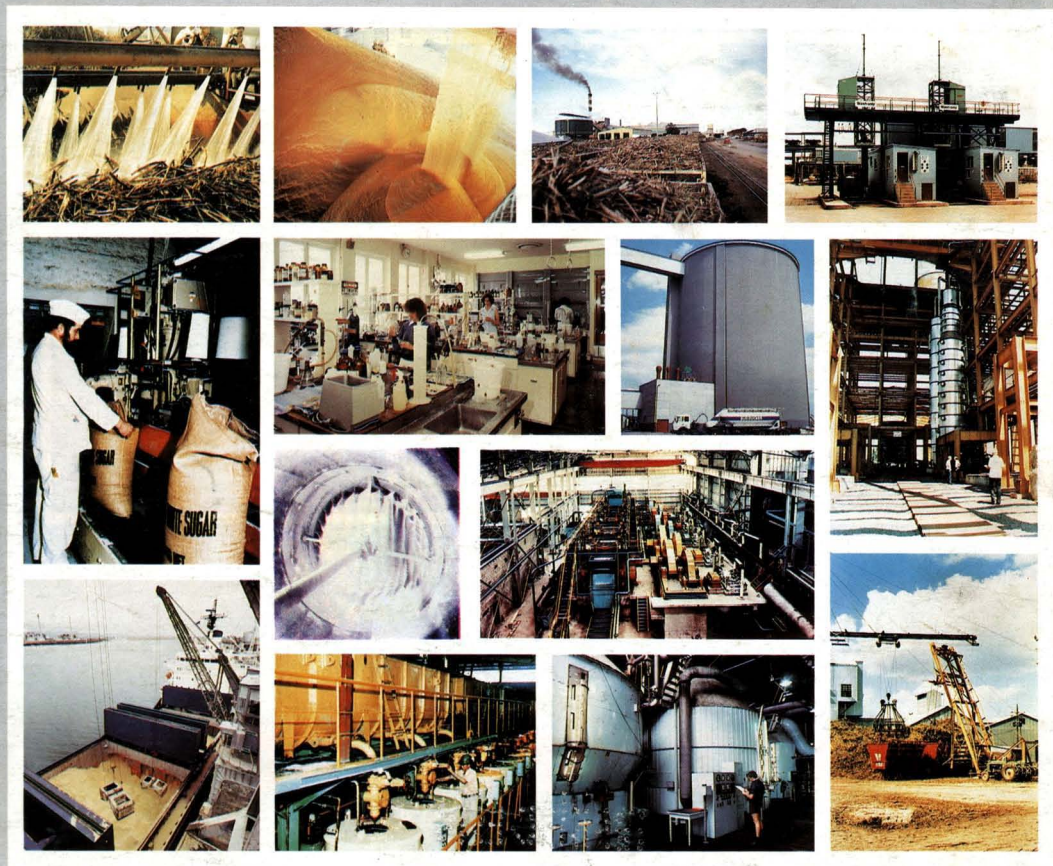
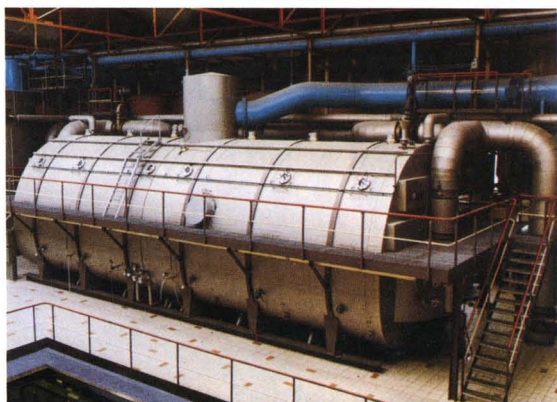


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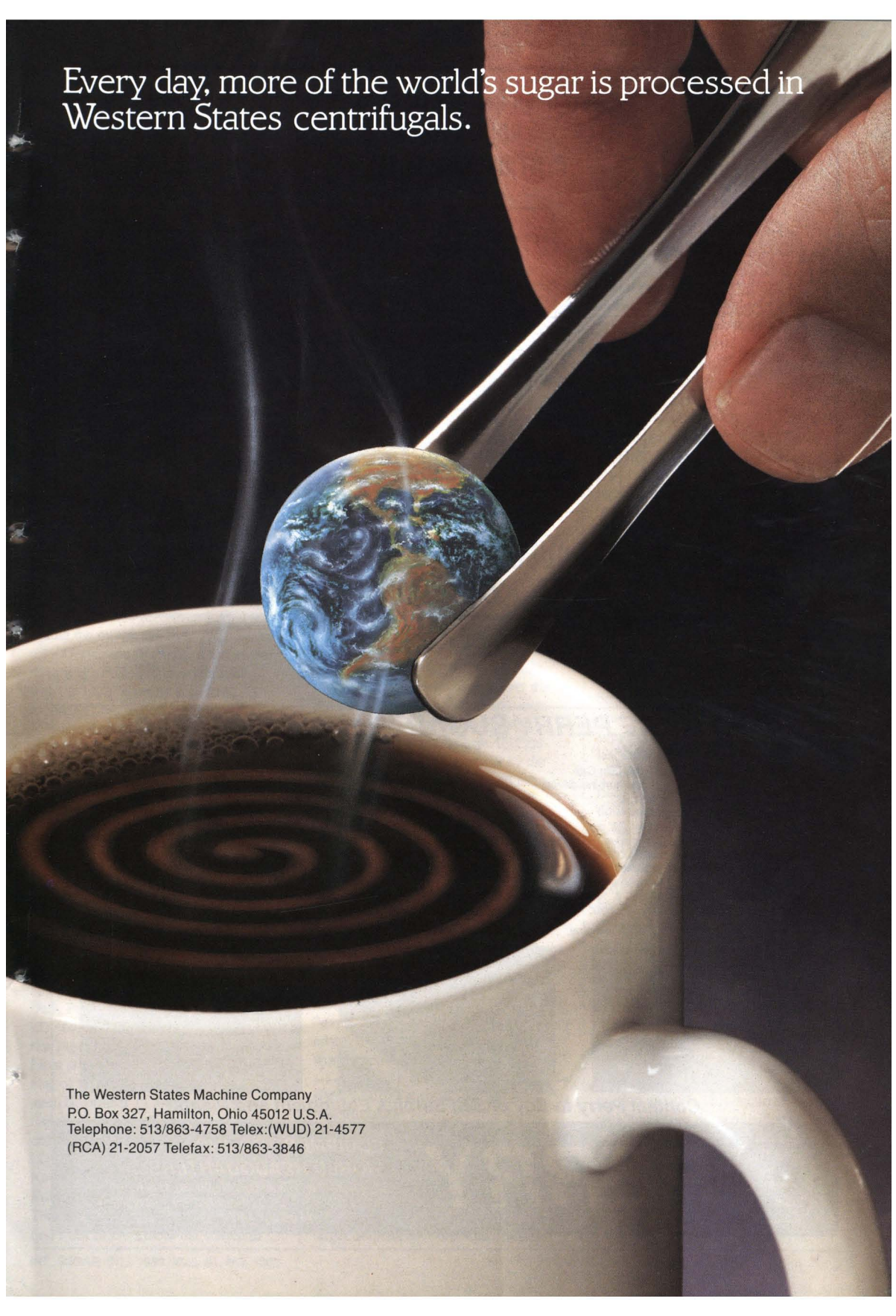
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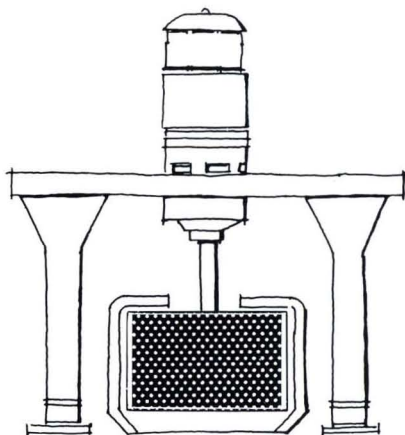
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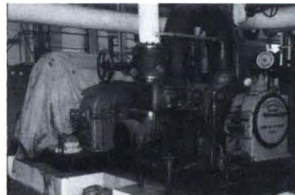
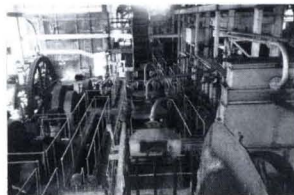
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News and views

World sugar prices

A lack of end-user demand and optimistic news put pressure on world sugar prices in early November and the London Daily Price for raw sugar fell from \$279.20 per tonne on November 1 to \$269.20 on November 9 and \$261.40 on November 18 with small rises between the two latter dates to \$274.40 and \$272.20, occasioned by the possibility that a tropical storm might hinder cane harvesting in Cuba, by a potential strike in Brazil and reports of severe frost in the USSR, as well as activity by speculators. Reduction in Licht's estimates of European sugar production, and expectation of buying by China and the USSR fuelled a new improvement in prices and the LDP started to rise, reaching \$284.40 on November 28 and ending the month at \$284.

During the first half of December there was a period of consolidation, with the LDP hovering around \$290, following purchases by commission houses and speculative funds. A positive effect came from reports that China and the USSR were interested in more sugar purchases but the market fell when none of these materialized. China even sold back to trade houses between 200,000 and 300,000 tonnes of Thai raw sugar; whether this was to obtain foreign exchange or to help achieve a return to lower prices was a matter of opinion, but the LDP, which fell to \$276 on December 16, stayed at about that level during the rest of the month, ending at \$278.20 per tonne on December 30.

