high green syrup.

(4) Raw massecuite crystal quality would no longer be a function of AP sugar crystal quality.

(5) Raw pan control could be improved, since pan feed would be high green syrup only, eliminating the variability of magma quality and quantity.

(6) Low purity low green syrup would enable AP pans to be boiled with 100% high green syrup charge, despite increased high green syrup purity.

One raw centrifugal was therefore adapted to spin magma, made with low green syrup, and discharge directly to the main dissolver. At the same time, a raw pan stirrer was installed for evaluation.

Having proposed to improve standard liquor quality, and therefore sugar quality, by increasing wash syrup purity, and following the success of the previous campaign on AP pans, it was decided that all pans would be full-seeded.

The amount of development work to be undertaken during the six-week refining period was therefore considerable, requiring specialist labour.

Unfortunately, the 1983 refining run did not proceed as smoothly as had been hoped, and problems were encountered throughout the run with AP massecuite handling and centrifugalling. This was eventually attributed to the high steam temperature (113°C as opposed to 100°C) giving very quick Brixing-up times and very hot strikes at dropping (92°C against 80°C). However the plant configuration did not allow this to be changed, nor could the pan control system be set up to simulate campaign conditions.

The affination system worked well and the average purity profile for the sugar end was on target.

Raw pan operation, in terms of both sugar purity and low green syrup purity, improved as expected. The control strategy used was essentially the same as that for AP pans. The stirred raw pan was not fully evaluated at this time. Figure 8 illustrates the full-seeded raw pan cycle.

Full seeding of white pans took a considerable time to develop, the main problems being the quality of seed slurry available—icing sugar in isopropanol—which had too wide a size variation, with up to 4% greater than 20 microns.

However, by the end of the refining run, the technique was well established and the control strategy is illustrated in Figure 9.1. The overall refining run results obtained for mean aperture, coefficient of variation and pan yield were disappointing. However, the same data plotted on a weekly basis indicated an improvement as the full seeding technique was refined.

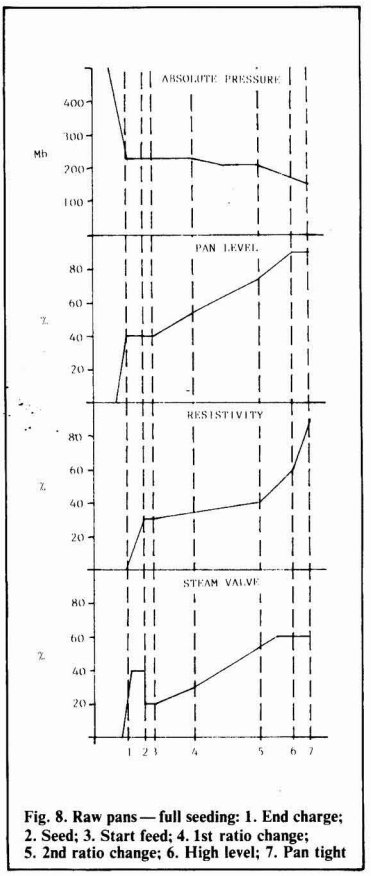


Fig. 8. Raw pans — full seeding: 1. End charge; 2. Seed; 3. Start feed; 4. 1st ratio change; 5. 2nd ratio change; 6. High level; 7. Pan tight

1983/84 Campaign

It was clear at the end of the 1983 refining run that sugar end operations were improving but that a period of consolidation was required. Therefore, no major plant changes were made for the 1983/84 campaign. However, after some consideration, the syrup used for affination purposes was changed to high green syrup, this being returned to the high green supply after use. In addition a small Ditmar slurry ball mill was purchased for pan seed preparation.

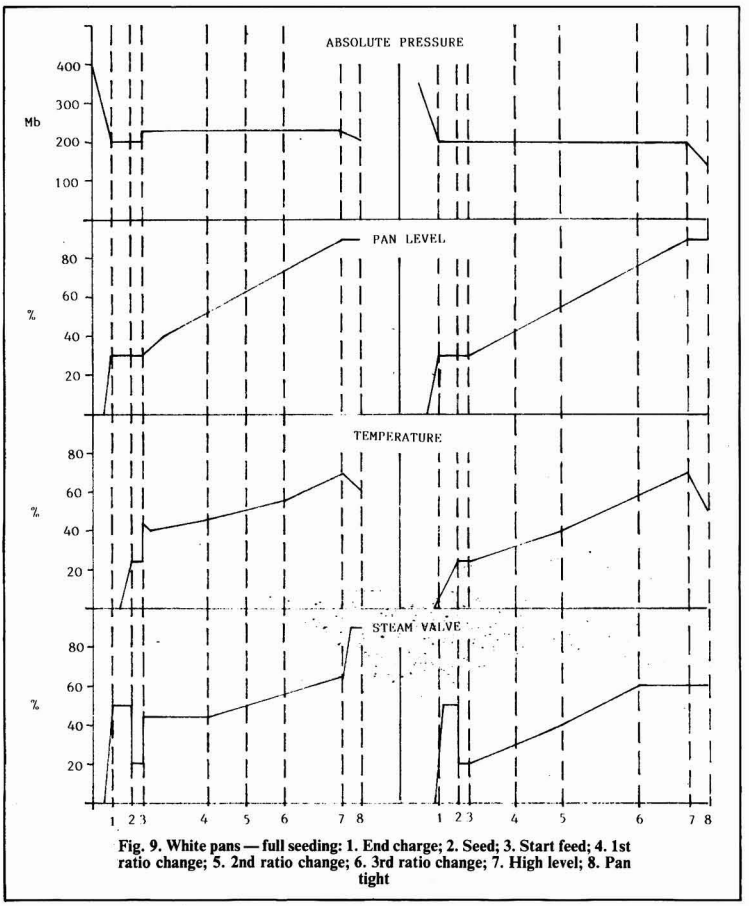


Fig. 9. White pans — full seeding: 1. End charge; 2. Seed; 3. Start feed; 4. 1st ratio change; 5. 2nd ratio change; 6. 3rd ratio change; 7. High level; 8. Pan tight

Having established the value of pan microscopes, the whole station was equipped with these, complete with closed-circuit TV cameras and monitors in the control room. As the most critical stages in the strike are during seeding and shortly after, two monitors were required for the four white sugar pans, one for the raws and one for the AP's, with a channel-switching arrangement.

Sugar end performance during the campaign was very good, and generally as expected.

Affination using high green syrup gave a higher purity, lower colour sugar and a lower purity affination syrup as spun. This decrease in purity was disproportionate to the amount of non-sugars removed from AP sugar and can therefore be attributed to the removal of fine grain from high green syrup.

The purity profile across the sugar end was quite satisfactory and a high white massecuite purity was obtained.

Full seeding of white pans again proved to give good results, but problems were once more encountered with seed slurry quality. A small quantity of slurry prepared in the Ditmar mill was available at the campaign start and crystal size analyses showed this unit to be giving good results. However, following particle size analysis using Coulter counter techniques a minimum milling time of 48 hours was required to give a CV in the low 30's. At this rate, the mill was not capable of maintaining the required slurry supply, and after two weeks icing sugar had to be used. A comparison of crystal size for the two periods shows that the Ditmar slurry gave far better results. A larger mill was therefore purchased and slurry from this mill again gave good results, similar to those obtained previously (See Appendix A, Figure A8). However, subsequent Coulter counter particle sizing and laser scattergram sizing both indicated that the CV of the slurry was very high—in the region of 60%. The product sizing obtained is therefore difficult to explain.

One possibility investigated was that full seeding was not being obtained in practice. To establish whether or not this was the case, a pan was "seeded" using only isopropanol. No grain formation was evident on the closed circuit TV monitor at any time during the period after seeding. A normal seed slurry was then added and grain formation was immediately evident.

Another possibility was that very small particles were being removed by being dissolved owing to variable supersaturation in the liquor bulk. However, analysis of particle size distribution indicated that not all the particles removed were small.

Disregarding the possibility that both crystal size analyses were incorrect, it seems most likely that a localized dissolving of a range of the smaller particles was occurring, probably at, or close to, the heating surface where liquor temperatures would be higher. Smaller particles would also be removed in the centrifugals, granulator and cooler. Regardless of the exact mechanism involved, the milled slurry gave good, controllable, repeatable results.

The pan microscopes proved to be very useful in establishing the required

seed point value—using an estimated crystal size as shown on the TV screen and stipulating an average size requirement of 50 microns at the end of the "hold" period it was a straightforward task to determine whether the seed value for that strike was correct.

Regarding the raw pan station, mother liquor extracted from the stirred and unstirred pan massecuites indicated that the stirred pan was producing about 10% more crystal than the unstirred. This result was in line with expectations.

After the problems experienced with the after-product pans during the refining run, it was gratifying to find that these problems were not apparent during the campaign, thereby confirming that steam temperature was the problem.

1984 Refining run

Once again this was a period of consolidation. Sugar end operation was identical to 1983/84 campaign, except that steps were taken to reduce steam pressures at the after product station.

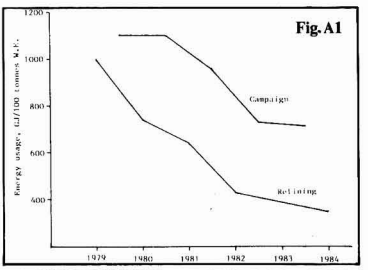
The one major change to the white sugar boiling scheme was the elimination of the small absolute pressure step change at the beginning of the "start feed" period. The reasons for doing this were that it was unnecessary when full seeding, and was detrimental owing to the high feed-rate of standard liquor at the "start feed" point (this being caused by the localized effect of high-temperature feed on the control temperature measurement). A vast improvement in white sugar crystal size was observed and the ash and solution colour of white sugar dropped dramatically, indicating that crystal regularity had improved. (White centrifugal wash water actually declined at this point). Pan yield for the whole of the refining run was on target and the improvement in white pan performance was the main factor in the reduction in energy usage shown previously in Table I. Figure 9.2 illustrates the current white pan cycle.

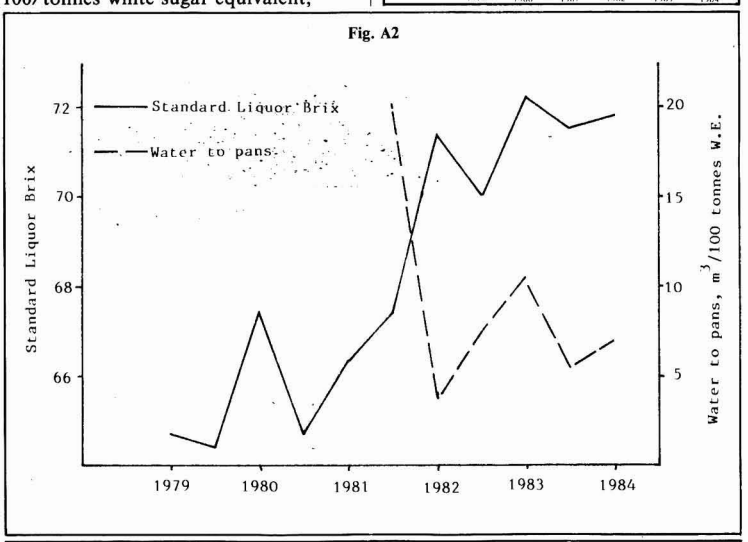
Appendix A

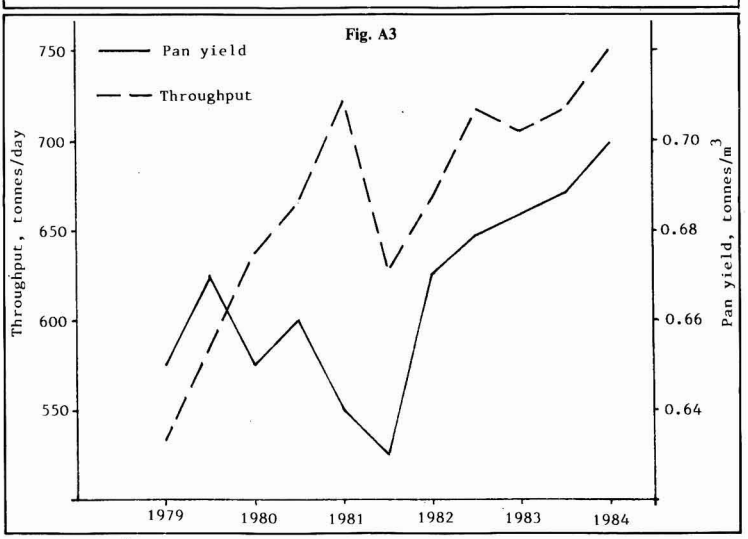
Summary of Developments 1981-1984

To demonstrate the effect of operational changes on sugar end performance over the period 1981-1984, and to illustrate some of the points made previously, a few key parameters are shown in Figures A1 to A8 below:

Figure A1. Energy usage per 100/tonnes white sugar equivalent,







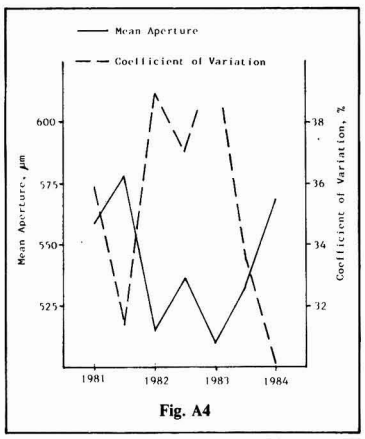


Fig. A4

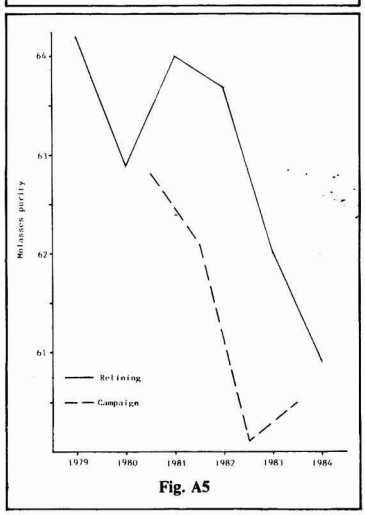


Fig. A5

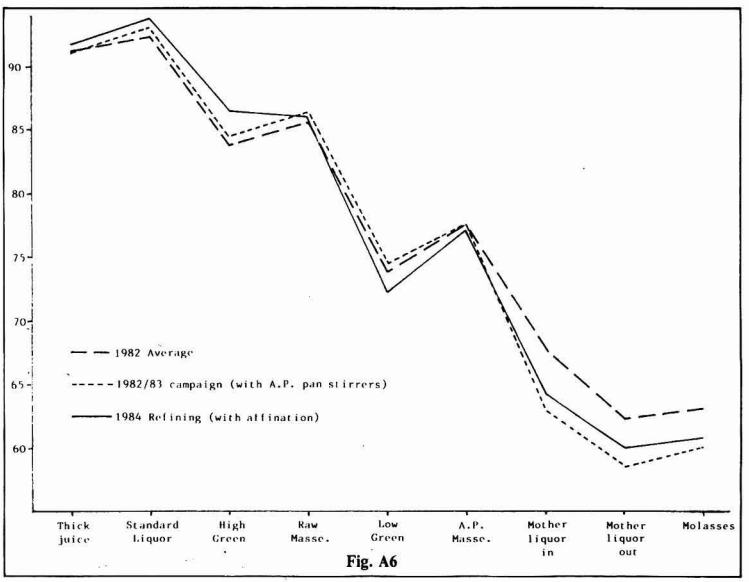


Fig. A6

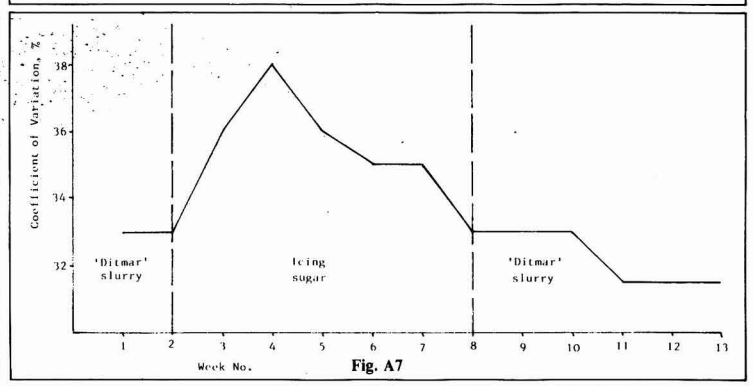


Fig. A7

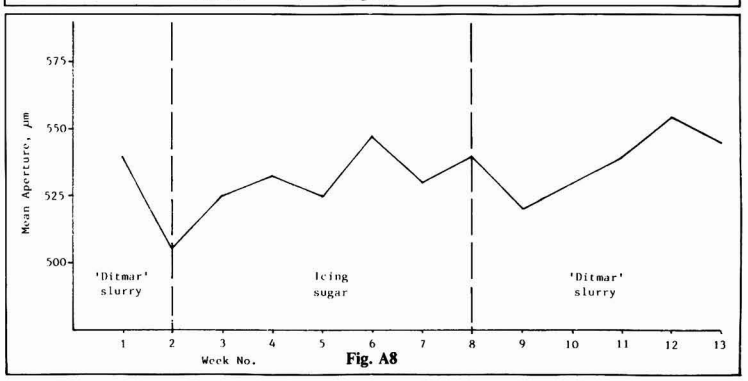


Fig. A8

1979-1984.

Figure A2. Standard liquor Brix and pan drinks, 1979-1984.

Figure A3. Pan yield and sugar end throughput, 1979-1984.