During November, the London Daily Price for white sugar followed the LDP fairly closely but the premium over raw sugar prices gradually increased. From around \$3 per tonne at the beginning of the month it rose to around \$5/\$6 up to November 11 and then steadily improved to reach \$16 per tonne by the end of the month. As a consequence, the LDP(W), which had been \$281 on November 1 had risen to \$300 by November 30, its highest since July. This premium level remained during the first week of December but started to

fall on December 9 and had shrunk to \$6.90 by December 15. White sugar values then recovered partially and the premium hovered around \$12 for the rest of the month, the LDP(W) ending the year at \$291 per tonne.

European beet sugar production, 1988/89

With the benefit of more up-to-date information and well into the 1988/89 campaign, F. O. Licht was able in November to publish a new estimate of beet sugar production in Europe¹. In the EEC a total of 14,779,000 tonnes, raw value, is now expected, while production in other West European countries raises the total to 18,098,000 tonnes.

In East Europe, output is expected to reach 13,781,000 tonnes, bringing the European total to 31,879,000 tonnes, raw value, against 31,808,000 tonnes as the revised figure for 1987/88. The greatest question mark hangs over the Soviet Union where early frosts, separated by a period of above-freezing temperatures struck the beet. C. Czarnikow Ltd. have reported² that by the first freeze most of the crop had been lifted and several millions of tonnes were either in roadside clamps or in transit to the factories. A freeze-thaw-freeze cycle could have damaged some of these beets and, even if the damage were slight, the situation is in marked contrast to 1987/88 when ideal conditions brought about very good results. Licht has marked down the Soviet sugar crop by 200,000 tonnes, raw value, and further adjustment may be needed as more information becomes available; "any sizeable change to one side or the other could have a marked impact on world market prices".

Brazil sugar and alcohol plan modification³

The Brazilian Sugar and Alcohol Institute has announced new figures for the 1988/89 crop plan, which will result in a reduced sugar export availability from the 1988/89 crop. The production target in the north/north-east has been

reduced to 2,733,000 tonnes, tel quel, (approximately 2,900,000 tonnes, raw value) from the previous 3,400,000 tonnes. The production originally authorized for export from this region totalled 2,058,000 tonnes; if the reduction of output goes fully to the debit of exports, the export availability in 1988/89 from the north/north-east will be reduced by nearly 700,000 tonnes from the originally authorized quantity to 1,391,000 tonnes. The authorized production of alcohol has also been reduced from 2378 to 2088 million litres.

C. Czarnikow Ltd. report⁴ that the new targets have met strong opposition from the region's producers. Some of these may have already exceeded the lower limits or expect to do so. On the other hand the IAA has underlined the importance it places on these reductions and has said that excess production will be penalized to the extent that it will not be paid for. The reason for this is the need to remedy the imbalance in alcohol supplies resulting from poor production last season.

Deliveries of cane to sugar factories receive payment within a week but deliveries to distilleries result in payment delays of up to a month which, with high inflation rates, is costing growers money. Although the revised alcohol quota is nearly 300 million litres below the original plan, it is 200-300 million litres above the level of production which might be achieved if no amendments were implemented.

Tate & Lyle 1988 results

Pre-tax profits by the Tate & Lyle Group rose for the tenth consecutive time in the year to end-September 1988, reaching £120.1 million, against £92.0 million in 1987. This occurred in a year which has seen the acquisition of Staley, the corn sweetener producer, and Amstar's sugar refining division, as well as increased interest in the CST group of

1 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 595 - 599.

2 *Czarnikow Sugar Review*, 1988, (1779), 161.

3 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 640.

4 *Czarnikow Sugar Review*, 1988, (1780), 178.

Continental Europe. The company's geographical balance has shifted towards North America, where 59% of the group's assets are now employed.

Profits from UK sugar refining improved further in 1988 and results are now coming from the initial stages of the long term capital expenditure program. In the US the beet sugar producing subsidiary Western Sugar had a good year although down on the previous record year. Marketing of the record beet sugar crop caused problems for the cane sugar refinery of Refined Sugars Inc. at Yonkers, New York, but Redpath Sugars In Canada enjoyed a good year.

Indonesia self-sufficiency target doubt⁵

Although Indonesia has imported sugar from time to time in the past, there has been a national goal of self-sufficiency over many years with the World Bank assisting in a number of rehabilitation projects for the sugar industry. Recently the government announced cuts of some 75% from earlier estimates of the allocation in subsidies for fertilizer and pesticides, which may signal an end to the official policy of aiming for self-sufficiency in all crops.

The subsidy cuts are aimed at soyabeans and the authorities are still understood to be committed to covering all rice requirements from domestic sources regardless of cost. However, a recent World Bank report has urged less government intervention in agriculture and a greater reliance on market forces. As a result, similar policies to reduce subsidies are under consideration for sugar cane and cotton.

A small cloud

It has long been recognised that the Soviet Union was a major sugar producer owing to the vast areas devoted to beet and a huge tonnage processed in hundreds of sugar factories. The average yield of 2.3 tonnes of sugar per hectare over the seasons 1981/82 to 1986/87 is only 30% of the equivalent figure of

more than 7.5 tonnes for the EEC and the impression given is one of poor crops produced by outdated methods and processed inadequately.

F. O. Licht GmbH have recently quoted⁶ observations made during two visits by an English agricultural journalist early last year and again in October. He remarked on the excellent soil conditions he found in the Ukraine and on the thinning he had seen by women using hoes; this practice is no longer necessary in western Europe where multigermin seed has been replaced by monogerm. After thinning, however, the fields were free of weeds and the plants looked healthy.

At the end of October grass and weeds had grown between the beet so that, when these were lifted, after two separate operations to remove leaves and tops, the mixture of beet and weeds had to be sorted by hand. As the lifting left some 10 - 15% of roots in or on the land these also had to be gathered manually.

Nevertheless, the yield and average sugar content were not too far below the sort of expectations which might be common in the European Community and the journalist estimated the amount of sugar actually grown per hectare at about 70% of which might be expected in his own part of the UK. It would seem, therefore, that the difference between 30% and 70% reflects losses in handling of the beets as well as by frost damage.

Changes are taking place in many aspects of the USSR, including agriculture, and the possibility of the return of privately owned farms has even been suggested at the highest levels. While a massive growth in agricultural yields and improvement of technical performance cannot be expected to occur suddenly, the potential for a massive expansion of sugar output from the same beet area must be recognised as a small cloud which could develop to a storm which could change the world sugar market almost out of recognition.

US sugar import quota, 1989⁷

On December 5 last the US

Department of Agriculture announced that the import quota for this year will be set at 1,125,255 tonnes, raw value, equivalent to 1,240,380 short tons or about 17% more than for 1988. It has also been forecast that planting restrictions would be placed on US sugar producers so as to ensure that imports from overseas suppliers remain at least one million short tons. Details of the new quotas are tabulated below, together with the metric equivalents of the 1988 quotas which were set in short tons.

	1989	1988
	tonnes, raw value	
Argentina	45,279	39,168
Australia	87,399	75,600
Barbados	7,444	7,444
Belize	11,583	10,020
Bolivia	8,424	7,466
Brazil	152,685	132,077
Canada	11,583	10,020
Colombia	25,272	21,863
Congo	7,258	7,258
Costa Rica	20,795.4	17,760
Dominican Republic	185,328	160,308
Ecuador	11,583	10,020
Fiji	9,477	8,196
Gabon	7,258	7,258
Guatemala	50,544	43,713
Guyana	12,636	10,932
Haiti	7,258	7,258
Honduras	19,197.4	16,218
India	8,424	7,466
Ivory Coast	7,258	7,258
Jamaica	11,583	10,020
Madagascar	7,258	7,258
Malawi	10,530	9,113
Mauritius	12,836	10,932
Mexico	7,258	7,258
Mozambique	13,689	11,843
Panama	30,537	0
Papua New Guinea	7,258	7,258
Paraguay	7,258	7,258
Peru	43,173	37,344
Philippines	166,374	143,916
St. Kitts	7,258	7,258
El Salvador	30,378.2	26,141
Swaziland	16,848	14,574
Taiwan	12,636	10,932
Thailand	14,742	12,704
Trinidad	7,444	7,444
Uruguay	7,258	7,258
Zimbabwe	12,636	10,931
Specialties	1,815	1,815
	1,125,255	958,600

5 *Czarnikow Sugar Review*, 1988, (1780), 189.

6 *Int. Sugar Rpt.*, 1988, 120, 608.

7 *Czarnikow Sugar Review*, 1988, (1780), 188.

Sucrose, sweetness and sucralose

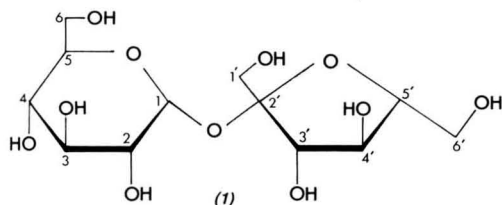
By Prof. Leslie Hough

(Dept. of Chemistry, Kings College, University of London)



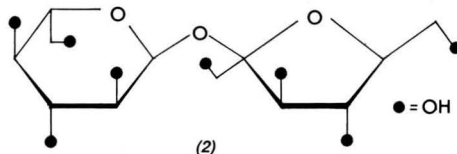
L. Hough

Sucrose (1)*, the most abundant of crystalline organic compounds, is an attractive feedstock for chemical and microbiological exploitation, with potential application in the chemical, pharmaceutical, food and related industries. The chemistry¹ of this unique, non-reducing disaccharide is determined by the multiplicity of hydroxyl groups, eight in all, and the acid labile interglycosidic bond joining the α -D-glucopyranosyl and β -D-fructofuranosyl units.



The first synthesis of sucrose by Hassid & Doudoroff in 1944² used enzymes, and was followed in 1953 by an ingenious chemical synthesis from D-glucose and D-fructose derivatives by Lemieux & Huber³. A similar chemical synthesis⁴ of the unnatural L-sucrose (2), the mirror image of natural D-sucrose, by combination of L-glucose and L-fructose derivatives, led to the surprising discovery that it was sweet. The sweetness of L-glucose and L-fructose has been known for many years⁵, in fact ever since Emil Fischer's pioneering studies on the carbohydrates and amino acids. The L-sugars are of considerable interest⁶ since these unnatural but sweet sugars are not metabolized; hence they

have potential as non-nutritive sweeteners could they be manufactured econ-



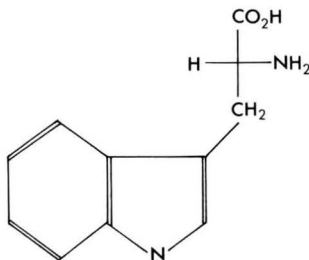
omically. The adsorption of L-glucose and L-fructose into the bloodstream and circulation for long periods could prevent their use.

The equivalent sweetness of D- and L-sucrose contrasts with D- and L-amino-acids, since the D-forms are usually sweet whereas the L-forms are

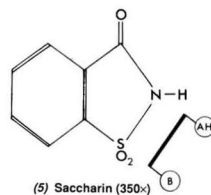
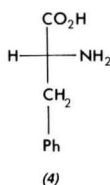
alanine (4) is seven times sweeter but the L-isomer is bitter. It should be noted that in the D- α -amino-acids the amino (NH_2), carboxylic acid (CO_2H) and sidechain (R) groups are orientated in a clockwise configuration whilst they are in the opposite, anti-clockwise configuration in the L-isomers. These differences led Louis Pasteur to postulate that the taste bud receptors are asymmetric or chiral, as a consequence of which mirror-image compounds of sweet

substances should give different responses⁹. The similarity in the sweetness of D- and L-sugars would therefore appear to be anomalous.

Sweetness is also induced by a surprising variety of remarkably different chemical structures; compounds such as saccharin (5), cyclamate (6), acesulfam-K (7), neohesperidin dihydrochalcone (8), which are all artificial or



not⁸. For example, D-tryptophan (3) is 35 times sweeter than sucrose, whereas L-tryptophan is bitter, and D-phenyl-

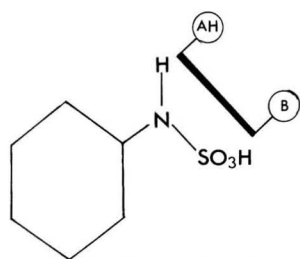


S.P.R.I. Science Award presentation at Conference on Sugar Processing Research, New Orleans, 1988.

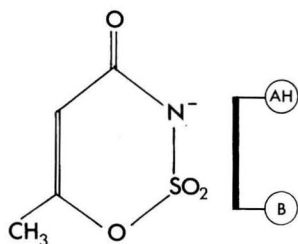
* Numbers in parentheses refer to the compound structure illustrations.

- Jenner: in "Developments in food carbohydrate-2" Ed. Lee (Applied Science Publishers, London), 1980, p. 91.
- Adv. Carbohydr. Chem., 1950, 5, 29.
- J. Amer. Chem. Soc., 1953, 75, 4118.
- Queen's University: Canadian Patent 1,556,007 (1979).
- Shallenberger: in "Carbohydrates in solution", Ed. Gould (Advances in Chemistry Series), 1973, 117, 262; Fischer: Ber., 1890, 23, 2611.
- Bakai: US Patent 4,459,316 (1984).
- Kier: J. Pharm. Sci., 1972, 61, 1394.
- Fischer: Ber., 1890, 23, 370, 389.
- Shallenberger: in "Sweetness and sweeteners", Ed. Birch (Applied Science Publishers, London), 1971, p. 47.

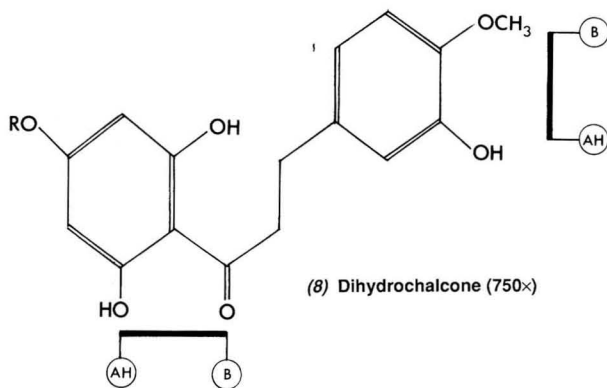
The Sugar Processing Research Inc. Science Award for 1988 was presented to the winner, Professor Leslie Hough, of Kings College, University of London, at a dinner at the recent Conference on Sugar Processing Research, by Dr. Chung Chi Chou, Chairman of the Judging Committee. The Award consists of a plaque, \$1000, and travel to the conference. The citation on the plaque received by Prof. Hough reads "For original and substantial contributions to the organic chemistry of sucrose and its derivatives."



(6) Cyclamate (50x)



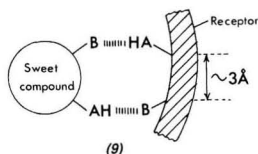
(7) Acesulpham-K (150x)



(8) Dihydrochalcone (750x)

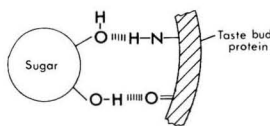
synthetic, were discovered by serendipity because of their intense sweetness. Deutsch & Hantsch¹⁰ proposed in 1966 that sweet compounds functioned in the taste bud by interaction with an area of hydrophobic bonding that is coupled with a site for electronic bonding, similar to the mode of action of drugs. Shallenberger & Acree^{11,12} focused attention on a structural feature that all sweeteners have in common, namely two constituent electronegative atoms,

A and B, separated by 2.5 - 4.0 Å (or 260 - 300 nm), with a hydrogen atom linked covalently to A (9), as in (5) - (8).



(9)

The glycol group is the minimum requirement for sweetness in the sugars; consequently, a pair of hydroxyls on adjacent carbon atoms was designated as the AH/B unit, with one hydroxyl functioning as the AH and the oxygen atom of the other hydroxyl as the B (10).

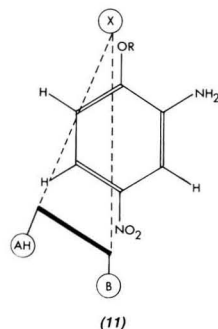


(10)

yls could act as the AH or B. It follows they could interchange their AH/B role, but in all other types of sweet compounds, including the amino acids, this is impossible. The difference in the sweetness behaviour of the D- and L-forms of amino acids and of sugars⁵ could therefore be due to the interchangeable AH/B unit in the sugars.

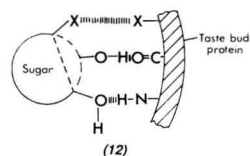
Whilst the Shallenberger hypothesis^{11,12} rationalized the characteristic structural element in all sweet compounds, it was recognised that a vast number of organic compounds also have identifiable AH/B units¹³ but are not sweet. Additional criteria were sought in order to refine the structural requirements for sweetness to occur.

Another parameter emerged from a study by Kier⁷ of 1-alkoxy-2-amino-4-nitrobenzenes (11), namely a third group



(11)

X which is hydrophobic (lipophilic) in nature and serves to guide or adsorb the sweet compound to the taste receptor. This additional criterion gives a triangle of groups^{14,15} (X, AH and B) known as the glucophore (12). The lipophile-



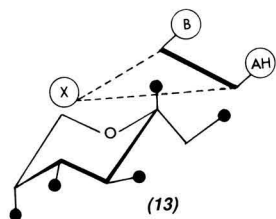
(12)

It was postulated that the sweetness sensation arose by the creation of a pair of hydrogen bonds from this AH/B unit to another AH/B unit of similar configuration on the proteinaceous receptor site. Proteins are ideally suited to form hydrogen bonds, since the peptide bonds have amide (N-H) and carbonyl (C=O) groups, which could act as the reciprocal AH/B units (9, 10). In the case of sugars A and B are the same, namely oxygen atoms; hence, either of the two hydrox-

10 *Nature*, 1966, 211, 75.
11 *ibid.*, 1967, 216, 480.
12 *J. Agric. Food Chem.*, 1969, 17, 701.
13 Bragg *et al.*: *J. Chem. Ed.*, 1978, 55, 281.
14 Shallenberger & Lindley: *Food Chem.*, 1977, 2, 145.
15 Heijden *et al.*: *ibid.*, 1978, 3, 207.

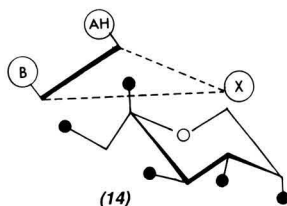
hydrophile balance is an important factor in sweetness intensification and all compounds, e.g. (5) - (8), that are sweeter than sucrose are more hydrophobic. Sugars are hydrophilic water-loving molecules that are only weakly attracted to the taste buds, and hence not very sweet in comparison with, for example, saccharin (5).