Figure A4. White sugar crystal size — Mean Aperture and Coefficient of Variation, 1981-1984.

Figure A5. Molasses purity, 1979-1984.

Figure A6. Sugar end purity profile, 1982-1984.

Figure A7. Effect of seed slurry quality on white sugar crystal CV, 1983-1984 Campaign.

Figure A8. Effect of seed slurry quality on white sugar crystal MA, 1983-1984 Campaign.

Summary

Micro-processor control of sugar boiling has been employed at Newark sugar factory since the 1977/78 campaign and a detailed account is given of the changes in both equipment and boiling methods which have been applied since then, together with the consequent effects on sugar crystal quality, molasses purities and energy consumption.

Aspects de la cuisson automatique à l'usine de Newark

Depuis la campagne 1977/78 on a utilisé à la sucrerie de Newark le contrôle par microprocesseur de la cuisson du sucre. On rapporte en détail les modifications en équipement et en méthodes de cuisson apportées depuis lors. On cite aussi les effets que ces modifications ont eus sur la qualité du sucre crystallisé, sur la pureté de la mélasse et sur la consommation d'énergie.

Aspekte von automatischem Zuckerkochen in der Zuckerfabrik Newark

Ein Mikroprozessor-System wird seit der 1977/78 Kampagne zur Regelung des Zuckerkochens in der Zuckerfabrik Newark angewendet, und die seitdem gemachten Änderungen der Vorrichtungen und Kochmethoden werden ausführlich beschrieben, wie auch die resultierenden Einwirkungen auf die Qualität der Zuckerkristalle, auf die Melassereinheiten und auf den Energieverbrauch.

Aspectos de cocción automática en la azucarera de Newark

Control por micro-procesor de la cocción de azúcar se ha empleado en la azucarera de Newark desde la campaña de 1977/78 y se presenta una cuenta detallada de las modificaciones de equipos y métodos de cocción que se han aplicado a partir de eso. También se discuten los efectos sobre calidad de cristales de azúcar, purezas de melaza y consumo de energía que han resultado de estos cambios.

A glucan from sugar cane

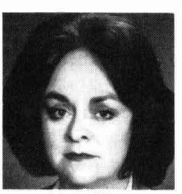
By Earl J. Roberts*, M. A. Clarke*, M. A. Godshall* and F. W. Parrish**

Introduction

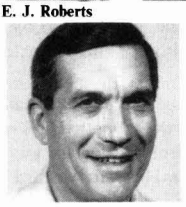
Sugar cane contains several types of polysaccharides; among them are starch, which is a mixture of amylose and amylopectin, and another type which we have designated indigenous sugar cane polysaccharide (ISP). These polysaccharides affect sucrose yield, and the efficiency of crystallization, press filtration, clarification and other process steps.

The composition of ISP may vary with cane variety, the method of purification and the age of the cane from which it is extracted. Upon acid hydrolysis ISP yields arabinose, xylose, rhamnose, mannose, galactose, and glucose[1]. Glucuronic acid has also been found to be a component of ISP[2]. No galacturonic acid has been found. It is now thought that the galacturonic acid reported to be in sugar cane in early literature (reported present as pectin) was actually glucuronic acid misidentified as galacturonic. There is

E. J. Roberts



M. A. Clarke



F. W. Parrish

galacturonic acid (as pectin) in beets and beet sugar, but none, apparently, in cane. ISP is the most abundant organic non-sugar in cane juice other than organic acids and amino acids[3]. We have shown that ISP is one of the causative factors in the formation of acid beverage floc[4]. The effects of ISP on sugar processing are recognized qualitatively, but are not known quantitatively.

Several investigators have reported the appearance of two peaks when ISP is chromatographed on gel filtration columns[5,6], indicating the presence of two fractions of different molecular weights; however, the compositions of these peaks were not reported.

Bruijn reported the isolation from stale cane of a glucan[7,8] which he called sarkaran. This glucan reportedly was composed of groups of 3 and 4 glucose units with α-(1-4) linkages

*Sugar Processing Research Inc., New Orleans, Louisiana.
**United States Department of Agriculture, Southern Regional Research Center, New Orleans, Louisiana.

1 Roberts *et al.: I.S.J.*, 1976, **78**, 163-165.
2 Roberts & Godshall, *ibid.*, 1978, **80**, 10-12.
3 Clarke *et al.: ibid.*, 197-202.
4 Roberts & Goodshall, *ibid.*, 105-109.
5 Vane: *Proc. Sugar Processing Research Conference*, 1982, 248-255.
6 Blake *et al.: Carb. Res.*, 1983, **115**, 26-272.
7 Bruijn: *I.S.J.*, 1966, **68**, 356-358.
8 Idem: Ph.D. Thesis, University of Natal, South Africa, 1973.

(maltotriose and maltotetraose) and these groups were linked together by α-(1-6) linkages. Blake & Littlemore[9] have isolated a similar polysaccharide from standover cane (cane harvested one crop year late) which they have identified as sarkaran, composed of almost equal quantities of maltotriose and maltotetraose combined in α-(1-6) linkages. Cuban workers have isolated a polysaccharide from molasses, and proposed a 1-3 glucan main chain with α-(1-6) side chains and some arabinose side chains[10,11]. This polysaccharide, like that identified by Blake & Littlemore[9], is thought to cause high viscosities in syrups and process streams. Cremata and coworkers in Cuba[11] observed that their polysaccharide caused crystal elongation along the C-axis, as does dextran.

In this paper we report the separation of a glucan from ISP from fresh cane. Evidence for the structure ascribed to the glucan is also presented.

Experimental

Methods and materials

Separation of ISP: The ISP was separated from juice from 450 lb fresh cane, as described by Roberts *et al.*[12]. Cane was in early maturity (11 months), machine cut (soldier harvester) and hand cleaned.

Purification of ISP: A 250 g portion of the filter aid, containing the ISP, was suspended in 800 ml of water and homogenized for about 30 seconds in a high speed blender to break up lumps. The suspension was then heated to boiling and filtered with suction on Whatman No. 4 paper. The filter cake was suspended in 500 ml of water, heated to boiling and filtered as before. The filter cake was again suspended in 500 ml of water, heated to boiling and filtered. The filter cake was discarded. The combined filtrates were concentrated under vacuum to 200 ml. The solution was deproteinated by the addition of 20 ml of 5% $ZnSO_4$ solution and 17.6 ml of 0.4N $Ba(OH)_2$. The solution was filtered on a filter aid mat, or centrifuged, and then dialysed in a 12,000 molecular weight cut-off bag against flowing toluene-saturated deonized water for 100 hr. The solution remaining in the bag was evaporated under vacuum to 100 ml. The solution was decolorized by stirring for 15-20 minutes with 5 g of DEAE-cellulose. The DEAE-cellulose was removed by filtration and the filtrate was freeze-dried. The yield of purified ISP was 5 to 7 g, from 250 g of the filter aid mixture.

Separation of the glucan from ISP: Five grams (5 g) of ISP was dissolved in 500 ml of distilled water and placed in the reservoir of a hollow fibre dialyser (Amicon Corp., Lexington, Mass.) with a 50,000 MW cut-off cartridge. The apparatus was connected to an external vessel containing 300 ml of water and the dialysis was carried out at a rate of 200 ml per minute. The water in the external vessel was changed six times during 30 hr of dialysis. The external solutions were combined and evaporated under vacuum to 50 ml and freeze-dried. The yield of material passing through the 50,000 MW cut-off fibres was 2.0 g (40% of the ISP).

Specific rotation: Specific rotation was determined on a Perkin Elmer 241 MC automatic polarimeter.

Acid hydrolysis of the glucan: An amount of 0.5 g was hydrolysed with 2N sulphuric acid as described by Roberts & Godshall[2], and subjected to GC analysis.

GC Analysis of hydrolysed glucan: GC analysis of the trimethylsilyl ethers of the acid-hydrolysed glucan was carried out on a Hewlett-Packard chromatograph model 5880 with a fused silica capillary column 12 metres in length coated with OV-101. The operating temperature was 175°C for four minutes, then programmed at 4°C/min.

Methylation of the glucan: An amount of 1.0 g of the glucan was methylated by the method of Hakomori[13].

Hydrolysis of the methylated glucan: The methylated glucan was hydrolysed by boiling under reflux in 2N sulphuric acid for 16 hr. The sulphuric acid was removed with barium hydroxide. The solution of the hydrolysate was concentrated and freeze-dried.

Reduction of the hydrolysate: An amount of 0.5 g of the hydrolysed methylated glucan was reduced to the methylated alditol with sodium borohydride as described by Roberts & Rowland[14].

GC analysis of the methylated alditol: GC analysis of the trimethylsilyl derivatives of the methylated alditol obtained from the methylated glucan was carried out on a Tracor chromatograph model no. 565. The column was a 30-metre capillary column coated with OV351. The operating temperature was 175°C programmed at 4°C/min to 240°C Additional methylation analysis was carried out on the Hewlett-Packard GC system described above.

Amylolysis of the glucan: An amount of 0.2 g of the glucan was dissolved in 5 ml of buffer at pH 5.0 with an excess of α-amylase (Mycolase, GB Fermentation Industries fungal α-amylase from *Aspergillus oryzae*), and the solution incubated overnight at 40° C. The hydrolysate was subjected to thin layer chromatographic analysis, as below.

Pullulanolysis of the glucan: An amount of 0.2 g of the glucan was dissolved in 5 ml of buffer at pH 5.0, an excess of pullulanase (Sigma Chemicals; from *Enterobacter aerogenes*) was added and the solution was incubated overnight at 40° C. The hydrolysate was subjected to TLC analysis and HPLC analysis.

Isoamylolysis of the glucan: An amount of 0.2 g of the glucan was

9 *I.S.J.*, 1984, **86**, 222-226.
10 Cremata & Orozco: *Proc. 17th Congr. ISSCT*, 1980, 2546-2555.
11 Cremata *et al.*: *Paper presented to the 18th Congr. ISSCT*, 1983.
12 *Proc. 1st Tech. Session, Cane Sugar Refining Research Project*, 1964, 76-94.
13 *J. Biochem.* (Tokyo), 1964, **55**, 205.
14 *Textile Res. J.*, 1970, **40**, 237-243.

dissolved in 0.5 ml of buffer at pH 3.5, an excess of isoamylase (Sigma Chemicals; from *Penicillium amyloderamosa*) was added, and the solution was incubated overnight at 40° C. The hydrolysate was subjected to TLC analysis and HLPC analysis.

Thin layer chromatography of the pullulanolysate: The pullulanase hydrolysate was analysed by thin layer chromatography using 20×20 cm glass plates precoated with silica gel without fluorescent indicator. The developing solvent was *n*-butanol:ethanol:water: acetic acid in the ratio of 50:30:15:5. The hydrolysate was applied to the plate which was developed for 2 hr. The plate was dried, sprayed with 2N sulphuric acid and heated in an oven at 105° C for 10 minutes[15].

Amylolysis of the fraction not hydrolysed by pullulanase: The unhydrolysed material and silica left at the origin of several developed and unsprayed plates was scraped off and treated at pH 5.0 with α-amylase. The hydrolysate was analysed by TLC.

HPLC analysis: High pressure liquid chromatography was conducted using a Waters Associates (Milford, Mass.) Model 6000 A solvent delivery system, with a R-401 Differential Refractometer detector, WISP Automatic injection system, and a Model 730 Data Module for recording and integration. The column (Waters Associates) was Dextropak in a radial compression (RCSS) system, with water at ambient temperature as solvent.

Viscosity measurement: Viscosities of aqueous and 60° Brix syrup (both raw and refined sugars) solutions of the glucan were measured at 20 ppm glucan on an oscillation viscometer, Model 7.006 (Nametre Co., Edison, N.J.). The instrument was zeroed in air and calibrated with water.

Polarized light microscopy: The glucan was examined under magnification in polarized light on a Vanox polarizing microscope (Olympus Optical Co., Tokyo, Japan).

Periodate oxidation: This was performed on the polysaccharide; periodate consumption was measured[16,17] and formic acid produced and formaldehyde produced[18] were analysed.

Beverage floc potential: The glucan was tested for acid beverage floc potential by the Coca-Cola and the Australian tests[19].

Results and discussion

The ISP was prepared from cane which was cut and crushed in an experimental mill located at the edge of the cane field, so that the maximum time that expired between cutting and crushing the cane was 2 hours, at temperatures below 20°C. The cane was crushed and macerated during a period of about 30 min; mixed juice was poured into a tank and filter aid and acetic acid were added immediately, along with sufficient absolute ethanol to produce an alcohol content of 75%. The precipitate was allowed to settle overnight and the supernatant liquid siphoned off. The precipitate was filtered-off, dried and the ISP extracted as indicated. By this procedure, no time was allowed for the action of microorganisms and the formation of dextran. Starch was eliminated in the extraction of the ISP from the precipitate. The yield of ISP was 29.5 g from 450 lb cane.

The yield of glucan, separated from the ISP by dialysis in an Amicon hollow-fibre dialyser with a 50,000 MW cut-off cartridge, was 40% on the ISP. It showed a specific rotation $[\alpha]_D^{14} + 120$. Upon acid hydrolysis, the glucan yielded about 98% glucose with traces of arabinose, galactose, and mannose. The glucan produced a red-purple colour with iodine, similar to that of amylopectin.

Under polarized light, and magnification up to to 500×, the glucan exhibited very slight birefringence, but no Maltese cross pattern was observed.

The glucan was permethylated, the methylated product was reduced to the alditol, and the alditol was analysed by GC. Comparison with the GC analysis of known 2,3,6-tri-O-methyl, 2,3,6-tri-O-methyl and 2,3,4-tri-O-methyl derivatives and the tetramethyl derivative showed that the glucan was predominantly α-(1-4) linked with some α-(1-6) linkages, and contained a relatively high percentage (11-13%) of terminal groups.

Periodate oxidation showed about 1 mole periodate consumption per molar proportion anhydroglucose unit, with production of a slight amount of formic acid or formaldehyde.

Viscosity measurements showed that the glucan produces only a very slight increase in viscosity upon addition to water, raw sugar syrup or refined sugar liquor. Levels are shown in Table I. The increase was greater upon addition to raw sugar syrup, as was expected because of the interaction with ash components. The solutions were prepared by weight of sugar; hence, the raw syrup shows a lower viscosity than the refined in Table I.

Table I. Viscosity (cp) of solutions of the glucan at 25°C

	Water	*60° Bx sugar (refined)*	*60° Bx sugar (raw)*
Without glucan	0.812	45.0	38.1
20 ppm glucan added	0.827	44.7	39.8

Beverage floc tests were negative: the glucan exhibited no floc-forming potential.

Treatment of a solution of the glucan with α-amylase at pH 5.0 yielded only glucose, as shown by TLC analysis. The α-amylase apparently contained α-glucosidase.

Treatment of a solution of the glucan with either pullulanase or isoamylase yielded glucose, maltose, maltotriose, maltotetraose, maltopentaose, maltohexaose,

15 Roberts & Godshall, *S.P.R.I. Short Report,* 1984, (2).
16 Aspinall & Ferrier: *Chem. and Ind.* (London), 1957, 1216.
17 Hay *et al.:* In "Methods in Carbohydrate Chemistry", Vol. 5, (Academic Press, New York), 1965, 357-380.
18 Parrish: Ph.D. Thesis, 1958, p. 312.
19 Clarke *et al.: Proc. Soc. Soft Drink Technol.,* 1980, 43-55.

maltoheptaose, and maltooctaose as indicated by TLC analysis and HPLC analysis, with maltotriose, maltotetraose, and maltopentaose predominating, as shown in Figure 1. Some carbohydrate material remained at the origin. This was scraped from the plate and when treated with α-amylase yielded only glucose.

glucoses ranging in length from glucose to maltooctaose linked to the backbone by α-(1-6) linkages, as shown in Figure 2. Possible structures are shown in Figure 3.

The high percentage (about 12%) of terminal groups indicates a high degree of branching. The highly branched structure accounts for the high water

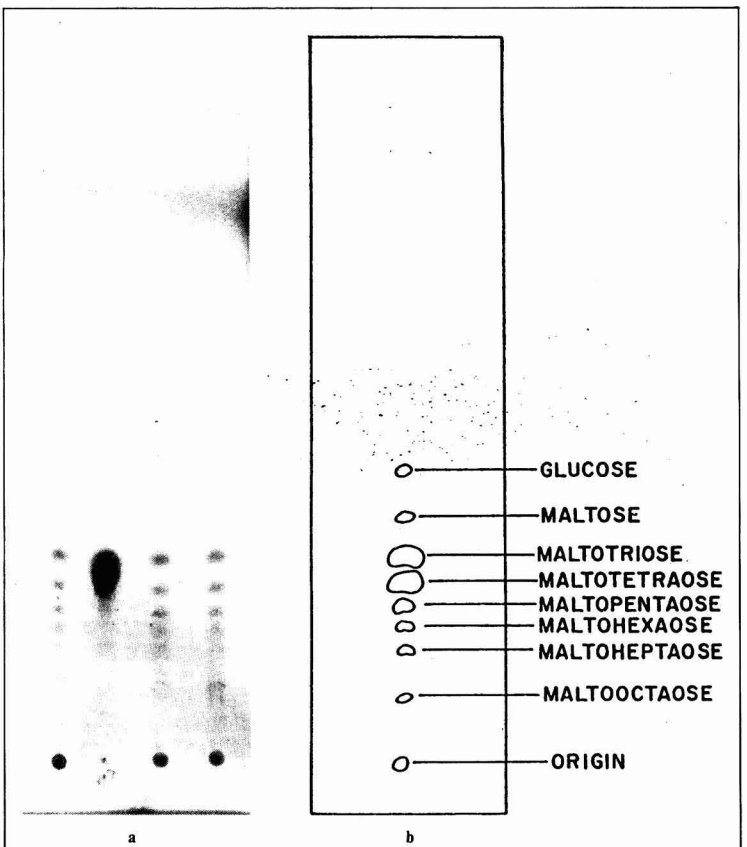


Fig. 1. Thin layer chromatogram (a) and diagram (b) of pullulanase hydrolysate of the glucan

Since pullulanase and isoamylase are debranching enzymes and cleave only α-(1-6) linkages, and since the material remaining at the origin yields only glucose when treated with α-amylase, it is concluded that the glucan has an α-(1-4) linked straight chain backbone with side chains of α-(1-4) linked

solubility of the glucan, and also for the lack of effect on viscosity, either in water or in raw or refined sugar solutions.

Conclusions

GC analysis of methylated alditols obtained from the methylated glucan along with known methylated alditols showed that the glucan was predominantly α-(1-4) linked with some α-(1-6) linkages. Periodate oxidation data were in agreement. The high positive rotation of the glucan indicated the linkages were in α-configuration. The large percentage of terminal groups shown by methylation explained the high degree of solubility of the glucan, as well as its low viscosity.

Treatment of the glucan with the debranching enzymes pullulanase and also isomaltase yielded maltooligosaccharides ranging from glucose to maltooctaose. Treatment of the material not hydrolysed by pullulanase with α-amylase yielded only glucose.

Based upon these results, it is concluded that the glucan is a straight chain α-(1-4) linked glucan with α-(1-4) linked side chains ranging in length from glucose to maltooctaose linked to the straight chain by α-(1-6) linkages. The side chain pattern is not yet established.

This structure is similar to amylopectin and glycogen but of lower molecular weight, and with a greater degree of branching. This glucan differs from amylopectin and glycogen in that it is readily soluble in water, giving a clear solution. It may be considered to be a phytoglycogen. Phytoglycogen material has been reported in corn[20] and in peas[21]. It does not show the Maltese cross character of amylopectin under polarized light. The glucan does not appear to have deleterious effects on processing: it does not increase viscosity appreciably, and does not cause acid beverage floc. It does have a high positive polarization.

Further work on the characterization of this glucan and its effect on sugar processing is in progress.

Acknowledgements

The authors wish to acknowledge the kind assistance and helpful advice of

20 Schoch: *Methods in Enzymology*, 1957, **3**, 11.
21 Colonna & Mercier: *Carb. Res.*, 1984, **126**, 233-247.

ISJ Abstracts

Cane sugar manufacture

Methods to select mill operating speed — a review

U. C. Upadhiaya. *Sugar J.*, 1985, **47**, (9), 6-11.

Selection of mill roller speeds to give optimum performance is discussed. Aspects covered include speed regulation; the pros and cons of three systems of mill operation (the thick blanket system developed in Java and based on decrease in speed in the successive mills in the tandem, the thin blanket system based on successive mill speed increases, and operation of all the mills in the tandem at the same speeds); the fundamentals of milling (with particular reference to reabsorption); the effect of roller speed on mill capacity, the general relationship between roller speed, compression ratio and crushing rate; and comparison of eight methods of speed selection in terms of mean roller speed and fibre loading. The formula of Parr is preferred, since it takes account of crushing rate, preparation factor, diameter and number of rolls in the tandem; in the case in question, it gives a fibre loading of 4.15 lb/ft² escribed surface, which is considered reasonable.

Sugar cane milling and imbibition

P. S. Sanjeevi. *SISSTA Sugar J.*, 1984, **10**, (3), 3 pp.

Monthly data from five factories are presented to show the effect of imbibition on sugar extraction (calculated as the difference between mixed juice pol % cane and primary juice pol % cane) and to demonstrate the general positive effect of increased imbibition.

Surface treatment of mill rolls

N. N. Prithviraj and V. P. Gunasekaran. *SISSTA Sugar J.*, 1984, **10**, (3), 4 pp.

Arc welding applied to cane mill rollers at Sakthi Sugars Ltd. eliminated chokes and slippage, considerably reduced roller wear and increased crushing capacity, although it did reduce the life of the scraper plates (considered unimportant by comparison with the major advantages). Some advice is given on when and how to carry out the resurfacing and on precautions to take before the operation.

Quick evaluation of sugar mill performance results

T. T. Oommen. *SISSTA Sugar J.*, 1984, **10**, (3), 4 pp.

Calculation of pol % cane by a simple formula developed by the author shows that losses at a number of factories are greater than originally reported. The discrepancies and poor results are attributed to inadequate imbibition rates (generally 100-180%), and data from six Tamil Nadu sugar factories indicate the benefits of 200-230% imbibition. Production of bold grain white sugar is considered economically inadvisable. The formula takes the form: pol % cane = (100 − 1.25 F) × P, where F = fibre % cane and P = pol % primary juice.

A simple device to catch extraneous matter in low-grade massecuites

S. N. Nagarajan. *SISSTA Sugar J.*, 1984, **10**, (3), 6 pp.

Rods in the bottom of a trough help remove large foreign bodies from low-grade massecuite flowing to the centrifugals. Details are given.

Applications of computer control in the Australian raw sugar industry

D. M. Jenkins. *Proc. 2nd Conf. on Control Eng.* (Australia), 1982, 80-84; through *S.I.A.*, 1985, **47**, Abs. 85-466.

The history of computer control in Australian cane sugar factories since its introduction in the early 1970's is described. The early installations used centralized computers, but recent trends have been towards distributed systems using microprocessors; the reasons for this are explained. Microprocessor-based controllers have now been applied successfully to most of the stations in cane factories, including cane reception, milling, the evaporator and the pan station. Benefits are better quality of control, flexibility and the ability to collect large quantities of data. Problems which have arisen are indicated; most systems have proved successful, with good acceptance by operators.

Extracting maximum sugar from sugar cane

D. P. Kulkarni. *Maharashtra Sugar*, 1984, **10**, (1), 111-113.

Advice is given on how to reduce losses in cane processing, starting with minimization of cane extraneous matter and examining each process station. Basics that should be borne in mind throughout the factory are set out, and sources of unknown losses are indicated.

Bagasse for cogeneration of electricity

H. Singh. *Maharashtra Sugar*, 1984, **10**, (1), 114-120.

The pros and cons of cogeneration of power for supply to the public grid under Indian conditions are discussed, and the realization of the full potential of bagasse as fuel by more efficient boiler operation is examined.

Clarification of syrup by flotation for improving sugar quality

J. F. Tong, Y. C. Hsiao and C. H. Chen. *Rpt. Taiwan Sugar Research Inst.*, 1984, (105), 45-53 (*Chinese*).

Experiments at Towliu sugar factory are reported. A specially designed flotation clarifier was used; raw syrup was introduced at the bottom via a funnel-shaped section. After treatment, it flowed along a channel formed by a

double-layer jacket and was discharged through a pipe. Scum collected at the top of the vessel in a wide-mouthed funnel section. Syrup at 60-65°Bx was aerated after addition of phosphoric acid (50-200 ppm P_2O_5 on solids) and adjustment to pH 6-7 with milk-of-lime; it was then heated to 85°C with live steam injected into a static mixer, and flocculant (10-15 ppm on solids) added immediately afterwards. The syrup was then held for about 2 sec in a reaction chamber before entering the clarifier. Results included a 44% reduction in sugar colour and a 8% rise in filtrability. Flotation of remelt liquor gave a plantation white sugar of 22% less colour.

The new look at Audubon Sugar Institute

J. A. Polack. *Sugar J.*, 1985, **47**, (10), 13-15.

A brief account is given of the history of the Audubon Sugar Institute of Louisiana State University, tracing it from the establishment of its predecessor, the Louisiana Sugar Experiment Station, at Kenner in 1885 and its move about two years later to what is now Audubon Park in New Orleans where it became part of LSU. A small sugar factory at the Audubon Plantation was used as experimental factory and training facility for the sugar technology students. In 1926, when LSU opened its present campus at Baton Rouge, it built Audubon sugar factory; the cane for this was grown in fields bordering the campus. The factory had a crushing capacity of 12-15 tch, processing typically 3000-4000 short tons in a season. Because of the relatively low throughput, the factory made a loss and was finally closed in 1967/68. The Audubon Sugar Institute was formed in 1977 with funding from LSU, the state and the Louisiana sugar industry. Details are given of the equipment, including the 11-roller milling tandem installed in the Audubon sugar factory and now used to crush 3-ton batches of cane. The 500 gal of juice are processed to raw sugar in pilot facilities, which have been updated over a number of years and include a stainless steel evaporator vessel of 375 gal capacity as well as a stainless steel vacuum pan and a Roberts centrifugal with 18-inch basket. The latest equipment installed is a process control computer. While the facilities are used primarily for research purposes, they are available for special studies by bodies outside the Institute, the most frequent users being agricultural chemical manufacturers. The training program comprises short courses for industrial personnel and research projects for graduates; the most popular short course concerns boiling, but others include sugar factory microbiology, energy conservation, the principles of sugar manufacture and procedures for chemical analysis and preparation of reports. Future plans are briefly mentioned.

Improving low-grade sugar crystallization

R. S. Patterson. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 97-101.

The desirability of improving low-grade massecuite treatment so as to reduce molasses losses is discussed, and a number of suggestions are made on ways of doing it. They cover preparation, quality and quantity of seed; the monitoring of crystal quality using a Polaroid camera; use of a molasses extraction bomb (similar to the Nutsch bomb used in South Africa) to monitor low-grade massecuite after dropping from the pan; determination of apparent Brix at the start and finish of cooling so as to establish whether significant sugar degradation takes place or whether excessive air is entering the massecuite; dropping the massecuite at a low temperature (preferably 150°F or lower) so as to minimize sugar degradation; possibly treating *A*- and *B*-massecuites for a short period in crystallizers in order to improve yield and reduce molasses recycling; cooling the low-grade massecuite as much as possible (e.g. to 105°F) and then reheating to about 125°F; use of saturated molasses (e.g. at 70-75°Bx) if necessary instead of water to improve fluidity in crystallizers; minimizing the amount of water used in the final centrifugals; and inspecting centrifugal screens for possible damage, wear or poor fit.

Conventional *vs.* high-fibre sugar cane

M. Giamalva, S. Clark and J. Stein. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 106-109.

Net cane and biomass yields were determined in 1976/80 for L 79-1002, L 79-1003 and CP 65-357 varieties, of 28%, 17% and 13% fibre contents, respectively. Data showed that at least five crops could be harvested from a single planting. The milling rate was very much lower than for conventional cane, but no problems were encountered in clarification or filtration; the need for greater quantities of imbibition leads to increase in the evaporation of a more dilute juice, and the resultant lower syrup purities make the first strike more a *B*- than an *A*-boiling. Calculations are made of potential ethanol yield.

Higher exhaust steam pressures

H. S. Birkett. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 120 (*abstract only*).

In comparing the Louisiana sugar industry with operations in other parts of the world 20 years ago, the following major differences would have been noted: cane quality was very low, with the cane trashy and often stale; pol extractions were generally much lower than in other countries; final molasses apparent purities, while low, were substantially higher than elsewhere; losses in filter cake were extremely high, and both the quantity of filter cake and its pol content very high; live steam pressures were

generally very low, e.g. 125-150 psig, and the use of superheated steam was extremely rare; gas consumption was very high, with about one half of most of a factory's steam requirements coming from natural gas; further, very few factories had electrical generating equipment, and those that did only generated a small portion of their electrical requirements; exhaust steam pressures were low, e.g. 10-12 psig, and the steam economies achievable by vapour bleeding were not utilized. Other items that marked the Louisiana industry were its short crop duration, the ability of farmers to supply cane in excess of mill crushing capacity, and the freedom from labour unrest in both the factory and field operations. Over the last two decades, the industry has greatly improved its performance in most of the above-mentioned sectors. A discussion focuses on the pros and cons of utilizing higher exhaust steam pressures, because this is one area where little progress has been made.

Clarifier flow characteristics

S. J. Clarke. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 120 (*abstract only*).

During the 1982 season, tracer techniques were used to determine the juice flow characteristics of the major types of clarifier in Louisiana. The analytical methods and results of the tests are described. Measured flow patterns were far from plug flow, and measured retention times were less than calculated from vessel size and juice flow rate. Other uses of tracer techniques in the raw sugar factory are outlined.

Improving performance and capacity in the clarification of sugar cane juice

P. E. Hohmann and R. P. Summerhays. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 121 (*abstract only*).

A test program was carried out at a sugar factory in Colombia to evaluate the performance of the Eimco Hi-Capacity thickener on the clarification of raw juice. The factory produces a plantation white sugar using the sulphitation process. According to the data collected, the thickener operated at much higher loading rates, produced a clear juice and experienced lower sugar inversion losses than a conventional tray-type clarifier operating on the same feed. The loading rate of the unit, expressed in gallons per minute per ft^2, were as much as 500% greater than with the tray-type clarifier, and inversion losses were improved to virtually nil, saving the equivalent of US $88,500 per year. The effluent clarity, measured in Kopke turbidity units, dropped from 37 to 23. Accordingly, it appears that both capital costs and operating costs can be reduced significantly with the thickener.

Microcomputer applications in the sugar house

F. Z. Llorens. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 121 (*abstract only*).

During the 1982/83 harvest season, a microcomputer was used at the Bryant sugar house laboratory to prepare the daily report as well as the stock inventory and sucrose account; later in the season, the computation of the molasses stock was added to the system. The bulk of these reports, and all data and records associated with them, were compiled and printed by the system from information entered every morning. The programming required for the system was composed of two individually run programs and the corresponding data files. The system consisted of a microcomputer with two disk drives and 64K of on-board memory; the language used was Basic. Both programs worked quite well; structured programming was used and debugging was simple and straightforward. The programs had a number of advantages: the daily report time was substantially cut, thus making the crushing data available earlier in the day, the stock inventory program was even better in this sense, with an even greater reduction in time requirement than with the previous program, and the number of errors was smaller — this was attributed to the fact that few numbers were handled during data inputing.

Impact fracture properties of cane varieties

W. Keenliside and S. J. Clarke. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 121 (*abstract only*).

The mechanical properties of cane varieties have been studied previously using static tests. However, this method does not simulate the effect of cane preparation equipment. Differences in cane varieties have been noticed during milling, and various claims have been made regarding the milling characteristics of individual varieties. Five cane varieties (CP 65-357, CP 70-321, NCo 310, L 60-25 and L 79-1003) were chosen for analysis and have been tested using impact fracture techniques where the anvil moves at a specific velocity. The data obtained for load at fracture, tensile strength, energy at yield point and energy of fracture have been analysed and show wide differences from variety to variety. A preliminary analysis of the results shows that it may be possible to correlate the mechanical properties with milling characteristics.

Concepts new to the Florida area being tested at Okeelanta

J. Prieto. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 122 (*abstract only*).

During the 1982/83 season at the Okeelanta Division of the Gulf + Western Food Products Co., three pieces of equipment new to the Florida area were successfully tested. They were a Lotus roll installed in a first mill, a falling-film triple-effect evaporator and a vertical crystallizer for *C*-massecuite.

Beet sugar manufacture

The beet yard of a sugar factory

P. Kolago. *Gaz. Cukr.*, 1984, **92**, 219-222 *(Polish)*.

Various aspects of beet reception, piling and quality evaluation are discussed, the main theme being optimum handling and maintenance of storage conditions so that the factory processes beets of highest possible quality and both processor and grower are satisfied. A diagram illustrates the layout of a suitable storage system provided with forced ventilation means.

Latest improvements to the SERES-IRIS purity analyser

G. Windal, B. Portalès and D. Maès. *Sucr. Franç.*, 1985, **126**, 151-154 *(French)*.

The on-line system for purity determination[1], based on the relationship between Brix, conductivity and purity, has presented a number of problems, chiefly concerning the system of pumping and of sample heating. A new hydraulic box was designed which houses a conductivity probe, temperature regulator and magnetic stirrer, as well as two small boxes, one for dilution using new pumps that are much more suited to the task, and an electric box containing all the connexions linking the hydraulic and electronic boxes. Results of tests at two factories and at two refineries have indicated that the systems operated as required, with almost no servicing required, and provided reliable measurements.

Main characteristics and stoichiometric aspects of acidogenesis of soluble carbohydrate-containing waste waters

A. Cohen, J. M. van Gemert, R. J. Zoetemeyer and A. M. Breure. *Process Biochem.*, 1984, **19**, (6), 228-232; through *S.I.A.*, 1985, **47**, Abs. 85-491.

Experiments were carried out to obtain data for the design of two-stage systems for fermentation of sugar-containing effluents to methane. Media containing 1% w/v glucose, sucrose or starch + mineral salts were subjected to acidogenesis in a chemostat by mixed populations of anaerobic bacteria. Concentrations of biomass and dissolved organic products, production rates of gases and oxidation-reduction potentials were monitored, and CO_2 concentrations in the effluent were calculated. There were shown to be two major types of fermentation (butyric acid and propionic acid types) which were complementary to each other. Overall reaction equations were derived showing conversion of substrate into fermentation products. No essential differences in product formation were found between effluents containing glucose, sucrose and starch.