Small changes in a monosaccharide structure can have a major influence upon its sweetness. Thus, D-glucose is significantly sweeter than D-galactose, its carbon-4 epimer, and D-fructose (13),

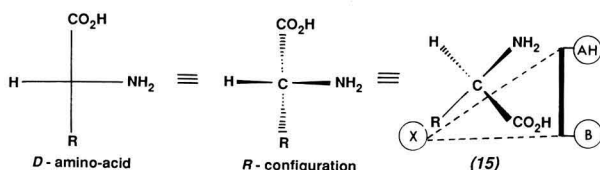


the 5-epimer of L-sorbose, is five times as sweet¹. D-fructose (13), a ketose, is somewhat sweeter than D-glucose, its aldose epimer, and fructose is also sweeter than sucrose (1), and this is due largely, if not entirely, to the high sweetness of beta-D-fructopyranose (13) (Table I). Consequently we have a fourth factor to consider in predicting or accounting for the sweetness of organic compounds, namely the overall shape or conformation of the molecule, coupled with the configuration at individual atoms and their effect upon the conformation. beta-D-fructopyranose adopts a chair conformation (13)^{12, 16-18} in which only one glucophore triad is possible, with AH=1-OH, B=2-O and X=6-H;

when viewed along the C₂-C₃ bond, the AH/B/X triad has a clockwise orientation. Methyl beta-D-fructopyranoside with the anomeric 2-OH blocked is much less sweet than beta-D-fructopyranose and the furanoside is not sweet at all. The sweetness of L-fructose (14) can be

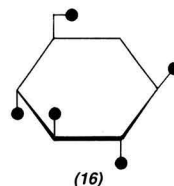


explained by reversing the role of the hydroxyls to give the same clockwise orientation of the glucophore (AH=1-OH, B=2-O and X=6-H). If the taste receptor is chiral, the clockwise glucophore allocated to D-fructose and L-fructose should also arise in the D-amino acids, and it does so with AH=NH₂, B=CO₂H and X=R completing a clockwise triad (15). In the L-amino-acids the arrangement of these groups is anti-clockwise, which suggests that this gives rise to the bitter taste in organic compounds.

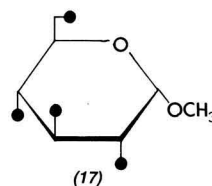


When the ring-oxygen of a pyranoid or furanoid sugar is replaced by a methylene group, it is known as a

pseudo-sugar, for example, psi-beta-D-glucopyranose (16). Since psi-beta-DL-glucopyranose, psi-alpha-DL-galactopyranose and psi-beta-D-fructopyranose are similar in sweetness to their parent sugars¹⁹, it follows that the ring-oxygen has little influence in determining the sweetness of sugars.



The sweetness of sucrose cannot be due to the individual glucosyl and fructosyl units since these two components of the disaccharide, as represented by methyl alpha-D-glucopyranoside (17), or



trehalose²⁰ (18), and methyl beta-D-fructofuranoside¹⁷ (19), are one tenth as sweet and zero respectively (Table I). These observations suggested a special

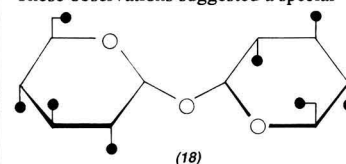


Table I. The sweetness of compounds relative to sucrose

Compound	Sweetness
Sucrose (1)	1.0
D-glucose*	0.6 - 0.75
D-galactose*	0.4 - 0.5
D-fructose*	1.1
beta-D-fructopyranose (13)	1.8
Methyl alpha-D-glucopyranoside (17)	0.1
Trehalose (18)	0.1
Methyl beta-D-fructofuranoside (19)	0
psi-beta-D-glucopyranose (16)	0.6 - 0.75

* Mutarotation equilibrated

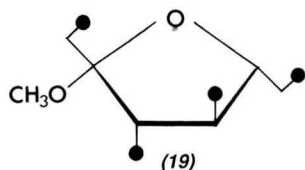
16 Lindley & Birch: *J. Sci. Food Agric.*, 1975, 26, 117.

17 Shallenberger: *Pure and Applied Chem.*, 1978, 50, 1409.

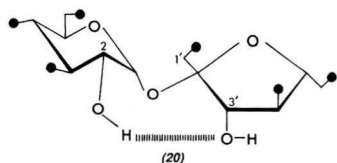
18 Birch & Mylvaganam: *Nature*, 1976, 260, 632.

19 Shallenberger & Lindley: *J. Food Sci.*, 1977, 30, 560.

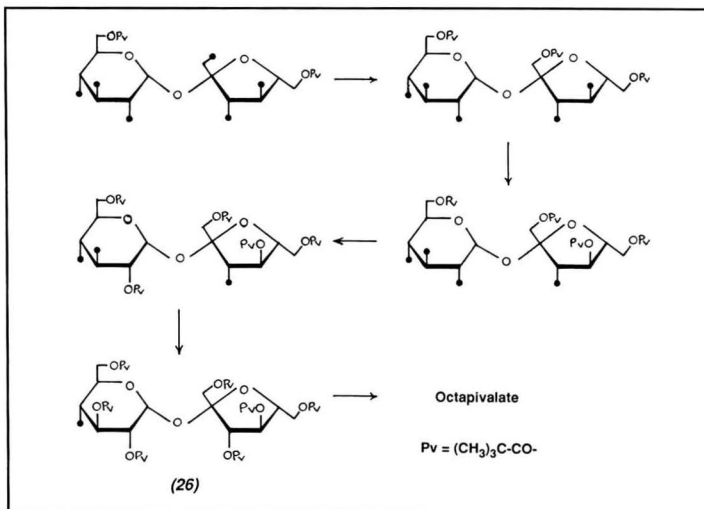
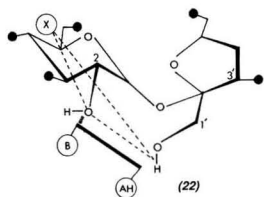
20 Birch: *Crit. Rev. Food Sci. Nutr.*, 1976, 7, 57.



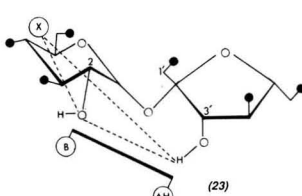
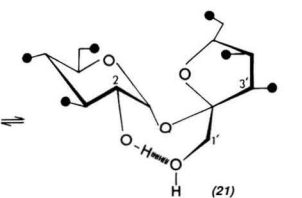
or unique arrangement²¹ of the gluco-
phore in sucrose wherein a hydroxyl
from each unit or each half of the
disaccharide participates in the AH/B
group. In the crystalline form sucrose
adopts a conformation¹ with the α -D-
glucopyranosyl unit in a chair form (⁴C₁)
and the β -D-fructofuranoside unit in a
twist shape (³T₄), and there are two
intramolecular hydrogen bonds, bridging
from O-6' to O-5 and from O-1' to O-2,
which hold the furanose ring at right
angles to the plane of the pyranose ring.
N.m.r. studies^{22,23} of sucrose in solution
(deuterated dimethyl sulphoxide) have
detected two hydrogen bonded conform-
ations, (20) and (21), in equilibrium,
owing to the 2-hydroxyl of the glucosyl
unit acting as a hydrogen bond acceptor
for either the 1'-hydroxyl (21) or the 3'-
hydroxyl (20) of the fructofuranoside
unit, and in the approximate ratio of 2:1,
respectively.



Examination of molecular models
of the conformations of sucrose to find
those groups of atoms that coincide with
the approximate dimensions of the Kier-
Shallenberger triangular template²⁴

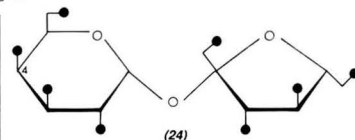


suggested that two such glucophores,
one involving X=4-H, AH=1'-OH and
B=2-O (22), and the other X=4-H,
AH=3'-OH and B=2-O (23). Both of
these triads are clockwise arrangements
in agreement with the aforementioned
chiral receptor theory. Support for these
assignments²¹ came from the synthesis

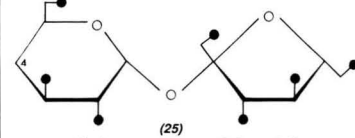


of galacto-sucrose (24) by inversion of
the configuration at C-4 of sucrose²⁵,
which resulted in loss of sweetness²⁶. On
the other hand, 4-deoxy sucrose (25)
retained its sweetness. Hence the axial

Fig. 1



configuration of the hydrophilic 4-
hydroxyl of galacto-sucrose (24) cannot
be tolerated and the equatorial 4-
hydroxyl in sucrose is not essential for
sweetness.

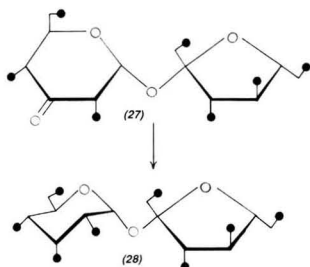


Galacto-sucrose (24) and 4-
deoxysucrose (25) were conveniently
synthesized²⁵ by conventional methods
from the readily available heptapivalate
(26) by the route shown in Figure 1.
Selective esterification of sucrose with
pivaloyl chloride (2,2-dimethyl-
propanoyl chloride) provides a valuable

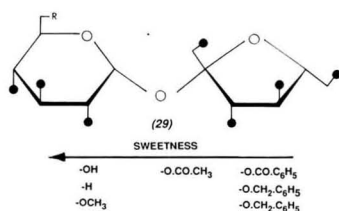
21 Hough: *Chem Soc. Rev.*, 1985, 14, 357.
22 Bock & Lemieux: *Carbohydr. Res.*, 1982, 100, 63.
23 Christofides & Davies: *J. Chem. Soc., Chem. Commun.*, 1985, 1533; *Carbohydr. Res.*, 1987, 163, 269.
24 Lee: *Adv. Carbohydr. Chem. and Biochem.*, 1987, 45, 199.
25 Chowdhary et al.: *J. Chem. Soc., Perkin Trans.*, 1984, 24, 19.
26 Lindley et al.: *J. Sci. Food Agric.*, 1976, 27, 140.

route to specifically blocked esters, many crystalline, such as the 6,6'-di-ester, 1',6,6'-tri-ester, 1',4',6,6'-tetra-ester and 1',2,4',6,6'-penta-ester, all in >30% yield.

The configuration of the 3-hydroxyl of sucrose must be equatorial for sweetness in sucrose since its 3-epimer, *allo*-sucrose (28)²⁷, proved to be tasteless, possibly because the large 3-hydrogen substituent in sucrose thereby exceeding the restricted area at this site on the receptor of the taste bud. *allo*-Sucrose (28) was prepared²⁷ from sucrose by oxidation with either *Agrobacterium tumefaciens* or dimethyl sulphoxide-acetic anhydride, to give 3-keto-sucrose (27) which, on reduction with sodium borohydride, afforded *allo*-sucrose (28) and sucrose (1) in the ratio 12:1. Hence by blocking, modifying or replacing specific hydroxyls in sucrose^{21,24}, it should be possible to locate those that are responsible for sweet taste, and provide an outline of structure versus sweetness activity²⁸.



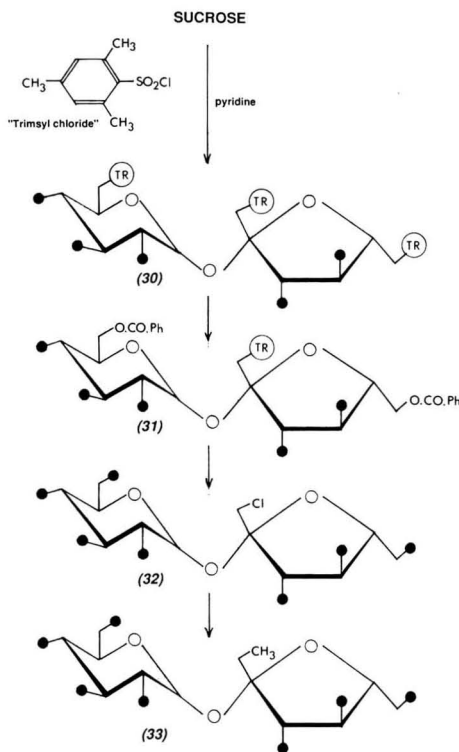
As illustrated above, esterification of sucrose can be highly selective, yielding under controlled conditions mono- to octa-esters, the latter fully substituted. There are 8 possible mono-esters and only one octa-ester, but in theory 28 di- and 56 tri-esters could arise²¹. Fortunately, higher reactivity at the primary hydroxyls, C-6, C-1' and C-6', simplifies these reactions, the order of reactivity being HO-6, HO-6' > HO-1' > HO-2. The primary 1'-hydroxyl is less reactive than those at the 6- and 6'-positions because of its hindered, neopentyl character.



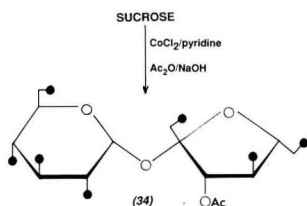
Mono-esterification of sucrose has a remarkable effect since its 6-mono-acetate^{29,30} [(29); R=O.CO.CH₃] is only slightly sweet and its 6-benzoate [(29); R=O.CO.Ph] and 6-phosphate [(29); R=O.PO₃H₂] are not sweet. Large groups at carbon-6 appear to result in loss of sweetness owing to a misfit of the enlarged molecule on the receptor site, since smaller groups at carbon-6 do not have a significant effect on sweetness, as in 6-deoxy-sucrose [(29); R=H] and 6-O-methyl sucrose [(29); R=

OCH₃]^{31,32}; significantly, the larger 6-O-benzyl ether [(29); R=O.CH₂.Ph] is not sweet. The sweetness of 1'-deoxy- and 1'-O-methyl-sucrose favour the participation of the triangle of groups at C-4(X), C-2(B) and C-3'(AH) (23). 1'-Deoxysucrose (33) was synthesised by reductive dehalogenation of 1'-chloro-1'-deoxysucrose (32) which can be obtained from the 1',6,6'-tri-trimsylate of sucrose (30) by benzoate displacement of the trimesitylene sulphonyxy groups at C-6 and C-6', giving the 1'-trimesitylate of the 6,6'-dibenzoate (31) followed by chloride displacement of the 1'-trimesitylene sulphonyoxy group³³.

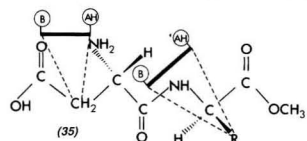
27 Hough & O'Brien: *Carbohydr. Res.*, 1980, 84, 95.
 28 Hough & Khan: *Trends Biochem. Sci.*, 1978, 3, 61.
 29 Kononenko & Kestenbaum: *J. Applied Chem.*, 1961, 11, 7.
 30 Khan: Unpublished data.
 31 Lindley et al.: *J. Sci. Food Agric.*, 1976, 27, 140.
 32 Idem: *Carbohydr. Res.*, 1975, 43, 360.
 33 Guthrie & Watters: *Aust. J. Chem.*, 1980, 33, 2487.



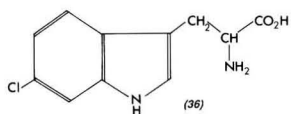
The 1'-chloro group of (32) had a significant effect upon the rate of acid hydrolysis which was reduced to one-tenth of that of sucrose; also it inhibited the hydrolytic action of invertase, a β -D-fructofuranosidase. In addition, loss of sweetness was observed when the 3'-hydroxyl was esterified, as in 3'-O-acetylsucrose³⁴ (34), presumably by eliminating the AH of the glucophore.



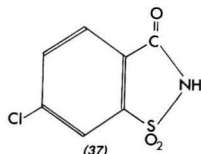
Enhancement of the sweetness of sucrose, would appear to require derivatization by lipophilic groups, especially at the axial 4-position²⁸, and possibly the 1'-position, but the hydroxyls at C-2 and at C-3' must remain unsubstituted since they appear to be essential components of the glucophore (23). Aspartame (35)



("Nutrasweet") or L-aspartyl L-phenylalanine methyl ester³⁵ requires the ester since the free acid is tasteless and of its four isomers only the L,L-isomer is sweet (100-200x); the D,D-, D,L- and L,D-isomers are tasteless³⁶. The introduction of a fenchyl group³⁷ (35) enhances its lipophilicity which results in the sweetness increasing enormously to over 100 fold. When D-tryptophan was converted into its 6-chloro-derivative (36) its



sweetness increased³⁵ by 30-fold from 35 to 1000x, but a related chlorination of saccharin (600 - 700x) to give 6-chlorosaccharin (37) (100 - 350x) was



not so successful³⁵. Any intensification of the sweetness of sucrose would clearly reduce caloric intake from this source and derivatization could also inhibit metabolism by blocking the hydrolysing action of invertase and α -glucosidase.

Chloro-derivatives of sucrose were available from sucrochemical studies and had been developed as convenient intermediates for the synthesis of thio-, deoxy- and amino-deoxy sugars, rare sugars with potential applications in the biological fields³⁸.

The direct replacement of a hydroxyl group in a carbohydrate by a chloro substituent was discovered by Helferich and his colleagues³⁹⁻⁴¹ when they reacted methyl α -D-glucopyranoside (17) with sulphuryl chloride (SO_2Cl_2) in pyridine-chloroform at 5°C and obtained a 4,6-dichloro-4,6-di-

deoxy-2,3-cyclic sulphate derivative. J. K. N. Jones and his co-workers^{42,43} showed that the reaction proceeded with inversion of chirality at carbon-4 to give a galactoside, methyl 4,6-dichloro-4,6-dideoxy- α -D-galactopyranoside 2,3-cyclic sulphate (41) (Fig. 2). Application of this reaction to sucrose by Bragg *et al.*⁴² gave rise to a complex mixture of chloro derivatives, in which the glucosyl residue was similarly converted into a 4,6'-dichlorogalactosyl derivative but the fructosyl unit had presumably undergone varied reactions. Repetition of the reaction at 50°C gave, after separation by chromatography, a tetrachloro- and two pentachloro-derivatives of sucrose in which the fructosyl unit had been converted into a 3',4'-epoxide (43), a 3'-ene (44) and a 1',4,6'-trichloride (45)⁴⁴.