Decolorization and fuel economy in the sugar factory

R. Tesi. *Ind. Sacc. Ital.*, 1985, **78**, 15-18, 20, 22 *(Italian)*.

It is calculated that for every unit rise or fall in beet pol from 14% there is a corresponding change in fuel consumption of ±5% on beet recoverable from the soil + losses, while a unit rise or fall in thick juice purity from 90 is equivalent to a change of ±2% on recoverable beet + losses, or ±5.4% on recoverable sugar + losses. The typical thick juice colour and ash contents in North European factories are shown to be much lower than in Italy and permit adoption of a 3-massecuite system, giving *A*- and *B*-sugars that meet EEC requirements while allowing fuel consumption to be minimized. Experiments at the author's factory (San Pietro in Casale) are reported, in which a 3-massecuite system was used and resin decolorization[2] applied to affined *C*-sugar to be used as melt for *A*-massecuite. The results showed a fall in colour from 95.59°St % Brix to 26.14°, with a consequent improvement in the quality of the *A*-massecuite and a 10% saving in fuel.

Water treatment

J. P. Lescure, B. Dellanoy, D. Verrier, S. Honoré and C. Vasseur. *Sucr. Franç.*, 1985, **126**, 157-164 *(French)*.

Further work on waste water treatment at Thumeries sugar factory is described[3,4]. During the campaign, from October to the start of December, beet flume and wash water (from the juice station 3 km away) containing 23.5 tonnes of COD daily is treated in a settling basin merely to reduce the COD in the water circuit, and then recycled to the beet yard and washer. During post-campaign processing of thick juice (February-March) the only incoming waste water is a small amount from the juice conditioning station, since the juice station is not operating, so that treatment (essentially fermentation) can be concentrated on the water from the settling basin. Up to 26 days after start-up of the plant (2 months after the end of the campaign), fermentation reduces the total COD content to <700 mg O_2/litre, at an insoluble COD content of <200 mg O_2/litre. After 26 days, increase in the amount of treated water (which is added to the recycle) causes a rise in suspended (bacterial) matter and increase in soluble COD to 700 mg O_2/litre, but the earlier situation is gradually re-established once recycling is stopped. Methane production is 0.32 m^3 per kg degraded COD out of a total gas of 0.37 m^3 per kg, and provides 30 tonnes of steam daily. Almost all of the volatile fatty acid produced is degraded in the upper half of the fermenter. Experimentation has demonstrated the feasibility of post-fermentation treatment of the effluent by biological oxidation so as to reduce the ammoniacal N content; a decrease of >90% has proved possible.

1 Windal: *I.S.J.*, 1976, **78**, 375.
2 Landi & Mantovani: *ibid.*, 1973, **75**, 392.
3 Lescure & Dellanoy: *ibid.*, 1984, **86**, 50A.
3 Anon: *ibid.*, 1985, **87**, 13A.

Experience in the operation of equipment for removal of extraneous matter from flume-wash water

N. M. Nikolaenko, A. A. Firsa, L. A. Korobka and N. D. Khomenko. *Sakhar. Prom.*, 1985, (4), 15-17 *(Russian).*

The performances of various types of plant for removal of physical impurities from flume-wash water are discussed, and a modified grid type described which has 3-mm gaps between the bars and has proved successful in reducing the solids load in waste water treatment.

Modification of a float-type density meter for milk-of-lime

A. F. Kravchuk and E. V. Deryuga. *Sakhar. Prom.*, 1985, (4), 17-19 *(Russian).*

Details are given of modifications to a density meter, particularly the redesigning of the float to provide highest sensitivity and minimize scale deposition. The resultant fluoro-plastic float, in the form of an elongated liquid droplet, has proved satisfactory in tests in which the difference between measured values obtained with the meter and by a gravimetric method did not exceed 2.5% relative at temperatures in the range 75-81°C.

Effect of sodium triphosphate on the flocculating action of polyacrylamide

K. P. Zakharov *et al. Sakhar. Prom.*, 1985, (4), 20-22 *(Russian).*

After tests had shown no significant difference between polyacrylamide (PAA) activated with NaOH and non-activated PAA in terms of the settling rate of 1st carbonatation juice, further tests were conducted on use of PAA to which sodium triphosphate had been added in a 1:1 or 2:1 ratio (w/w) so as to make up for any phosphate deficiency in juice (which can have an adverse effect on clarification). Results showed that the triphosphate increased the settling rate considerably by comparison with the use of PAA alone, the 1:2 PAA:triphosphate mixture proving optimum (a 1:3 mixture gave no added benefits). Best results were given by a PAA addition of not less than 0.0013% on weight of juice, and by preparation of the flocculant solution at 20-50°C rather than 90°C (unless it was to be used within 1 hour of preparation). The use of the mixture gave a clear juice as against a cloudy one when PAA was used alone.

Production tests with a ShI-PSK-6,0 supercavitation juice mixer at Chortkov sugar factory

B. A. Yuzhakov, A. F. Nemchin, A. T. Rudenko and V. I. Simak. *Sakhar. Prom.*, 1985, (4), 23-25 *(Russian).*

The horizontal lime-juice mixer, supplied with compressed air at 0.5-0.6 kg/cm² pressure and a feed rate of 60 m³/hr, was installed between the prelimer and main liming tank. Mixing was carried out by an electrically driven stirrer on a horizontal axis, and the ratios of juice to lime (1:1 in most cases) and of juice to air were automatically controlled. While causing no significant changes in the filtration and settling parameters of juice at the same alkalinity, use of the mixer increased mass transfer considerably as a result of the flocculating effect of the cavitation bubbles, so that juice lime salts were reduced by 14% and the colour of thick juice and white sugar by 14% and 8%, respectively.

Test on use of hydrocyclones to thicken flume-wash mud

Yu. V. Raskin and A. P. Parkhomets. *Sakhar. Prom.*, 1985, (4), 25-26 *(Russian).*

At Yagotin sugar factory, mud from the clarifiers for flume-wash water is dewatered by centrifuge or (if the centrifuge is not operating) is sent to a mixing tank for Class III effluent. Experiments were conducted on the use of hydrocyclones connected to the clarifiers to reduce the quantity of mud fed to this tank. Results showed a reduction in the amount of mud continuously withdrawn from the clarifiers from 28 m³/hr to 4 m³/hr per clarifier, and a decrease in the water content from 86% to 72%; the purification efficiency of the hydrocyclones, as calculated by a formula allowing for the effects of a number of parameters, was 36%. However, there was need for 8-10 minutes' liquidation of the clarifiers once per shift, for which 70-80 m³ dilute mud had to be removed from each so as to avoid accumulation of particles in the water recirculation system. As a result, the overall amount of mud flowing from the clarifiers to the mixing tank was halved by use of the hydrocyclones.

A method for determining the minimum possible molasses purity

V. S. Shterman, V. I. Smagina and A. R. Sapronov. *Sakhar. Prom.*, 1985, (4), 27-29 *(Russian).*

While knowledge of the temperature and dry solids content at which molasses purity is minimum for a given maximum permissible viscosity is essential for calculation of low-grade crystallization conditions, neither the approach based on standard molasses of 80, 82 and 84% dry solids at 30, 40 and 50°C, respectively, nor the application of a nomogram to determine certain optimum parameters allows for differences in viscosity that can occur between different molasses. A new method is proposed which is based on calculation of mother-liquor parameters, starting from temperature and initial non-sugars content; formulae are given for calculation of the saturation coefficient, sucrose content, non-sugars content, dry solids, purity and viscosity. An approximation

method is used until the calculated viscosity reaches the permissible maximum viscosity at a given maximum non-sugars content, from which is calculated the minimum molasses purity attainable as a function of *b*, *m* and *k* (the first two being coefficients defining the effect of non-sugars composition on sucrose solubility, while *k* is a coefficient defining the degree of effect of non-sugars on run-off viscosity). Results are tabulated for maximum viscosities of 4400 and 6500 mPa/sec at temperatures in the range 20-80° C; data demonstrate the fact that minimum purity may be achieved at final crystallization temperatures other than 40° C. The dominant effect of non-sugars composition in the form of coefficients *b* and *m* is indicated by regression equations for the two viscosity values given above.

Crystallization with a reduction in massecuite level in a 2nd product vacuum pan

S. I. Potapenko, I. S. Gulyi, L. I. Trebin, A. P. Lapin, V. Ya. Zalesnyi and L. F. Skol'zkova. *Sakhar. Prom.*, 1985, (4), 29-31 *(Russian)*.

In a 2-massecuite boiling scheme, intermediate centrifugalling of 30-35% of the contents of a pan and return of the run-off to the pan permits a reduction in the massecuite level and hence in the solids contents and viscosity, with a consequent increase in exhaustion and decrease in molasses losses. In the proposed method, withdrawal of the portion of massecuite for spinning is carried out when the pan contents are 150-170% on the initial charge and the crystals measure at least 0.2 mm. Laboratory and factory tests are reported. In the latter, at almost identical 2nd massecuite boiling times, the new method gave a 1.4 unit lower molasses purity. While the purity of the sugar was 0.5 units lower than with conventional boiling, that of the sugar from the intermediate centrifugalling was 0.7 units higher. The average crystal content was only 37.7% and the Brix 90.4, indicating that the massecuite exhaustion could have been taken to a greater level, but the absence of means for intensified spinning prevented this.

The use of the enzyme, dextranase, at Shibetsu beet sugar factory

Anon. *Sakhar. Prom.*, 1985, (4), 52-53 *(Russian)*.

Difficulties in filtration of 2nd carbonatation juice at the Shibetsu factory of the Nippon Beet Sugar Manufacturing Company on the island of Hokkaido, Japan, were found to be caused by dextran resulting from beets of poor quality. Trials were conducted on the use of dextranase to counter the effects, and results showed that addition of 10 g per tonne of processed beet to raw juice flowing to preliming and containing up to 200 ppm dextran removed the filtration difficulties.

The tasks and significance of the evaporator system within the energy economy of a sugar factory

A. Laudański. *Gaz. Cukr.*, 1984, **92**, 233-235 *(Polish)*.

In a discussion of the role of the evaporator in the heat economy of a sugar factory, the author introduces the "evaporation factor" *n*, i.e. the ratio of the amount of water evaporated to the heat content of the steam supplied to the evaporator and used to evaporate the water in the juice in the 1st effect (no allowance being made for that heat used for heating purposes). Two equations are presented for calculation of *n*: (1) where the pan station is regarded merely as a consumer of bled-off vapour, and (2) where the actual use of the vapour for boiling in a given pan is considered. For modern evaporator systems, the value of *n* will be less than the number of effects *k* except in the case of a triple-effect evaporator using thermocompression, where $n \approx k$. The question of the optimum value of *n* is discussed; it is given by dividing the amount of water to be evaporated from thin juice by the total quantity of process steam required from the evaporator. Under Polish conditions, values in the range 1.8-2.2 are considered adequate, although cases are cited where higher values are of benefit. Elimination of fluctuations in vapour bleed is briefly discussed.

Pressing thin layers of (beet) pulp in extremely short periods of time

K. Buck and A. Mróz. *Gaz. Cukr.*, 1984, **92**, 235-239 *(Polish)*.

Experiments are reported in which fresh pulp samples of approx. 7.5% dry solids content, weighing 135 and 270 g and forming layer thicknesses of 15 and 30 mm, respectively, were subjected to pressures in the range 0.5-2.5 MPa for periods of 15, 30, 60 and 90 seconds in a special laboratory-scale hydraulic press. Graphed results show that moisture removal was greatest at MPa 2.5 applied for 90 sec, a dry solids content of approx. 13.7% being obtained with a 15 mm layer and one of approx. 14.8% with a 30 mm layer. While these results are considered surprisingly good in view of the short pressing time, they are regarded as inadequate for normal sugar factory operation. The results obtained are briefly analysed.

The processing quality of sugar beet

J. Trzebiński. *Gaz. Cukr.*, 1984, **92**, 240-242 *(Polish)*.

Factors affecting beet processing quality are reviewed, including climate, nitrogen fertilizer application and the chemical composition of the beet. The effects of the various sugars and non-sugars on processing are indicated, and a survey then presented of equations derived by different authors for

calculation of molasses losses and yield, sugar yield and alkalinity coefficient. Some methods developed for determination of beet juice purity are briefly mentioned.

α-Amino-nitrogen in sugar processing

N. J. van Geijn, L. C. Giljam and L. H. de Nie. *Proc. Symposium on Nitrogen and Sugar Beet* (IIRB), 1983, 13-25; through *Zuckerind.*, 1985, **110**, 98.

The behaviour of α-amino-N (AmN) in individual phases of sugar manufacture is reviewed. From practical factory experience (alkali must be added when the AmN content exceeds 17 meq/100 g sugar) and the well-known Dedek equation, Suiker Unie has derived empirical formulae for calculation of molasses sugar (S_M) as a function of beet or raw juice K, Na and AmN (meq/100 g S); at AmN $\leqslant$17 meq/100 g S, $S_M = 0.342\ (K + Na)$, while at AmN $>$17 meq/100 g S, $S_M = 0.342\ (K + Na) + 0.15\ (AmN - 17)$. White sugar yield is given by $100 - S_M$. Under Dutch conditions, the formulae are more appropriate for evaluation of beet quality than those developed in Austria.

Effluents from regeneration and rinsing of ion exchange resin beds used for juice decolorization in sugar factories, and their neutralization

T. Wolski. *Gaz. Cukr.*, 1984, **92**, 247-249 (*Polish*).

Effluent from cation exchange resins in Ca^{++} form used for decolorization and deliming contains large quantities of NaCl or $CaCl_2$ as a result of regeneration with brine, and tests were conducted on its addition to pulp for ensilage and on its anaerobic treatment with other sugar factory waste water. The pulp ensilage tests have already been reported[1], and it is stated that the process is of benefit in reducing overall effluent treatment costs while proving of advantage to stockbreeders. For the anaerobic treatment, the regeneration effluent was added to the other waste water in amounts designed to provide a higher chloride content after treatment than is normally found; 48 hours' treatment reduced the COD by about 75% from 8900 mg/dm³ and the BOD_5 by about 70% from 4500 mg/dm³. Two-stage activated sludge treatment of anaerobically treated effluent containing 1000 and 2000 mg Cl^-/dm³ had a 90-94% efficiency but required 13½ hours to give a final COD that was still >200 and 350 mg/dm³ and a BOD_5 of 80 mg/dm³ in both cases; the brine had an unfavourable effect on activated sludge growth. The required volumetric capacity of fermentation tanks to handle effluent from 8 resin columns per day is put at 1280 m³, while about 2000 kW per day was consumed in the aeration tanks used for activated sludge treatment.

Closed circuits for industrial waters in sugar factories

T. Wolski. *Gaz. Cukr.*, 1984, **92**, 249-252 (*Polish*).

Tabulated details are given of the condensate at three sugar factories and of the flume-wash water at five factories over the period 1979/83, showing the effects of treatment for their recycling and re-utilization. However, it is stressed that, because of the large number of factors affecting the quality of recycled water and the differences between factories, the data are of value only for statistical purposes or where there is no need for any great degree of accuracy in calculations; planning of a water/waste water system at a factory must be based on tests conducted at the same factory, while planning for future factories must be based on tests conducted with the latest available plant.

Rational thermo-technological systems in a sugar factory

A. Laudański. *Gaz. Cukr.*, 1984, **92**, 261-263 (*Polish*).

The role of the evaporator as a means of concentrating thin juice and as a source of vapour for other processes is discussed, and the problems created by the increasing demands on steam from all quarters are examined. A scheme is proposed in which the evaporation factor is 2.7-3.0, allowing thin juice to be concentrated from 14° to 65°Bx at 115% on beet in a triple-effect evaporator at a steam consumption of 32-35% on beet. The application of vapour compression allows a reduction in fuel and steam consumption by comparison with a quadruple-effect evaporator without vapour compression and with an evaporation factor in the range 1.8-2.3. The use of a steam accumulator is of particular importance in the scheme.

A method of reducing juice coloration by aeration during main liming

S. Murawski and F. Nowak. *Gaz. Cukr.*, 1984, **92**, 269-270 (*Polish*).

Tests on juice aeration during liming at Tuczno sugar factory are briefly reported. Results showed a reduction in invert content of between approx. 21% and 56% (from an initial value of 0.043% on Brix), compared with a reduction between 27.4% and 34.4% without aeration. The best results were achieved at an air rate of 0.95 m³/m³ juice. The treatment raised juice purity by up to 0.6 units. No foam was observed as a result of the aeration, but if any did form it could be removed in a foam trap after the 1st carbonatation vessel.

The modernized main drive of the ZUP-Nysa centrifugal beet slicer

K. Buck. *Gaz. Cukr.*, 1985, **93**, 3-7 (*Polish*).

Reasons are given for the decision to upgrade the D.C. variable-speed drive of the ZUP-Nysa beet slicer (available

1 Januszewicz *et al.*: *I.S.J.*, 1984, **86**, 19A.

in two sizes), the first being the under-powering of the drive at high rotary speeds, especially when operating with sharp knives. Details are given of the new drive and of tests conducted on a 1700 mm slicer at Opalenica sugar factory.

Tests on acceleration of sugar factory effluent treatment

B. Poleć. *Gaz. Cukr.*, 1985, **93**, 45-47 (*Polish*).

Tests on flume water treatment with flocculants are reported and the results tabulated. No details are given of the flocculants (numbered 1-8), seven of which were Polish and one imported. Greatest COD reduction was 56.4%, and up to 85.3% of the total suspended solids was removed.