- 34 James (Miss): Unpublished results, 1988.
- 35 Crammer & Ikan: *Chem Soc. Rev.*, 1977, 6, 455.
- 36 Mazur: *J. Toxicol. Environ. Health*, 1976, 2, 243.
- 37 Fukino *et al.*: *Naturwiss.*, 1973, 60, 351.
- 38 Szarak: *Adv. Carbohydr. Chem. and Biochem.*, 1973, 28, 225.
- 39 *Ber.*, 1921, 54, 1082.
- 40 *ibid.*, 1923, 56, 1083.
- 41 *ibid.*, 1925, 58, 886.
- 42 Bragg *et al.*: *Canad. J. Chem.*, 1959, 37, 1412.
- 43 Jones *et al.*: *ibid.*, 1960, 38, 1122.
- 44 Ballard *et al.*: *J. Chem. Soc., Perkin Trans.*, 1973, 1, 1524.

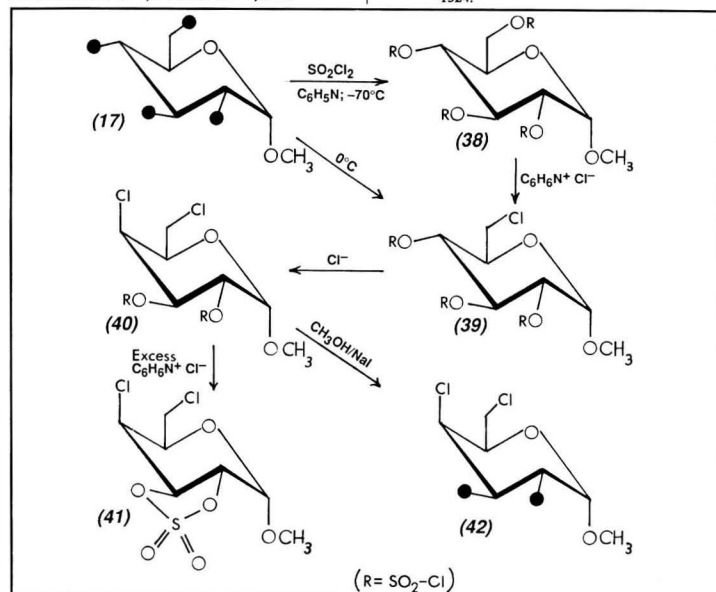


Fig. 2

TWO NEW QUALITY INSTRUMENTS

SUMA
PRODUCTS

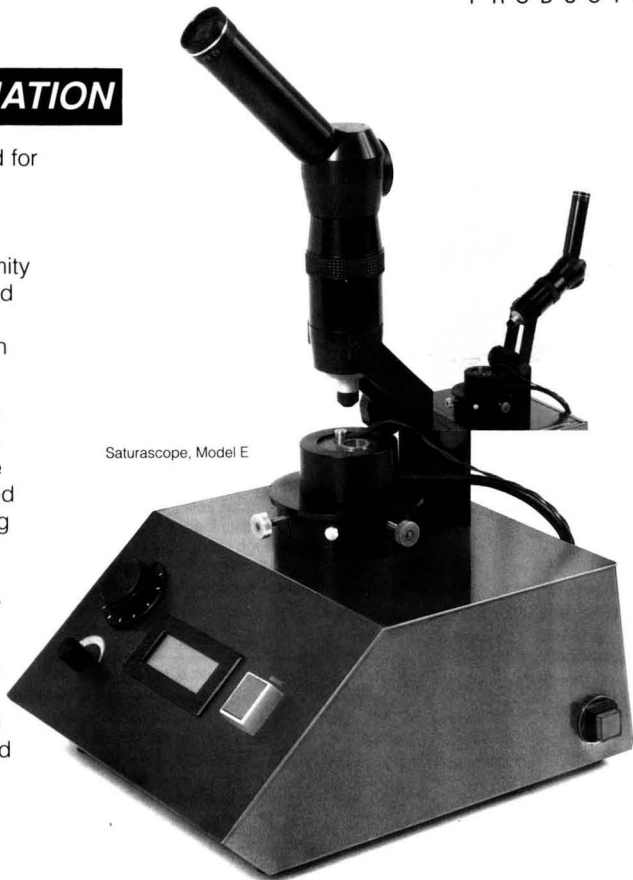
MASSECUITE EXAMINATION

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

Using a polarised light source, the massecuite is examined through a X150 microscope which allows the crystal melting point to be indicated on the digital indicator. The heating element uses 110/220 volt single-phase A.C. and is provided with a coarse and fine control for the rate of heating.

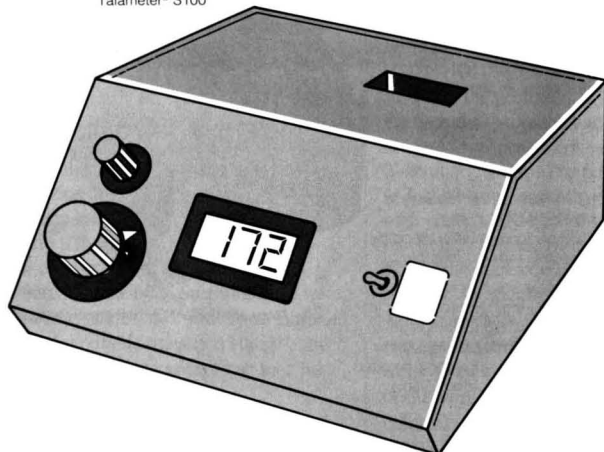
The microscope is attached to the instrument by means of a pivotal mount, thereby allowing increased accessibility to the sample cup and minimum re-adjustment of the focusing system.

Saturascope, Model E



SUGAR COLOUR

Talameter® S100



The **Talameter® S100** is a new, purpose designed, sugar colorimeter intended for use in quality control laboratories of both Sugar Factories and White End Refineries.

This new instrument, developed by Tate & Lyle Process Technology Limited, has been licenced to 'Suma Products' to manufacture and market. It is based on the same principle of the original "8000 Series Talameter®" but with a simplified method, aimed strictly for repetitive colour determinations in dissolved sugar. Measurements in ICUMSA units or RBUs can be made in factory process streams from raw juice to final product sugar.

A RANGE OF QUALITY INSTRUMENTS

SUMA

PRODUCTS

BAGASSE ANALYSIS

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

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

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

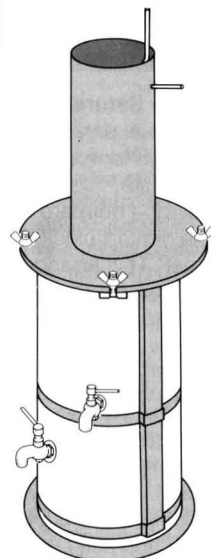
For the rapid and accurate determination of moisture in Bagasse (or suitably prepared Cane samples). Equal in accuracy to the oven drying method.

The quick action of the **Moisture Teller** is due to thermostatically controlled hot air being blown through a thin layer of Bagasse which is contained in the sample pan which has a woven wire base. The pan and sample are weighed before and after drying to give the moisture. A feature of this machine is that a large sample (1400 c.c.) is used, thus increasing the accuracy of the method.

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



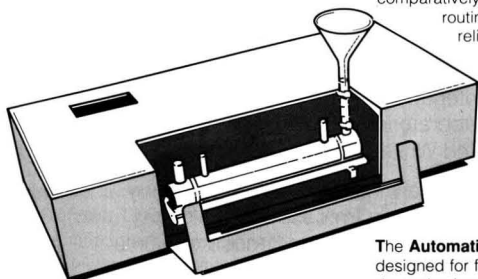
Moisture Teller



Deerr Type Bagasse Digester

JUICE ANALYSIS

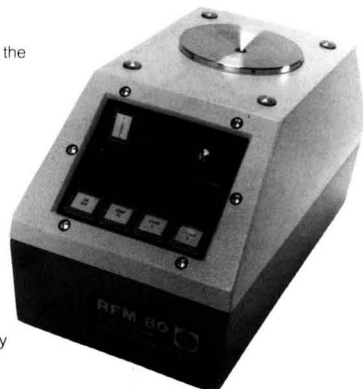
The **Automatic Digital Polarimeter** is a versatile instrument which is highly suited to both research work and routine daily quality control. It is very easy to use; the polarimeter does all the hard work involved in taking readings, leaving you time to concentrate on your samples and results. Also, comparatively unskilled technicians can carry out the routine work and obtain accurate and reliable results.



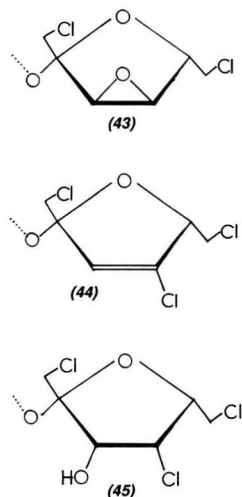
Automatic Digital Polarimeter

The **Automatic Digital RFM80 Refractometer** is designed for fast response, high accuracy determinations of Sugar solution concentrations by measurement of the refractive index of samples.

The RFM80 provides the ideal solution to the problem of accurately measuring concentrations in the range 0 - 95% Sugar w/w. Integral sample temperature sensing and compensation capability permits both ambient and temperature compensated results to be shown on the digital readout display, together with sample temperature.

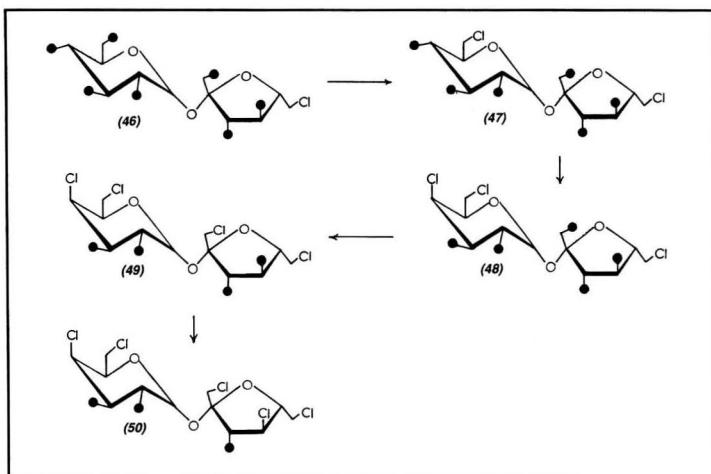


Automatic Digital RFM80 Refractometer



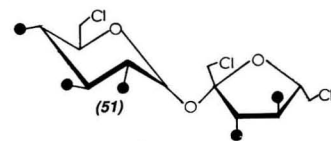
Cyclic sulphate formation can be avoided by using the minimum quantity of pyridine in the sulphuryl chloride reaction when chlorosulphate esters are then formed and any that remain after chlorination can be removed by treatment with methanolic sodium iodide solution, thereby liberating the hydroxyl groups⁴⁵. This variation of the reaction with methyl α -D-glucopyranoside (17) then gave methyl 4,6-dichloro-6-dideoxy- α -D-galactopyranoside (42). Study of the progress of this reaction at low temperature showed that the initial product was the 2,3,4,6-tetrachloro-sulphate (38), which then underwent nucleophilic bimolecular substitution by chloride anions, at the more reactive primary 6-position, giving the 6-chloride (39), followed by a slower reaction at the secondary 4-position, in this case accompanied by inversion of configuration, to form the final product, the 4,6-dichloro-galactoside 2,3-bis-chlorosulphate (40). Substitution reactions at carbon-2 and -3 are inhibited by unfavourable transition states³⁸, and the chlorosulphate groups can then be removed to give (42).

A similar approach was used to study the reactions of sucrose with sulphuryl chloride, and the major pathway²¹ proceeded first to the

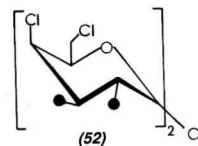


1'-chloride, (46) (29% yield), then to the 6,6'-dichloride (47) (29% yield)⁴⁴ and progressed via the 4,6,6'-trichloro-galacto-sucrose (48) (50% yield)^{46,47} to the 4,6,1',6'-tetrachloro (49) (45% yield)⁴⁸ and 4,6,1',4',6'-pentachloro derivatives (50)^{48,49} (Fig. 3). The introduction of the 4'-chloro-substituent in the fructosyl unit probably proceeds via a 3',4'-epoxide (43)⁴⁸ since steric factors prevent direct substitution of the 4'-chloro-sulphate. The observed selectivity in the reaction of sucrose with sulphuryl chloride suggested that the order of reactivity was HO-6' > HO-6 > HO-4 > HO-1' > HO-4'. The chlorination is slower at the primary 1'-hydroxyl than at the 6- and 6'-positions because it is a hindered neo-pentyl type, adjacent to the 2'-anomeric group. The 6,6'-dichloride (47) can be conveniently prepared⁵⁰ in high yield (>70%) by a highly selective reaction of sucrose with triphenyl phosphine in carbon tetrachloride and pyridine. Originally 4,6,1',6'-tetrachloro-4,6,1',6'-tetradeoxy-galactosucrose (49) was synthesized⁵¹ from the 6,1',6'-trimisylate (30) of sucrose by substitution of the sulphonyloxy groups with lithium chloride to give the 6,1',6'-trichloride (51), which underwent a selective reaction with sulphuryl chloride, as anticipated, at carbon-4 with inversion

Fig. 3

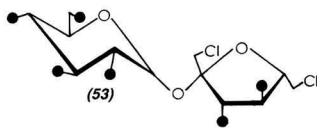


of configuration. When this compound (49) was tasted it was 200 times sweeter than its parent, sucrose, the first time that the sweetness of a carbohydrate had been intensified by derivatization⁵¹. A prior taste study had revealed that a slightly different but similar trehalose derivative, 4,6,4',6'-tetrachloro-4,6,4',6'-tetradeoxy-galacto- α , α -trehalose (52) was as bitter as quinine⁵², thus emphasising the importance of structure and configuration in determining sweetness and bitterness.

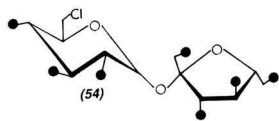


45 Jennings & Jones: *Canad. J. Chem.*, 1963, 41, 1151.
 46 Hough *et al.*: *Carbohydr. Res.*, 1975, 44, 37.
 47 Parolis: *ibid.*, 1976, 48, 132.
 48 Lee: *ibid.*, 1987, 162, 53.
 49 Phadnis: Unpublished results.
 50 Annisuzzaman & Whistler: *Carbohydr. Res.*, 1978, 61, 511; 1980, 78, 185.
 51 Hough & Phadnis: *Nature*, 1976, 263, 800.
 52 Birch: *Olfaction and Taste*, 1977, 6, 27.

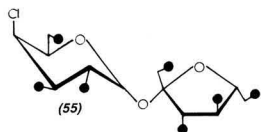
This discovery led to the synthesis⁵³ of an extensive range of chloro-derivatives of sucrose for pharmacological and toxicological evaluation, and the assessment of their sweetness and quality of taste.



The 1,6'-dichloride (53) was obtained by selective nucleophilic 6-mono-substitution of the 6,1,6'-tri-O-trimethylsilylate (30)^{54,55} with benzoate thus giving the 6-benzoate 1,6'-disulphonate, which gave the required 1,6'-dichloride (53) on subsequent reaction with chloride anions⁵⁶. 1'-Chloro-1'-deoxy-sucrose (32) was 20 times sweeter than sucrose, similar to the 6'-chloro derivative (46), but 6-chloro-6-deoxy sucrose (54) was bitter and not sweet. On the

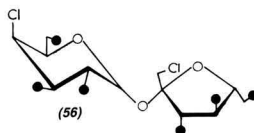


other hand, the 4-chloro *galacto*-sucrose derivative (55), prepared⁵⁷ from the readily available hepta-pivalate (4-OH free: 26), was five times sweeter²⁸.



Like the 6-chloro derivative (54), 6,6'-dichloro 6,6'-dideoxy sucrose (47) was not sweet, the 6-chloro substituent clearly having an adverse effect due either to the size of the substituent at carbon-6, as described earlier, or to the 6-chloro group locking onto the hydrophobic receptor site to give a misfit²⁸. In the 1,6'-dichloro derivative (53), the effect of the dichloro groups was synergistic, enhancing the sweetness more than 70 times, and this effect was

even greater in 4,1'-dichloro-4,1'-dideoxy-*galacto*-sucrose (56), with 120 times the sweetness of sucrose. Synthesis of the latter was achieved by direct chlorination of a 6,6'-diester of sucrose with sulphuryl chloride at the 4 and 1' positions³⁰.



Substitution of another chloro substituent in (56) at the 6'-position, to give the 4,1',6'-trichloro derivative (57) enhanced the sweetness five-fold, and this product, 4,1',6'-trichloro-4,1',6'-trideoxy-*galacto*-sucrose ("sucralose"), was 650 times sweeter than sucrose⁵³, non-toxic, non-metabolized and hence non-caloric. Sucralose is significantly more stable to acid hydrolysis than sucrose and has been developed jointly by Tate & Lyle plc (UK) and Johnson and Johnson (USA) for approval to market as a high quality intense sweetener. Sucralose is synthesised⁵⁸ by formation of the 6,1,6'-tri-O-trityl ether of sucrose (58), followed by acetylation to (59) which on de-tritylation rearranges to give the key 2,3,6,3'4'-penta-acetate (60) intermediate by a 4→6-acetyl migration. Substitution of the free hydroxyls at carbons 1', 4 and 6' by chlorination with SO₂Cl₂, followed by the removal of the acetate groups by de-esterification, yields the required 4,1',6'-trichloro derivative of *galacto*-sucrose

(57) as a water soluble, white crystalline solid (Figure 4).

The next development was to synthesise sucrose derivatives with a 4'-chloro substituent on the fructofuranoside^{48,59} by exploiting a novel conversion⁶⁰ of sucrose into its 3',4'-*lyxo*-epoxide by the agency of triphenyl phosphine (TPP)-diethylazodicarboxylate (DEAD) (Figure 5). Application of this reagent to 4,1',6'-trichloro-4,1',6'-trideoxy-*galacto*-sucrose (sucralose) (57) gave the corresponding *lyxo*-epoxide (61) which on nucleophilic attack with chloride anion, underwent ring-opening stereospecifically at carbon-4' to revert back to the *fructo*-configuration with a 4'-chloro group, giving the required 4,1',4',6'-tetrachloride (62). Since this product is 2200 times sweeter than sucrose, the replacement of the 4'-hydroxyl by chloride results in a four-fold increase in the sweetness of sucralose^{48,61}.