The 1984 campaign

E. Reinefeld. *Zuckerind.*, 1985, **110**, 367-377 (*German*).

An outline is presented of the situation in 1984 as regarded beet growth conditions and harvesting, the area under beet as well as crop yields, sugar production and quality of beet and juice. Because of the high beet quality, factories frequently operated at a slicing rate in excess of the nominal capacity; at a number of plants, the amount of soil in the flume and wash water circuits was so great that a critical point was reached at which large quantities of flocculants were needed. This resulted in marked foaming and, in turn, necessitated the use of antifoam agents; the buoyancy of the flume water fell noticeably as a consequence of the foaming and fall in density, while the amounts of antifoam oil used were increased because of losses by adsorption where the water was highly turbid. The positive effect of the flocculants was often delayed for lack of suitable supply tanks and dosing arrangements. While liquid products are easier to handle than powdered products, they are also more expensive to use, and mineral oil is used in their manufacture to keep swelling of the flocculant and hence the viscosity within limits. Mention is made of the very good quality of cossettes obtained at one factory using Maguin and Putsch drum-type slicers; a number of reasons are suggested (by a representative of H. Putsch GmbH & Comp.) for the failure of this type of slicer to be more widely used, bearing in mind its high efficiency. Brief mention is made of work on improving pulp pressing, and a table shows the steady rise in average dry solids content (at 20 factories) from 19.60% in 1976 to 27.61% in 1984. Darkening of juices reported in 1983 was the subject of investigations which indicated that enzymes were responsible, their activity being particularly favoured by the low temperatures in prescalders (beet invertase is inactivated at >50°C). Invert sugar formed enzymatically during diffusion occurs mostly as a result of microbial infection. Raw juice browning differed in time according to the concentration of oxygen or sulphite ions. Details are given of a 20 tonnes/hr Babcock-BSH low-temperature band pulp pre-dryer as installed at Lehrte; tests showed an average 10-unit rise in dry solids content, from 25 to 35%. The warm air is heated with flue gases from the drum dryer located after the pre-dryer, and a Keller two-stage wet dust separation system used for the gases is outlined, as is a system used at Düren where a bed of pulp is diverted from the main stream and used to extract the dust from flue gases passing through it as the pulp is carried on a polyester belt; the dust extraction thus contributes to evaporation of the water in the pulp, which attains a dry solids content of 85-90% before it is reunited with the main stream of dry pulp, while the dust content in the gas is reduced to <75 mg/m^3. A pulp drying scheme using medium-temperature 3rd effect vapour is briefly described; advantages over low-temperature drying include halving of the belt surface area and reduction in the amount of energy needed to drive the blower fans. Cases of high thick juice alkalinity, particularly in the opening weeks of the campaign, were attributed to the presence of increased quantities of acids precipitable with calcium and of low glutamine concentrations; the latter caused noticeable reductions in acid formation during evaporation, so that the alkalinity increased from thin to thick juice almost linearly with Brix. The phenomenon was demonstrated by a laboratory experiment. Studies of falling-film evaporator operation under conditions comparable to those in the 4th effect of a quintuple-effect system showed that increase in juice circulation caused no increase in heat transfer coefficients; this was attributed to the fact that increase in heat transfer as a result of increased film flow rate on the tube surface was balanced by increased thickness of the film as the volume of juice in circulation increased. While this volume does not affect the mean residence time, it does influence the residence time distribution; under normal operation, the mean residence time is a function of the required juice volume, which would normally be far smaller than with a Robert evaporator, as indicated by a diagram comparing the two different types of vessel. The performance of the BMA crystallization system at Wabern is discussed, and variants of a scheme for crystal footing generation are described. Use of syrup as wash material in centrifugals increased throughput by about 50% while reducing the amount of run-off and its purity. A scheme is described for methane generation from solid material such as beet fragments and leaves, and details are given of a Sulzer system for waste water fermentation treatment at Wevelinghoven. Mention is made of investigations of sulphur emission from sugar factories, mainly in the form of boiler and pulp dryer gases.

Laboratory studies

Intensive over-saturation in sugar juice purification

M. I. Daishev, R. S. Reshetova, M. S. Kulibali and Yu. I. Molotilin. *Izv. Vuzov, Pishch. Tekhnol.*, 1984, (6), 75-78 *(Russian).*

The role of OH^- ions in juice liming is examined. Increase in their concentrations, as with $Ca(OH)_2$ addition, stimulates the occurrence of acid properties in both the carboxylic and hydroxylic groups in the hydroxy compounds which make up the majority of the precipitable non-sugars, but this in turn increases their hydration and tendency to dissolve. However, over-saturation to a pH below the optimum for 1st carbonatation juice causes dehydration of the carboxylic and hydroxylic groups in the non-sugars and thus improves the settling and filtration properties. Results confirmed that over-saturation to pH 9.75 and 6.9 markedly increased the settling rate in the first 5 minutes and reduced the mud volume after 25 minutes as well as the filtration coefficient by comparison with the effects of pH adjustment to 11.0. The benefits of intensive over-saturation were also found with cane juice; in one case, the juice was brought to pH 8.0-8.5, heated, filtered and sulphited to pH 6.8-7.0, while in another the juice was adjusted to pH 10.5-11.0 and immediately afterwards gassed to pH 7.5-7.0, heated, brought to pH 8.7-8.9, filtered and sulphited to pH 6.8-7.0. In the latter case, treatment raised juice purity by 2 units, and decreased the reducing sugars and lime salts contents by comparison with the former case. Experiments at a factory confirmed the advantages of preliming followed by gassing to a negative alkalinity of 0.01-0.05% CaO against phenolphthalein.

Improving beet quality

M. Loilier. *Sucr. Franç.*, 1985, **126**, 107-117 *(French).*

A brief illustrated account is given of the beet analysis line developed by IRIS and installed for the 1984/85 campaign at Lillers for enzymatic determination of glucose and sucrose, flame photometric measurement of potassium and sodium, and determination of α-amino-N by the ninhydrin method; 60 samples are analysed hourly. New formulae are presented for calculation of the alkalinity coefficient, molasses sugar (one of two formulae is applicable according to whether the alkalinity coefficient is above or below 1.8), recoverable beet sugar and the amount of NaOH to add to juice; these formulae are intended to replace those of Wieninger & Kubadinow used by IRIS hitherto. Results of beet varietal and nitrogen trials are tabulated.

Utilization of carbonate determination to detect the Maillard reaction

J. P. Ducatillon, G. Deruy and J. P. Lescuré. *Sucr. Franç.*, 1985, **126**, 133-136 *(French).*

Since the Maillard reaction occurs between amino-acids and reducing sugars formed by sucrose hydrolysis when the pH of a sugar solution falls to a sufficiently low level, measurement of the CO_2 produced would give an indication of the reaction and possibly provide a means of preventing it. Experiments involving the use of a CO_2-selective electrode are reported in which the first aim was to buffer the test sample and maintain a pH of 4.8-5.2 at which the carbonates and bicarbonates would be converted to CO_2. Measurements carried out at 18 sugar factories on molasses and low-grade massecuite at the start, in the middle and at the end of the mixer showed no simple correlation between CO_2 as measured and colour at two successive points (generally between the start and the middle of the mixer), but there was a rise in CO_2 content attributed to the Maillard reaction which was proportionally greater than that of colour (often a difference between >10% and <5%).

Development of a "fermentation index" test applicable to diffusion juice

J. P. Ducatillon. *Sucr. Franç.*, 1985, **126**, 139-143 *(French).*

Details are given of two enzymatic methods, one for laboratory use and the other for use on site, applied to glucose and sucrose determination where juice samples are kept for up to 6 hours at the same temperature as at sampling. The laboratory method involves stabilization of the sample with formalin, followed by addition of β-fructosidase, glucose oxidase and peroxidase. The colour formed by oxidation of the 4-aminophenazone is measured at 505 nm. The other method is based on use of an auto-analyser after clarification with lead acetate, filtration and possibly treatment with invertase for sucrose determination, after which the solution is fed into a vessel where glucose is converted to oxygen by immobilized β-fructosidase and catalase, and the oxygen measured with a selective electrode. The fermentation index is given by

$$\frac{\text{sucrose at sampling} - \text{sucrose after n hours}}{\text{sucrose at sampling}} \times 100.$$

Results for cold juice, hot raw juice and press water are shown in graph form and discussed. Correlation was found between the index and sampling temperature, and the index is considered of value as an indicator of potential loss due to infection.

Development of a procedure for determining the sugar in beet using a non-toxic clarifying agent

V. N. Mardal', A. A. Lyashenko, A. A. Petrenko and A. A. Lipets. *Sakhar. Prom.*, 1985, (4), 34-35 *(Russian).*

Because of the toxic properties of lead acetate, experiments were conducted on the use of calcium oxide and aluminium sulphate as possible

alternatives. Preliminary results showed that both were suitable. The maximum quantity of clear filtrate was given by 1.5 g CaO and 1 g $Al_2(SO_4)_3$ per 52 g brei, although 1.5-2.0 and 1.0-3.0 g of the oxide and sulphate, respectively, were permissible, i.e. high accuracy in dosing was not necessary; further tests involved 2 g oxide and 1.5 g sulphate per 52 g brei. Comparison was made between the results obtained by alcohol extraction (used as standard procedure and of greater accuracy than cold digestion) and by cold digestion using lead acetate, calcium oxide and aluminium sulphate, respectively. The values given by CaO and $Al_2(SO_4)_3$ were closer to the alcohol extraction results than were the values given by lead acetate. Of four different materials tested for their suitability as filter cloths in an automatic analysis line, a Terylene-type fabric proved best in giving the greatest quantity of filtrate having an optical density no higher than 0.6 units for a 200-mm saccharimeter tube and having requisite regeneration properties. An experimental automatic line was tested, in which distilled water was fed into the digestion vessel instead of lead acetate, followed by CaO before the first brei preparation, while aluminium sulphate was added before the second brei preparation. Optical densities were identical to those given by cold digestion using lead acetate in 8 out of 10 cases, with only 0.2 units difference in the other two cases, all values being below 0.6 units at 589.3 nm in a 200-mm tube.

Thin-layer chromatography of amino-acids in sugar cane and their changes during post-harvest storage and processing

D. B. Ghule, A. D. Sawant and S. J. Jadhav. *Maharashtra Sugar,* 1984, **10,** (1), 105, 107-109.

Harvested cane was stored for up to 120 hours at room temperature (29 ±4°C) and samples taken every 24 hr for crushing and analysis of the juice for total amino-acids using TLC, with ninhydrin as spray reagent and spotting of the amino-acids on plates of cellulose MN 300 developed with various solvent systems. Results showed four acids: asparagine, glutamine, aspartic acid and glutamic acid. The top portion of mature cane was found to contain more total amino-acids than the bottom section, while the reverse was true for immature cane. The content fell during the first 24 hr of storage, after which there was a gradual increase. Analysis of factory juices, syrups, massecuites and final molasses demonstrated the gradual decrease in amino-acids (as a result of the Maillard reaction) up to *A*-massecuite (when expressed as mg/100°Bx), while there was increase in the content from *B*- to *C*-massecuite and final molasses.

Dextran tests with Roberts' copper method as practised in China

Wen Musheng. *Sugar y Azúcar,* 1985, **80,** (3), 18-19, 21.

Application of a modification of the Roberts method for dextran determination[1] to cane juice samples in China is described. The modifications included: using 3 ml of 10% trichloroacetic acid instead of 1 ml because of the high protein levels in the samples; washing the cell of the spectrophotometer with distilled water before rinsing with the sample solution so as to prevent interference with the colour reading by large numbers of tiny bubbles caused by the high viscosity of the solution (this happened despite twice washing with the solution); using test tubes of 15 mm diameter rather than 20 mm in the phenol-sulphuric acid colour reaction in order to eliminate spattering or loss of test solution resulting from the violent reaction; and filtering rather than centrifuging to separate the dextran-copper sediment. Results with the modified procedure are tabulated, as are the dextran contents found in 1st extracted and mixed juice samples at five Chinese factories.

False pol in sugar cane juice — causes and detection

R. P. DeStefano. *J. Amer. Soc. Sugar Cane Tech.,* 1985, **4,** 80-85.

Determination of crusher juice pol may be affected by the presence of optically-active components, particularly dextran, fructose and glucose. However, studies on grab samples of crusher juice and juice from 12 different cane varieties harvested over a 5-month period showed that the error is very minor (1-2% of the pol) under normal conditions, even in somewhat immature cane. On the other hand, the mean difference between sucrose determined by HPLC and polarimeter readings for 297 samples of crusher juice from frozen cane was 4.57% of the pol. Cane that had suffered the biggest fall in yield appeared to give the poorest agreement between the two sets of results. HPLC has been found to be more suitable than Clerget polarization and GLC for determining the "false" pol.

Estimation of dextran levels in sugar, syrups and cane juices by HPLC

M. A. Clarke and W. S. Tsang. *J. Amer. Soc. Sugar Cane Tech.,* 1985, **4,** 120 (*abstract only*).

Rapid analysis of dextran in cane juice and sugars is highly desirable, but no accurate rapid analysis is currently available. HPLC techniques can be used to estimate levels of polysaccharides in sugars, syrups and juices. The application of an HPLC system, using ion exchange-type columns, to estimate dextran levels is presented. The effects of various enzyme treatments of samples on the dextran estimation are also considered, and the accuracy and precision of the measurement discussed.

1 *I.S.J.,* 1983, **85,** 10-13.

By-products

Pig fattening with sugar cane molasses. II. Digestibility indices and passage along the gastrointestinal tract

J. Ly. *Cuban J. Agric. Sci.*, 1984, **18**, 163-172.

Pig feeding trials showed that digestibility of a ration containing high-test molasses was better than that of a maize ration, while the pigs made poor use of a ration containing final molasses, as demonstrated by the rapidity of passage of the diet. The maize, high-test molasses and final molasses made up 89, 90 and 82.4% of the dry diets, respectively.

Use of palmwine cultures for ethanol production from blackstrap molasses with particular reference to conditions in the tropics

S. K. Layokun. *Process Biochem.*, 1984, **19**, (5), 180-182; through *S.I.A.*, 1985, **47**, Abs. 85-503.

Nigerian cane molasses was diluted, heat-sterilized and filtered, and either supplemented with salts or left unsupplemented. It was fermented either by Engendura yeast (a strain of *Saccharomyces cerevisiae*) or by yeast from palmwine, containing 17 strains of yeast and various bacteria. Yields of ethanol and biomass were increased by supplementation; they were considerably higher with the palmwine yeast than with the Engendura yeast. This was probably because some of the organisms in the mixed (palmwine) culture break down higher sugars, which can then be fermented.

Ethanol production with immobilized cell reactors

P. Linko, M. Sorvari and Y. Y. Linko. *Annals New York Acad. Sci.*, 1983, **413**, 424-434; through *S.I.A.*, 1985, **47**, Abs. 85-504.

Experiments are reported on the fermentation of various substrates to ethanol by immobilized yeasts and bacteria. Cane molasses (17.5% sugar w/v) was fermented with *Saccharomyces cerevisiae* immobilized in alginate; in 3-4 days' fermentation, 6-7.5% ethanol w/v was obtained. Data are also given on the fermentation of commercial corn syrup.

Studies on continuous ethanol fermentation of sugar cane molasses. I. A system for continuous fermentation. II. Continuous alcohol fermentation and product removal in a laboratory-scale plant

A. Haraldson and C. G. Rosen. *Eur. J. Appl. Microbiol. Biotechnol.*, 1982, **14**, (4), 216-219, 220-224; through *S.I.A.*, 1985, **47**, Abs. 85-507, 85-508.

I. A laboratory system which can be used for the continuous fermentation of molasses is described. A rotating microporous filter, which is connected to the fermentation vessel, allows the free escape of metabolic products while retaining the yeast in the system. The vinasse is recirculated after removal of ethanol by distillation. The resulting build-up of non-fermentables and the concentration of yeast cells are limited by controlled bleeding.

II. Concentrated solutions of cane molasses were fermented to ethanol with simultaneous product removal in laboratory continuous tests lasting 150 hours. With increasing oxygen tension, ethanol yield progressively decreased, but yeast growth increased, at least up to 1000 ppb oxygen; 50 ppb was sufficient for continuous fermentation to occur. With 10 g sugar/litre in the fermenter and a dilution rate of 0.017/hr, an ethanol yield of 90% on sugar could be sustained. No inhibition due to accumulation of non-fermentables was observed up to a dry solids concentration of 20%.

Energy considerations in bagasse depithing

D. E. Lengel. *Non-Wood Plant Fibre Pulping Progress Rpt.* (TAPPI), 1983, (14), 1-7; through *S.I.A.*, 1985, **47**, Abs. 85-532.

The importance of an all-inclusive, overall systems approach, from cane field to final product, is emphasized. The costs and power consumption of depithing *vs.* non-depithing systems are examined, confirming the advantages of early moist depithing at the sugar factory. The terms of bagasse purchase contracts are discussed. The energy costs of various methods of wet bulk piling are compared, indicating that, while there are several suitable ways to convey the bagasse to the pile, for conveying it from the pile to the plant, the wet slurry retrieval system seems preferable. Depither design and depither system efficiency are also discussed, with special reference to the Rivenco depither.

The effect of milling on the papermaking properties of several Australian sugar cane varieties

G. Gartside, N. G. Langfors and K. Miller. *Non-Wood Plant Fibre Pulping Progress Rpt.* (TAPPI), 1983, (14), 37-44; through *S.I.A.*, 1985, **47**, Abs. 85-535.

A study was made of the papermaking properties of six commercially grown varieties of sugar cane in Australia. Soda pulps were made from cane, prepared cane and bagasse of each variety. At a freeness of 250 Cfs, pulps from bagasse had poorer strength properties than pulps from cane, the tear index was about 30% lower and the burst index and breaking length were about 15% lower. Pulps from prepared cane had intermediate properties. Measurements of fibre length showed that these changes were brought about by a weakening of the fibres rather than fibre breakage. It is considered that alternative processes for sugar extraction are needed if maximum strength pulps are to be obtained from bagasse.

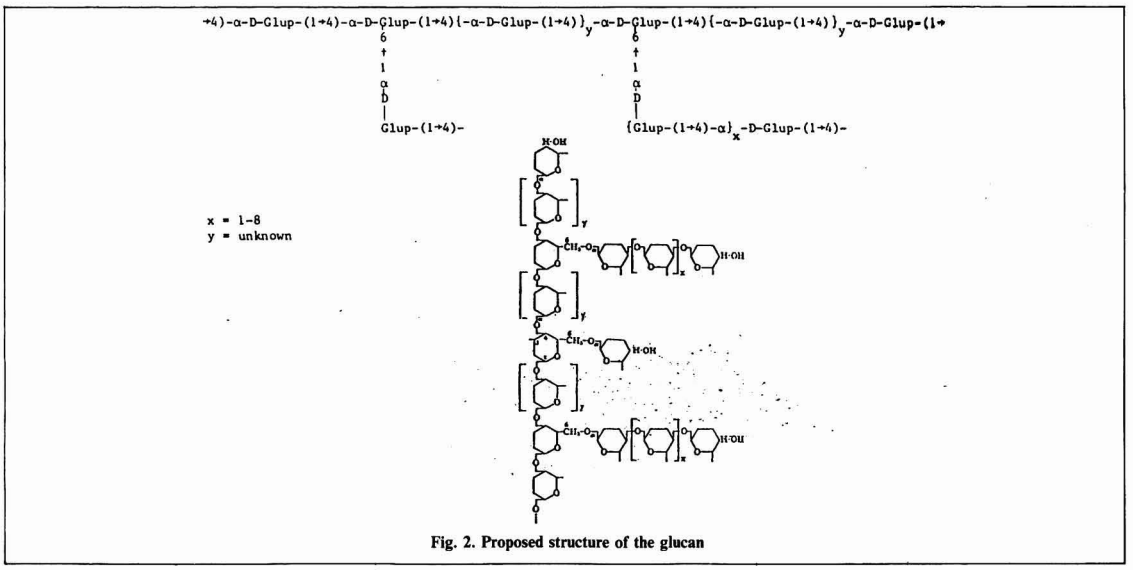


Fig. 2. Proposed structure of the glucan

Dr. C. W. S. Tsang, in performing all the HPLC analysis, and of James Harris, in making GC analysis of methylated compounds.

Summary

A glucan has been separated from indigenous sugar cane polysaccharide obtained from fresh cane juice. An account is given of studies aimed at elucidating its structure and conclusions drawn from the results are reported.

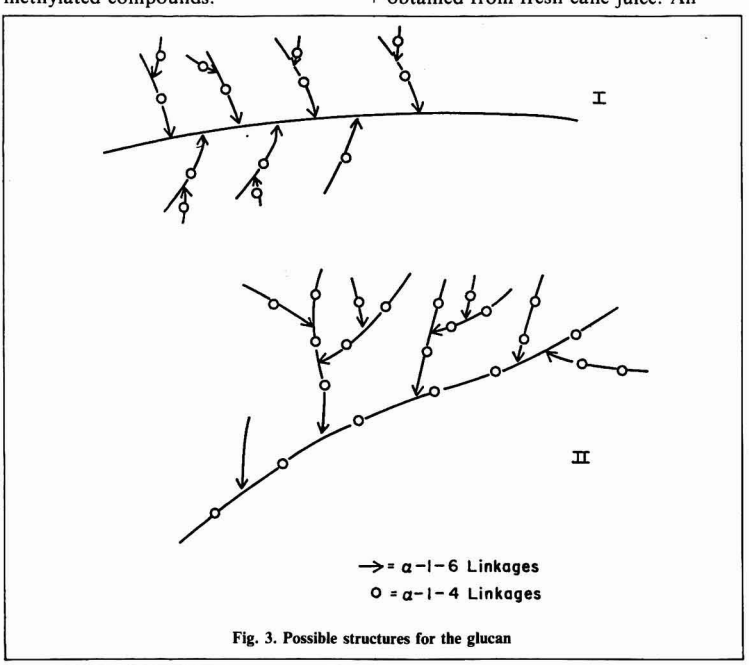


Fig. 3. Possible structures for the glucan

Une glucane aux dépens de la canne à sucre

On a séparé une glucane à partir d'un polysaccharide de canne à sucre indigéne obtenu aux depens de jus frais. On rapporte les études effectuées en vue d'élucider sa structure et on cite les conclusions tirées de cette étude.

Ein Glucan aus Zuckerrohr

Ein Glucan aus nativen Zuckerrohr-Polysacchariden wurde aus frischem Rohrsaft erhalten. Berichtet wird über Studien zur Aufklärung seiner Struktur, und über Schlüsse aus den Ergebnissen.

Un glucano de caña de azúcar

Se ha separado un glucano del polisacárido indigeno de caña de azúcar obtenido del jugo de caña fresca. Se presenta una cuenta de estudios que tuvieron por fin la elucidación de su estructura, y se presentan las conclusiones que se han tirado.

Anaerobic waste-water treatment plant in the Offstein factory

By H. Schiweck, H. Kutschke and C. Nähle

(Süddeutsche Zucker-AG, Mannheim, Germany)

After pilot-scale trials over some years[1] and with different systems (upflow, contact sludge, etc.) and a planning and construction phase of 8 months, the company's first anaerobic waste-water treatment plant was put on stream at the Offstein factory of Süddeutsche Zucker-AG in 1983. The process chosen was the contact sludge process (Fig. 1) because, owing to alkalization of flume and beet wash water in Germany, the waste-water contains rather high amounts of calcium. The alkalization of flume water is practised by Süddeutsche Zucker-AG in general in order to check bacterial growth, to improve the settling of dirt in the mechanical decanters and to maintain the quality of washed beet during storage[2].

The anaerobic plant at Offstein was designed for three different operating conditions:

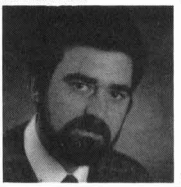
(1) part of the waste-water generated during the campaign is treated immediately and removed; this stream amounts to 160 m³/hr and is heated to 35°C by means of the condenser water available at 55-60°C.

(2) the remainder of the waste-water is treated between the end of the campaign in December and the beginning of April at a load of about 50 m³/hr; during this period steam is used to heat the waste-water.

(3) the plant treats about 10 m³/hr of waste-water from liquid sugar and fructose production. Since this effluent is generated all the year around, the anaerobic treatment plant must run at a load of about 10 m³/hr from April to the beginning of the next campaign in September.

H. Schiweck

H. Kutschke



C. Nähle

The plant consists of a methane reactor or digestion tower and a settling tank or thickener with a "degassing unit" with stirrer and vacuum pump located between them[3] (Fig. 1). The mixing in the methane reactor is effected through gas injection. The settling tank equipped with a scraper separates the sludge from the treated effluent, the thickened sludge being returned to the methane reactor.

As the degassing unit was installed at mid-level between the digestion tower and thickener, uncontrolled liquid flow with siphoning both ahead of and after degassing occurred. This was eliminated only after the installation of a proper level control consisting of

Paper presented to the 23rd General Meeting of the American Society of Sugar Beet Technologists, 1985.

1 Nähle: *Zuckerindustrie,* 1984, **109,** 19-27.
2 Schiweck: "Ullmanns Encyklopädie der technischen Chemie", Band 24, 1983, 703-748.
3 Nähle *et al.: Sucr. Franç.,* 1985, **126,** 83-87.

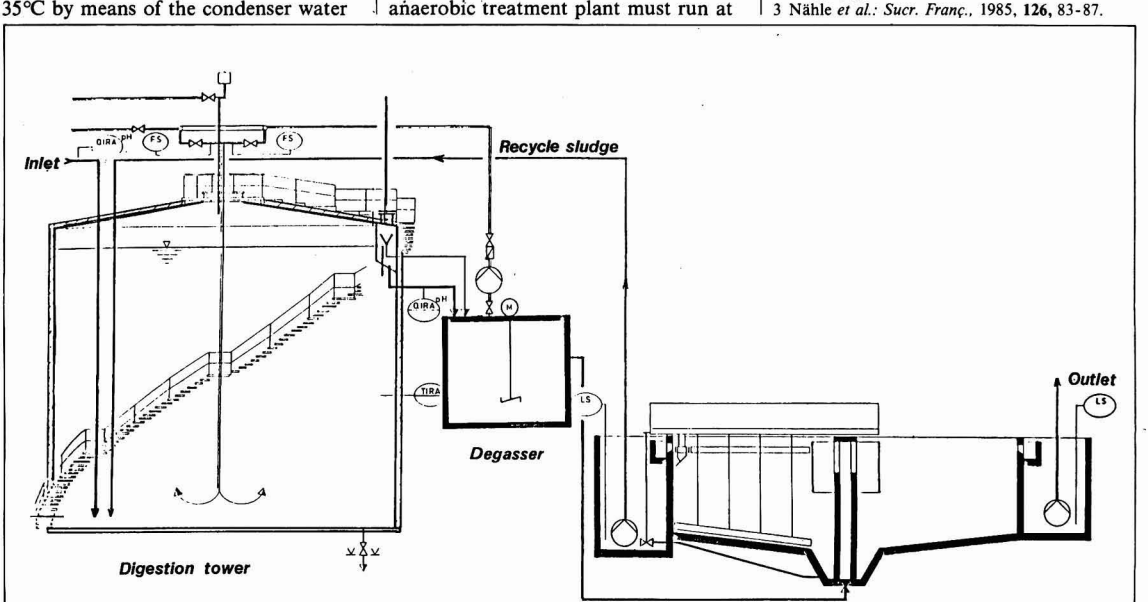


Fig. 1. Anaerobic waste water treatment at Offstein factory

level probes, flow meters and a control valve.

This experience was taken into consideration in the case of another plant being built this year in Südzucker's Plattling factory and the degassing unit there has been modified accordingly.

The reactor in the Offstein factory, which has been designed for a daily load of 23 tonnes of COD, has a volume of 2100 m^3. With a design waste-water flow rate of 160 m^3/hr, this corresponds to a space loading of approx. 11 kg COD/m^3/day and a hydraulic retention time of about 13 hours in the reactor. The degradation rate had been guaranteed at a 90% reduction of COD. The settling tank has a diameter of 32 m corresponding to a surface area of 800 m^2 and should give an ascending velocity for water of less than 0.2 m/hr.

The flow rate through the plant—which was started up in early October 1983 with digested municipal sludge—was increased progressively up to about 100 m^3/hr by mid-November 1983. The COD reduction rate during this period amounted to 83% and increased to 95% at a flow rate of 140 m^3/hr by the end of November 1983. Figure 2 shows the flow rate (m^3/hr), COD load (tonnes/day) and gas production (m^3/hr) during the two campaigns. During the 1984/85 campaign flow rates of up to 200 m^3/hr, corresponding to a COD load of up to 26 tonnes/day and amounting to 127% of the rated capacity, could be maintained successfully. The gas production was about 500 m^3/hr with a methane content of 76-82%.

The efficiency in terms of COD reduction as well as the COD content of the effluent from the plant from October 1983 until December 1984 are shown in Figure 3. An average efficiency of about 95% was attained and at a COD-content of 7-9 g/litre waste-water (design criterion 6 g COD per litre) the efficiency was better than the guaranteed 90%. The plant shows great process stability. After the adaptation phase the COD content in the effluent from the anaerobic plant ranges between 200 and 300 mg/litre. Production of approx. 0.4 Nm^3 of biogas per kg of decomposed COD was confirmed.

The average loading of the settling tank per unit surface area during the proving run was 146 kg total solids/m^2/day compared with a design loading of 96 kg total solids/m^2/day. The feed rate per unit surface area was 0.20-0.25 m/hr during the 1984/85 campaign.

The formation of calcium carbonate, first detected during the pilot runs, was found to occur also during the campaign as well as later. Figure 4 shows the results obtained during the 1983/84 and 1984/85 campaigns. The calcium content of waste-water being fed to the anaerobic plant was 1200 mg Ca/litre whereas the effluent contained an average of only 409 mg Ca/litre. This means a production of 6.6 tonnes of $CaCO_3$/day under guarantee conditions. During the 1984/85 campaign up to 9.5 tonnes of $CaCO_3$/day was produced.

As a result of the strict separation of

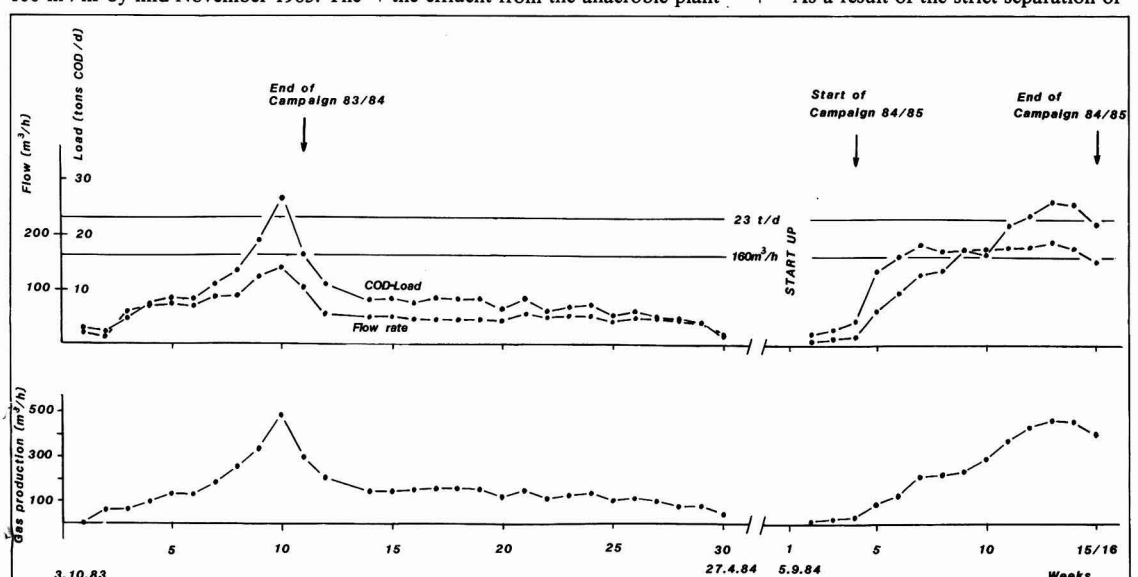


Fig. 2

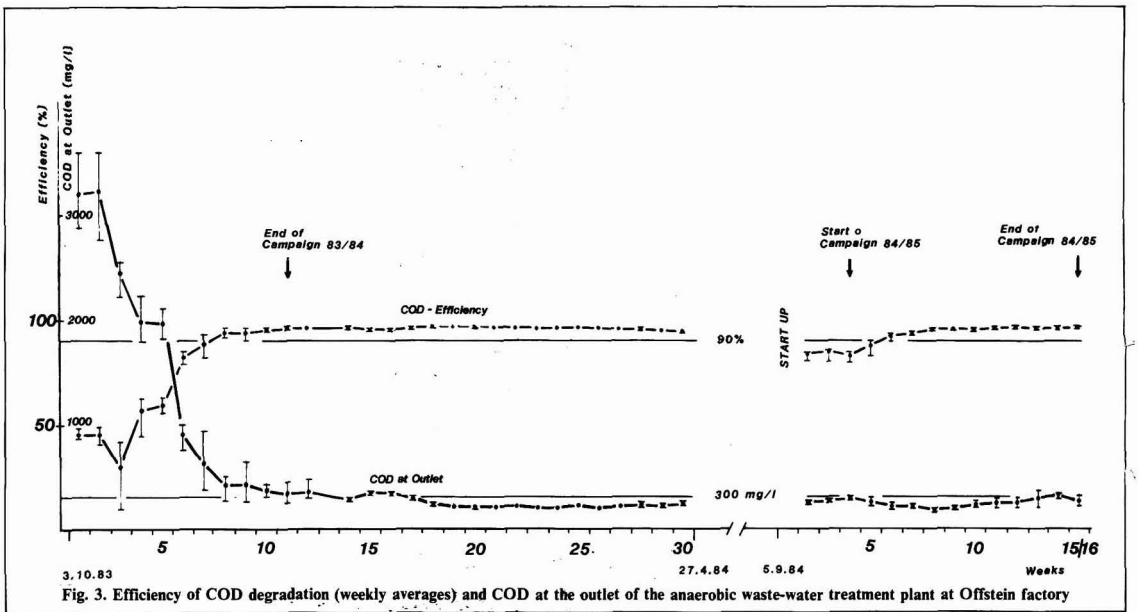


Fig. 3. Efficiency of COD degradation (weekly averages) and COD at the outlet of the anaerobic waste-water treatment plant at Offstein factory

the methane formation and phase separation stages, it is possible to modify the individual stages if needed, or to introduce additional process steps, for example a centrifugal separation of $CaCO_3$ from organic matter in the sludge recovery system. The calcium elimination from the system in the form of carbonate varied

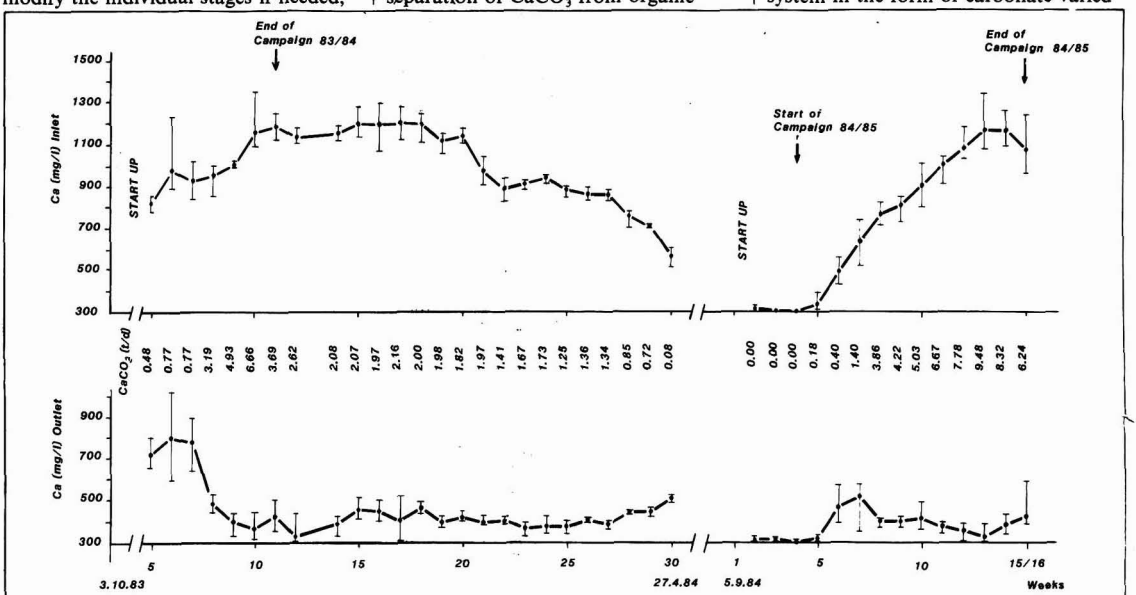


Fig. 4. Weekly average calcium content at the inlet and outlet of the anaerobic treatment plant at Offstein factory

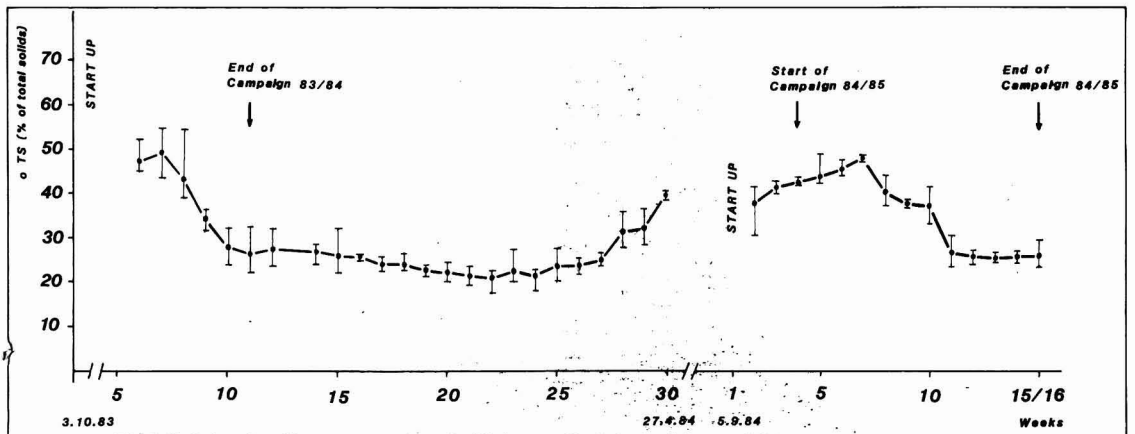


Fig. 5. Variation of weekly average organic total solids in anaerobic sludge from the anaerobic treatment plant at Offstein factory

over the entire operating period. The start-up phase, lasting until early November 1983 with progressively increasing decomposition rates of up to 80%, was not included in the diagram. Until mid-November 1983, with a COD decomposition rate of up to 90%, the difference in the calcium content between the feed and discharge was about 170 mg/litre.

Figure 5 shows the percentage of organic total solids (OTS) in the anaerobic sludge, as a function of the operating period. At the low calcium elimination of about 170 mg/litre, there was no dilution of OTS contained in the sludge. The OTS content amounted to about 50% of the total solids content. The sludge produced daily contains theoretically 40% organic total solids, assuming that 5 kg of biomass is produced during the degradation of 100 kg COD. During the period from the end of November to the beginning of December 1983, the difference in the calcium content was about 500 mg Ca/litre at a COD decomposition rate of about 96%. In this case there is a distinct change in the OTS content of the anaerobic sludge. Near the end of this phase the OTS content of the sludge was found to be 30%. Theoretically, 20% of the new sludge generated during this

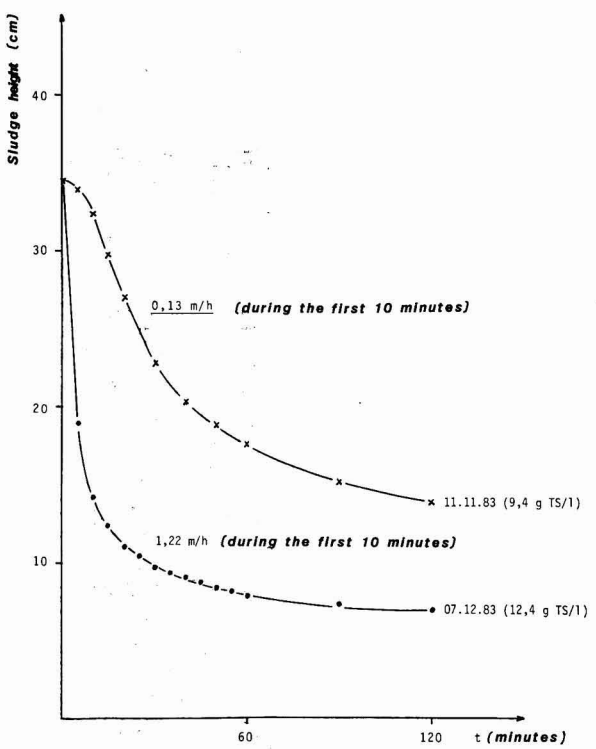


Fig. 6. Anaerobic sludge settling rate with (•) and without (x) calcium carbonate

period should consist of organic total solids. This shows that at a calcium elimination rate of about 800 mg/litre the OTS content of anerobic sludge shifts slowly towards lower OTS concentrations so that the theoretical OTS content of the fresh sludge amounts to only 18%. After 20 weeks of operation the anaerobic sludge in the plant contained about 22% organic total solids. If the theoretical yield of 5 kg fresh biomass per 100 kg of COD decomposed be correct, then an equilibrium OTS concentration of 18% in sludge would be expected at the given calcium elimination rate of 800 mg Ca/litre.

Owing to the formation of calcium carbonate in the system, the properties of the anaerobic sludge are changed. This applies especially to the settling rate which, among other factors, has a determining influence on the performance of the settling tank. Figure 6 shows the settling rate of the anaerobic sludge on two different days. On November 11, the settling rate during the first 10 minutes was 0.13 m/sec, with an OTS content of about 50% in the sludge, i.e. the sludge did not contain any appreciable amount of calcium carbonate. Four weeks later, the sludge settling rate had gone up by a factor of 10, with an OTS content of about 28% in the sludge.

The amount of suspended matter in the effluent, i.e. the sludge or biomass loss from the plant, was affected directly by the increase in the density of the sludge due to calcium carbonate. If the sludge loss is higher than the amount being generated, then it does not take long before operations have to be stopped. Before the amount of calcium precipitated in the system increased (up to Nov. 19, 1983), 3-5 mg suspended matter per litre (corresponding to a sludge loss of 200-300 mg/litre with about 60% OTS) could usually be found in the effluent. During this period, however, the production of OTS exceeded the losses in the effluent, so that no operating problems occurred. After the increase in calcium carbonate formation the amount of suspended matter found in the effluent was 0.5 ml/litre, corresponding to less than 60 mg total solids per litre.

The plant is now being operated in such a manner that the amount of OTS required for the degradation of the maximum projected COD-load is retained in the system, the excess OTS (excess sludge) being discharged. Figure 7 shows the sludge quantities in tonnes of total solids which were removed in the 1983/84 and 1984/85 campaigns. It is sufficient to maintain 15 tonnes of organic total solids in the reactor, corresponding to a sludge loading of 1.5 kg COD per kg OTS per day, to decompose 23 tonnes of COD per day (design load during the campaign). With a reactor volume of 2100 m^3 this amounts to an OTS concentration of about 7 g/litre in the reactor, which corresponds to a sludge concentration

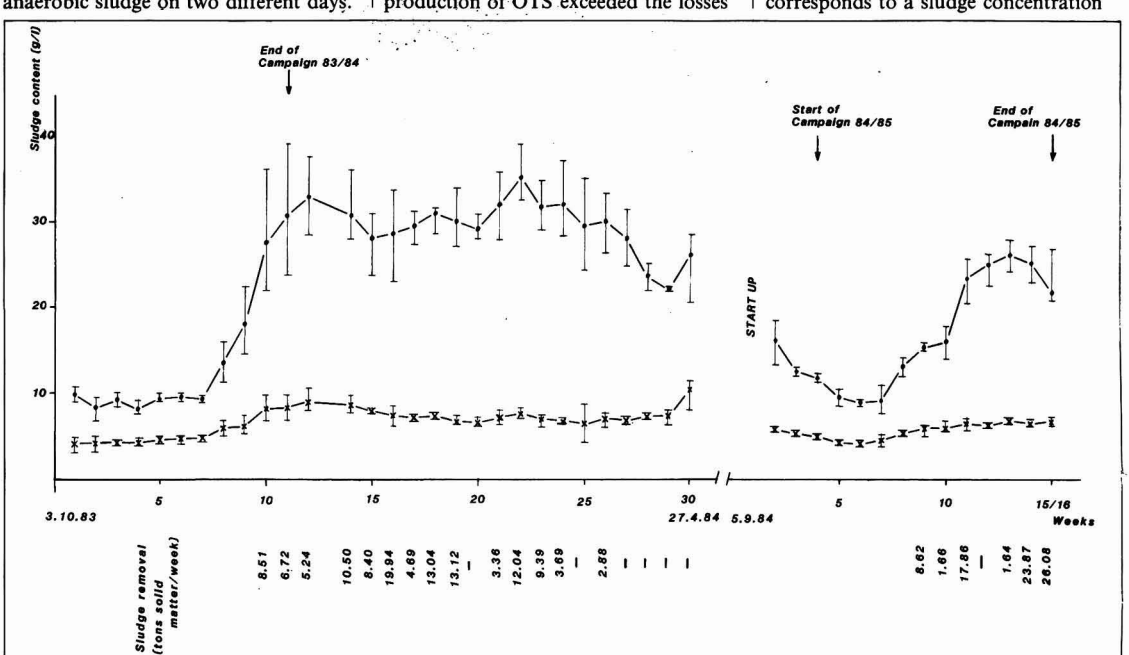


Fig. 7. Weekly aveage sludge concentration (total solids and organic total solids) in the reactor of the anaerobic treatment plant at Offstein factory

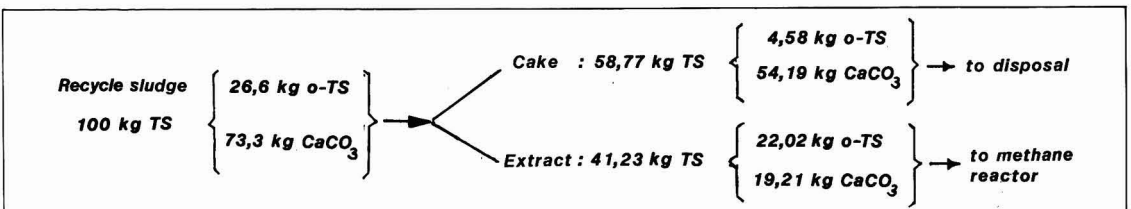


Fig. 8. Reduction of $CaCo_3$ content in recycle sludge at the Offstein factory anaerobic plant. Efficiency rates: $CaCO_3$ separation 73.9%; Organic total solids recovery 82.8%

of approx. 32 g/litre of total solids at an OTS content of 22% in the sludge. Figure 7 shows the sludge concentration in the reactor (in terms of total solids and organic total solids) during the 1983/84 and 1984/85 campaigns.

Under the given extremely severe operating conditions, especially with regard to $CaCO_3$ formation particularly under the high sludge concentrations to be maintained, it is not possible to avoid the formation of deposits in the lower part of the reactor. Removal of calcium carbonate from the sludge through centrifugal separation could help prevent this.

During the campaign, pilot runs with a decanter centrifuge were carried out to separate the calcium carbonate from the recycle sludge. The results of these trials are shown in Figure 8. The recycle sludge contained 26.6% organic total solids. After the centrifugal separation the cake contained 92% $CaCO_3$ and about 8% organic total solids whereas the decantate contained about 53% OTS and 47% $CaCO_3$. Of the total of 73.3 kg $CaCO_3$ in the anaerobic sludge fed to the centrifuge 54.19 kg was removed; this corresponds to an efficiency of about 74%. Of 26.6 kg of OTS fed to the centrifuge, 22.02 kg or about 83% was recovered in the decantate. The cake had a total solids content of over 50% which may facilitate its disposal.

In our opinion as much calcium carbonate as possible must be removed by centrifuging from recycle sludge in order to avoid formation of deposits which may otherwise necessitate additional cleaning. The centrifuge does not have to be run continuously; it is sufficient to operate it from time to time and then only for a few days during or after the campaign, depending upon the OTS content of the sludge.

Rather high heat losses from the surface of the settling tank, particularly at low ambient temperatures, are another important aspect of the process which can still be improved. A temperature difference of up to 8°C between the reactor and the settling tank may occur at temperatures below 0°C. This is a major disadvantage, particularly when steam is being used to heat the waste-water. To avoid this heat loss it would be necessary to cover the surface of the settling tank.

Summary

The first anaerobic plant at a factory of Süddeutsche Zucker-AG was installed at Offstein sugar factory in 1983. The plant uses the sludge contact process and is dimensioned for a COD input load of 23 tonnes/day, corresponding to a volumetric loading of approx. 11 kg COD/m³/day. Results achieved from the start of the 1983/84 campaign to the end of the 1984/85 campaign (a total of 46 working weeks) are reported. The plant displays considerable process stability. The COD degradation rates were 95% throughout the entire period. The rated performance was exceeded in both hydraulic and degradation terms. The problem of calcium carbonate formation in the system is examined in greater detail. Suggested solutions are put forward.

Installation pour le traitement anaérobie d'eau résiduaire à la sucrerie de Offstein

La première installation anaérobie dans une usine de la Süddeutsche Zucker-AG fut installée en 1983 à la sucrerie de Offstein. L'installation utilise le procédé du contact avec la boue et est dimensionée pour une charge à l'entrée de 23 tonnes/jour, ce qui correspond à une charge volumétrique d'environ 11 kg DCO/m³/jour. On rapporte les résultats obtenus depuis la mise en route durant la campagne 1983/84 jusqu'à la fin de la campagne 1984/85, soit un total de 46 semaines de travail. L'installation possède une stabilité considérable dans le processus. La dégradation de DCO était de 95% pour l'ensemble de la période. La performance estimée fut dépassée, tant pour les valeurs hydrauliques qu'au point de vue de la dégradation. On examine en détail le problème de la formation de carbonate de calcium dans le système et on mentionne les solutions suggérées.

Anlage zur anaeroben Abwasserbehandlung in der Zuckerfabrik Offstein

Im Jahre 1983 wurde in der Zuckerfabrik Offstein die erste Anaerob-Anlage in einem Werk der Süddeutschen Zucker-AG aufgestellt. Die Anlage arbeitet nach dem Schlammkontaktverfahren. Sie ist für eine CSB-Eingangsfracht von 23 t/d entsprechend einer Raumbelastung von ca. 11 kg CSB/m³/d dimensioniert. Es wird über die erzielten Ergebnisse von Anfang der Kampagne 1983/84 bis

Brevities and statistics

Indonesia sugar imports, 1984[1]

	1984	1983	1982
	tonnes, raw value		
Cuba	0	0	14,236
India	0	42,400	301,161
Korea, South	0	50,300	96,682
Malaysia	2,555	16,300	0
Philippines	0	4,000	86,321
Thailand	3,198	45,494	68,959
Other countries	186	0	268
	5,939	158,494	567,627

continued from previous page

Ende der Kampagne 1984/85 (insgesamt 46 Betriebswochen) berichtet. Die Anlage zeigt eine große Prozeßstabilität an. Die CSB-Abbauraten lagen über den ganzen Zeitraum bei 95%. Die Auslegungsleistung wurde sowohl hydraulisch als auch abbaumäßig übertroffen. Auf das Problem der Calciumcarbonat-Bildung im System wird näher eingegangen. Hierfür werden Lösungsvorschläge unterbreitet.

Instalación para el tratamiento anaérobico de agua residual en la azucarera de Offstein

La primera instalación anaérobica en una fábrica de la Süddeutsche Zucker-AG se ha establecido a la azucarera de Offstein en 1983. Esta instalación utiliza el proceso de contacto con el lodo y esta dimensionada para una carga a la entrada de 23 toneladas por día de DQO, que corresponde a una carga volumétrica de algunos 11 kg de DQO por m^3 por día. Se presentan los resultados que se han logrado del comienzo de la campaña de 1983/84 hasta la terminación de la campaña de 1984/85 (46 semanas de trabajo en total). La instalación demuestra una estabilidad considerable del proceso. La degradación de la DQO estaba de 95% durante el período entero. El cumplimiento estimado ha sido superado en términos hidraúlicos y en términos de degradación también. El problema de formación de carbonato de calcio en el sistema se examina en detalle y se presentan soluciones sugeridas.

Sugar Industry Technologists Inc. Meade Award

The judging committee of SIT, under the Chairmanship of David Humm, has selected the paper "Continuous vacuum pans for white sugar" by E. D. Bosse of BMA/Silver Engineering as the winner of the George and Eleanore Meade Award for the best paper presented at the 1985 meeting in St. John, N.B., Canada. The Award will be presented to Mr. Bosse at the 1986 meeting, which will be held in Baltimore during May 18-21, 1986.

Thailand alcohol program[2]

Thailand plans to produce an initial 31 million litres of alcohol next year for use as a gasoline extender, according to the Director of the Industry Ministry's Alternative Energy office. Three local sugar factories plan to use about 470,000 tonnes of surplus cane to make alcohol for domestic consumption, while the office plans to encourage ten factories to produce 134 million litres/year of alcohol from 2 million tonnes of cane, subject to world sugar prices and Thai energy policies. Thai farmers will receive about 300 Baht per tonne of cane used for alcohol manufacture, against about 140 Baht per tonne for cane used in sugar manufacture. A private Thai firm will start next year to produce alcohol from molasses and will export about 60 million litres per year of its production.

China sugar production, 1984/85[3]

Cane sugar output in China in the 1984/85 season rose by 30.7% to 3,496,000 tonnes (3.8 million tonnes, raw value) and beet sugar production fell by 126,000 tonnes or 15% to 814,000 tonnes. Overall production was a record at 4,310,000 tonnes, white value, up 750,000 tonnes on the previous season. In 1985/86 sugar production is expected to rise to nearly 5.2 million tonnes, raw value, filling 80% of consumption. Sugar imports in 1985 are forecast at 800,000 tonnes, while official statistics report 1984 imports as 1,231,000 tonnes.

Argentina 1984 sugar crop[4]

Production of sugar totalled 1,447,107 tonnes, tel quel, in 1984 against a total of 1,537,184 tonnes in 1983. It included 1,122,211 tonnes of white sugar (1,004,044 tonnes in 1983) and 324,896 tonnes of raw sugar (533,139 tonnes) and was obtained by crushing 13,970,564 tonnes of cane (14,904,437 tonnes in 1983), harvested from 318,500 hectares (313,400 ha).

Ivory Coast sugar production, 1984/85[5]

Sugar production in the four complexes of the state-owned Sodesucre in 1984/85 is estimated at 119,000 tonnes, raw value, against 125,500 tonnes in 1983/84. The cane area was reduced from 31,700 hectares in 1983 to 31,400 hectares in 1984.

Jamaica sugar production, 1985[6]

The 1985 sugar crop in Jamaica amounted to 205,900 tonnes, up 12,000 tonnes from the 1984 crop but slightly below the target of 210,000 tonnes.

1 *I.S.O. Stat. Bull.*, 1985, **44**, (7), x.
2 *Amerop-Westway Newsletter*, 1985, (142), 12.
3 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 496.
4 "El azúcar en cifras" (Centro Azucarero Argentino), 1985.
5 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 536.
6 *Financial Times*, September 5, 1985.

British Society of Sugar Cane Technologists

The Autumn 1985 technical meeting of the B.S.S.C.T. was held at the Royal Commonwealth Society in London on October 21 where members were welcomed by the President, Dr. M. C. Bennett, who reminded those present of the forthcoming ISSCT meeting in Indonesia before handing over the chair to Dr. R. A. Yates, Vice-President of the Society. Dr. Yates described the program and introduced the first speaker, Dr. N. Coote of Tate & Lyle Process Technology, whose paper discussed the operation of deep-bed filters and the application of his company's equipment in the sugar industry. Mr. Harold Deacon then presented a review of developments in mechanization in cane harvesting and transport, which was followed by an account by Mr. M. Squire of Wright Rain Ltd. on the procedure followed in investigating and establishment of the most appropriate system of irrigation for a sugar cane project or estate.

The final paper of the meeting was an analysis of the world sugar market by Dr. James Fry of Landell Mills Commodities Studies, with a discussion of the significance of that market as a proportion of trade in sugar, in general and for different countries. He also referred to the changes in raw and white sugar trading of recent years. The meeting was then closed by Dr. Bennett but members were invited to stay to watch a video film sent by the organizing committee of the 19th Congress of the ISSCT in Indonesia, describing that country and aspects of the sugar industry to be observed by participants.

New books

The South African sugar year book, 1983-1984 edition

Ed. G. Dewey. 198 pp; 21 x 29.4 cm. (The South African Sugar Journal, P.O. Box 1209, Durban, South Africa.) 1985. Price: R 20.00.

This well-known year book includes a number of special articles and features (mostly concerned with the South African sugar industry but also including one entitled "Problems of designing and negotiating an International Sugar Agreement" by A. W. B. Buchholz) as well as reports from the various sugar organizations and a review of the 1983/84 milling season in Southern Africa. As the Editor points out in his foreword, the season saw the worst drought in memory followed by the most severe floods on record; together with sugar export prices substantially below production costs, these made for considerable hardship within the industry. The Reference Section includes information on the structure of the South African sugar industry and details of South African sugar enterprises as well as information on sugar processing enterprises in neighbouring countries. This is a well-produced book which is to be recommended to all those interested in the South African sugar industry.

ICIDCA 20 aniversario (20th anniversary of ICIDCA)

23 pp; 15.4×22.9 cm. (Ministerio de Cultura, Editorial Científico-Técnica, Calle 2 No. 58, entre 3ra. y 5ta., La Habana 4, Cuba.) 1983.

This small paperback was issued in 1983 (but only now made available outside Cuba) to celebrate the 20th anniversary of the Instituto Cubano de Investigaciones de los Derivados de la Caña de Azúcar, an institute set up to conduct research on cane by-products, particularly bagasse and molasses. The activities and achievements of the institute are outlined with the aid of some illustrations.

Ethanol export potential of Brazil

The Brazilian Ethanol Producers' Special Committee. 19 pp; 14.1×20.7 cm. (The Brazilian Ethanol Producers' Special Committee, Avenida Paulista 2028, 6th Floor, 01310 São Paulo, SP, Brazil.) 1985.

A brief account is given of the National Alcohol Program instituted in Brazil in 1975 and which has made considerable strides; as stated in an introductory section, "In a seven-year time span the object of initial discredit has become a reason for pride". Statistics concerning ethanol production give details of land occupation in Brazil (with a total of 3,286,668 square miles, the fifth largest country in the world) and show how the area planted to cane is only 9.39 million acres (8.4% of the total cultivated area) despite the fact that the quantity of cane represents 25% of the world total. Data are given on cane, sugar and ethanol production, and the market for ethanol is examined; while the volume of anhydrous ethanol blended with gasoline is restricted by gasoline consumption (which is expected to remain stable in future years as the sales of gasoline-consuming vehicles fall), the demand for hydrous ethanol grows commensurate with 500,000 new alcohol-burning vehicles sold every year. Sales of vehicles and the impact of ethanol on these are discussed, and the effect of alcohol manufacture on job creation is indicated. Current yields in the ethanol industry, its energy balance per tonne and per acre of cane and planned expansion of the industry are included; currently, there are 540 alcohol distilleries in Brazil, and approval of projects for the construction of new units rests with the government so as to ensure no over-production. The benefit of alcohol in place of gasoline in terms of elimination of atmospheric pollution with lead is briefly discussed with the aid of graphs, and Brazil's alcohol export potential is considered (in 1984, total alcohol exports represented 11.1% of that produced). Since production has to increase by some 500 million gallons annually to keep pace with domestic market requirements, it is stressed that the surplus available for export will be expected to fall from now on, unless adjustment is made to the ratio of ethanol to gasoline that is used in the blends and unless the proportion of alcohol to sugar produced is increased.

Le sucre. Mémo statistique 1984

Anon. (Centre d'Etudes et de Documentation du Sucre, 30 rue de Lubeck, 75116 Paris, France.) 1984.

This is a collection of 20 tables of French, EEC and world sugar statistics. The first 9 concern France: the sugar balance for the 1983/84 beet campaign; beet production in 1955/85; beet areas in 1984/85; production, consumption and net export of sugar in 1979/84; the number and sizes of beet sugar factories; white sugar production in 1939/40 and 1957/84; sugar consumption in 1962/84; distribution of sugar use; and indirect uses of sugar for human consumption. The EEC data include production quotas; prices for the 1984/85 campaign; production of sugar in the member-countries; the sugar industries of the member-countries (showing beet areas in 1983/84 and 1984/85, number of sugar factories and average sugar yield/ha); sugar consumption in the member-countries; and imports and exports for each member. The world data include a sugar balance for 1981/82, 1982/83 and 1983/84 (estimated); the major beet and cane sugar producers (with production figures for the three seasons up to and including 1983/84); development of world sugar production and consumption from 1900; and consumption in those countries ranking highest and lowest (>40 kg per caput and <8 kg per caput, respectively) as well as in countries where the per caput consumption is 9.1-39.7 kg.

Trade notices

Anti-abrasion and -corrosion steel

Cromweld Steels Ltd., Cornwall House, Sandy Lane, Newcastle-under-Lyme, Staffs. ST5 0LZ, England.

3CR12 is a special steel developed for high abrasion/corrosion conditions; it has already saved British Sugar plc a considerable amount of money in applications ranging from troughs, flumes and hoppers to diffuser screens and chimneys. The latest application, at Bury St. Edmunds sugar factory, is as material for a wind box weighing approximately 18 tonnes, together with associated ducting and gas recycle mixing chamber, for a Babcock Power Ltd. hot gas generator.

PUBLICATIONS RECEIVED

BMA Information

Braunschweigische Maschinenbauanstalt AG, P.O. Box 3225, D-3300 Braunschweig, Germany.

The latest available edition of BMA Information features Guirga cane sugar factory in Egypt for which BMA was awarded a contract covering all the process equipment as well as steam and power generation plant and water supply equipment; start-up is planned for 1987. New orders for tower diffusers in 1984 brought the total supplied by BMA to 300, and further orders have been placed in 1985. The first BMA cane diffuser in Indonesia was installed at Kedawung factory, near Surabaya in East Java, and is rated at a daily throughput of 2400 tonnes of cane, replacing an earlier 1200 tonnes/day milling train. The evapo-crystallization tower installed at Wabern in 1983 completed another successful campaign in 1984; designed for the production of 40-45 tonnes of white sugar massecuite per hour, it has a diameter of 4.5 m, an overall height of 22.6 m and a total heating surface area of 1590 m^2; it consists of four separate superimposed compartments, each with a calandria, vapour space and a massecuite stirrer. The massecuite flows from top to bottom under gravity, with entry into each compartment controlled on the basis of the level in the compartment. The plant was responsible for about 80% of the total white sugar production at the factory in 1984. Performance data are tabulated. A set of four falling-film evaporators was installed in Aarberg sugar factory/refinery in Switzerland to act as effects 2-5 inclusive in a quintuple-effect evaporator, with a double-effect evaporator as the 1st stage. The entire evaporator is rated at a daily juice throughput equivalent to a beet slice of 8000 tonnes/day. Results for the four BMA evaporators showed a rise in juice Brix from 27.6 to 63° when thick juice was used to melt raw sugar (temporary concentration to 67°Bx was also achieved at a heat transfer coefficient in the 5th effect of 1100 $W/m^2/°K$). There was no significant increase in juice colour during evaporation. Also featured in BMA Information are a number of innovations for continuous and batch centrifugals, including the provision of a flanged spindle and arrangement of the basket above the centrifugal platform in the case of G series batch machines so as to permit easy, low-cost removal of basket and drive head without the need to dismantle the complete centrifugal. The range of baskets for these machines has been supplemented by fully-perforated hooped baskets, which can be of fine-grained structural steel or stainless steel. Simultaneous opening of the discharge valve and positioning of the spindle in a fixed location plus provision of the discharger shoes with spring-loaded tips (with facility for easy changing of the edges) have considerably reduced the water requirement for screen washing. An additional nozzle assembly for wash water has reduced water consumption and increased crystal yield. There is a choice between pole-changing 3-phase drives and frequency-controlled drives. Successful operation of G 1500 machines in a South African and a South Korean factory is reported. In continuous centrifugals, such as the highly successful K 1300 (designed for crystal separation as well as melting), allowance for the difference in purity between green syrup and wash syrup is made by segmental removal of the syrup from the basket and by syrup-collecting ducts provided with adjustable mixing valves. The new basket for continuous machines with a syrup separator has slots in its middle area but still keeps the solid-bowl design. Trials of a newly developed crystal decelerator have shown that crystal breakage typical of continuous centrifugals can be reduced considerably. A new massecuite/magma pump is of the overhung type with only one bearing point and a clearance between pump housing and bearing, which has the advantage of needing only one seal for the rotary piston and facilitating access to the parts inside the housing. The housing is so designed as to allow high throughputs even at low piston speeds, which contribute to a reduction in wear of those components in contact with the massecuite. Three sizes of pump are available covering delivery ranges of 1-30, 30-40 and 40-65 m^3/hr. Even massecuites of high viscosity are reliably handled by the pump, as shown by trials with the largest of the three. Mention is also made of expansion of the beet sugar factory operated by Monitor Sugar Co. at Bay City, Michigan, USA, and of tests on a low-temperature beet pulp dryer which has been conceived as a tower having a number of superimposed drying levels as well as a central warm air distribution chamber. The individual levels rotate separately and have screen linings of stainless steel. Pulp feed to the screen plates and removal of the dried pulp from the plates are carried out by variable-speed screws. Brief items referring to orders for specific pieces of equipment are included, and details are given of the use of turbo-compressors for direct compression of alcohol vapours in a distillation system designed by Starcosa GmbH.

Metal perforating catalogue

Ferguson Perforating & Wire Co., 130 Ernest Street, Providence, RI 02905, USA.

A new catalogue from Ferguson Perforating describes the various types of wire screens available, including those for straining and filtration. The company can perforate various materials, including steel, aluminium, stainless steel and most alloys up to 60 inches wide in coils and in plates up to 72 in by 180 in long and $\frac{5}{8}$ in thick.

Microprocessor-based strip chart recorders

Kent Industrial Measurements Ltd., Howard Road, Eaton Socon, St. Neots, Huntingdon, Cambs. PE19 3EU, England.

The P100M strip chart recorder provides high accuracy and resolution on up to three continuous trace records, while the P600M offers 1-6 dotted records, each trace being of a different colour to ensure legibility and differentiation between the channels monitored. Both recorders have touch-sensitive switches to enable reprogramming to be carried out simply and thus provide maximum application flexibility. Leaflet P100M 0485/1 gives details of both recorders, while additional technical data are provided in leaflets 0807 (for the P100M) and 0808 (for the P600M).

Automatic boiling control

A P96M microprocessor-based digital display controller has been installed at the Peterborough factory of British Sugar plc for temperatures control in white sugar boiling. Manufactured by Kent Industrial Measurements Ltd., the P96M is sufficiently compact to be fitted to existing control panels and is easy to program. It is planned to install another four units for temperature control of the water fed to the vacuum pan condensers.

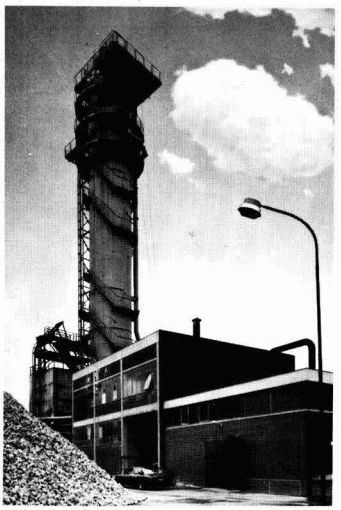
Rohm and Haas subsidiary formed

Rohm and Haas Co. announce the formation of a European separation technologies business unit which combines the company's ion exchange and adsorbent resin business with Hydranautics reverse osmosis membranes and Romicon ultrafiltration membranes. The aim is to supply a full range of separation products and technology to meet customer requirements in the fields of water treatment and special applications such as in the sugar industry.

Cane mill roller bearings in India[1]

Walchandnagar Industries Ltd., which operates a sugar factory as well as making cane sugar machinery, is to install SKF spherical roller bearings in its mills as replacements for the plain bearings used up to now. Savings of about 25% in energy consumption are expected from the results of successful experience with the bearings and new seals in Australia and Cuba. Almost all the cane mills in India use plain bearings, and this initial order could develop into considerable business in replacements with roller bearings.

1 *Indian Sugar*, 1985, **35**, 5.



"Eberhardt" lime kiln

Rotating hopper lime kilns

The burning system of these new kilns, for outputs up to 350 tonnes CaO per 24 hr, includes coke mixture firing and forced air draught operation.

Construction features include:

Vertical skip hoist with maximum operating safety.

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Platform installed in the upper part of the kiln with easy access as inspection and working platform for refractory lining. An officially approved winch can also by supplied for personal transport.

High working shaft corresponding to the requirements of the sugar and chemical industries.

Lime discharge through a double gate system, with 4-6 vibrating conveyors according to kiln size.

Level measurement by means of a gamma-ray device.

Fully automatic operation.

Heat consumption: <3750 kJ/kg burnt lime (<900 kcal/kg burnt lime).

The kiln produces lime with high reactivity, with less than 2% residual CO_2 in burnt lime and more than 40% by volume CO_2-content in waste gas.

GEGR. 1860

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