The corresponding 4,1',4',6'-tetrabromo derivative has a remarkably high sweetness, 7500 times that of sucrose. All of the halogeno-substituents in sucralose (57) and its 4'-chloro derivative (62) are on the upper face of

53 Hough et al.: British Patents, 1,543,167; 1,543,168 (1979).

54 Creasey & Guthrie: *J. Chem. Soc., Perkin Trans.*, 1974, 1, 1373.

55 Almqvist & Reist: *Carbohydr. Res.*, 1976, 46, 33; *J. Carbohydr. Nucl. Nucl. Nucl.*, 1976, 3, 261.

56 Hough et al.: *Carbohydr. Res.*, 1975, 44, C12.

57 Idem: *J. Chem. Soc., Perkin Trans.*, 1984, 1, 419.

58 Fairclough et al.: *Carbohydr. Res.*, 1975, 40, 285.

59 Khan: *Pure and Applied Chem.*, 1984, 56, 833.

60 Guthrie et al.: *Carbohydr. Res.*, 1980, 85, C5; 1983, 121, 109.

61 Lee: UK Patent 2,088,855A (1982).

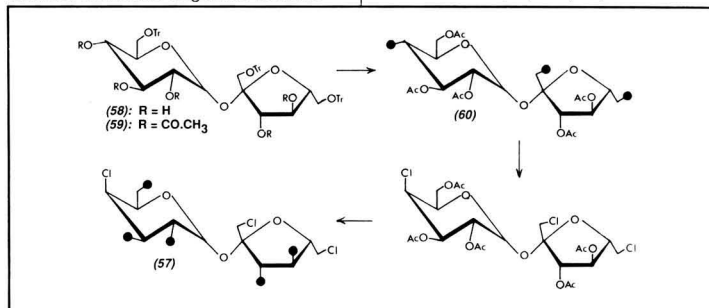
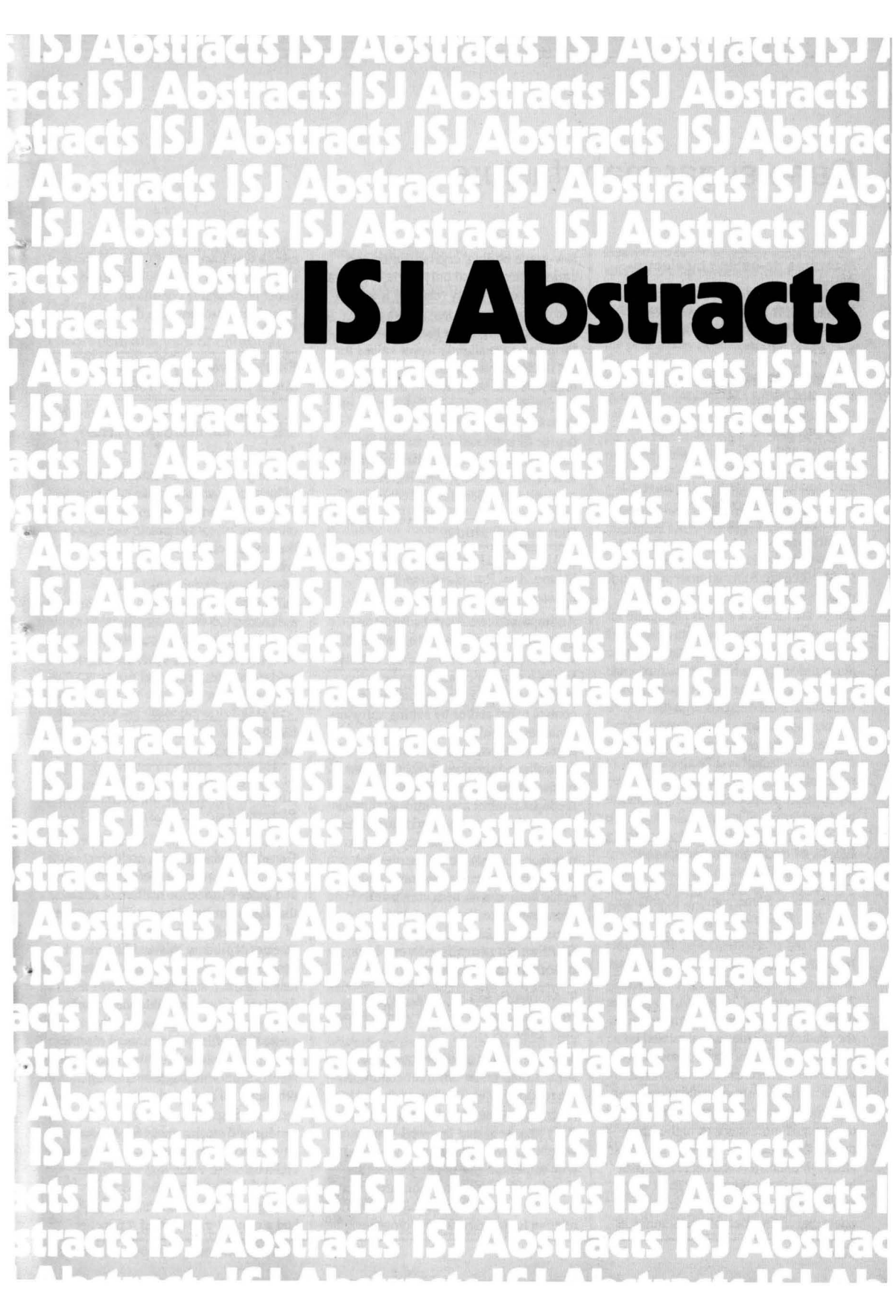


Fig. 4



ISJ Abstracts

Cane sugar manufacture

Molasses de-ashing by electro-dialysis

D. Hsu and B. J. Somera. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 58 - 61.

Molasses electro-dialysis tests were conducted with a DZL anion-selective membrane on its own and coupled with other membranes – a LMP cation-selective and a UZL anion-selective membrane, respectively. Since there was no dramatic increase in cell-pair resistance or marked decrease in the pH of the treated molasses, the limiting current density was >60 mA/cm², apparently a result of the initial high ash content (4.44 - 6.26%). Runs without application of D.C. current showed that sugar loss across the membranes was negligible for the two anion membranes but very much greater for the cation membrane; the almost identical purities of the feed and waste indicated that the loss was due to bulk flow of the feed through the membrane. Sucrose purity seemed to increase as de-ashing progressed. The treatment was highly effective in its removal of K, one of the major ash components responsible for crystallization problems.

Effect of dextran on molasses exhaustibility

D. Hsu, B. J. Somera and T. Moritsugu. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 61 - 63.

In exhaustibility tests, the purities of two molasses samples (one inoculated with 2.3% by weight of 70,000 M.W. dextran dissolved in water) were compared with the predicted purities as calculated on a carbonate ash and a conductimetric ash basis; the viscosities at various refractometric solids levels were also compared. As expected, the viscosity of the dextran-treated molasses was higher than that of the untreated sample at any Brix; although the difference decreased with increase in the solids, at 90°Bx it was still 130% (1050 vs. 450 poises), which could cause considerable difficulties in

low-grade boiling, crystallization and curing. Dextran had only slight effect on refractometric purity (causing it to fall) and on the reducing sugars:ash ratio (causing it to rise), so that the two purity formulae gave slightly lower values for the treated molasses and indicated a high potential sugar loss in molasses in the presence of dextran. Exhaustion of dextran-treated molasses to the same degree as untreated molasses would entail boiling to a higher Brix and hence to a higher viscosity, with increased operational difficulties and costs.

Pan control study

D. Hsu, W. K. Hashimoto and G. E. Sloane. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 63.

An improved two-loop feedback program for a digital process controller on a vacuum pan at Oahu Sugar Co. allowed any of a number of modes to be activated by setting external switches on the control panel and/or by setting software switches provided in the program together with correct selection of controller parameters. Tests with two modes (conventional, continuous linear feedback control and control of mother liquor solids as a function of steam feed or of massecuite consistency through pan feed control) yielded successful results in both seed strikes and high-grade boiling with both constant and changing controller set-points.

Studies on storage of very low colour (VLC) sugars

T. Moritsugu and S. Goya. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 69 - 70.

Tests conducted on three lots of VLC sugar stored under different conditions are reported. Results showed that sugar having an acceptable deterioration factor (DF) may be stored in a well-ventilated warehouse without loss in dry pol and with minimum rise in colour, but that significant pol loss and moisture absorption may occur during storage at high relative humidities, while colour in-

crease was lower in VLC sugar than raw sugar of higher initial colour stored under comparable conditions. Six Hawaiian factories were due to produce VLC sugar in 1988.

Energy inventory of Hawaiian sugar plantations - 1986

C. M. Kinoshita and W. K. Hashimoto. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 72 - 73.

Although in 1986, 2.7 million short tons of bagasse was burnt as fuel by Hawaiian sugar factories, a steep decline in fuel oil prices led to a dramatic increase in the amount consumed, resulting in an oil and coal consumption that was about 70% greater than in 1985. Of 878 million kWh of electricity generated by the industry, 84% was attributable to bagasse and woodchips compared with 90% in the previous year; the amount sold to the public utilities was 30% greater than in 1985.

Evaluation of cane residue recovery methods

L. A. Jakeway, L. T. Santo and C. M. Kinoshita. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 73 - 74.

Generally, when cane is not burnt, considerable quantities of tops, leaves and other extraneous matter are left in the field after harvest; tests in a number of countries have indicated that the amount of fibre in this residual material can approach that in milled cane and hence in the resultant bagasse, so that development of a suitable method of recovery and storage would allow generation of large amounts of electricity without the use of fossil fuels when insufficient or no bagasse is being produced. In an experiment conducted by Oahu Sugar Co., covering bales of residue and storing them for 3 months gave a moisture content that was lower and a calorific value that was higher than for bales left uncovered at an average ambient temperature of 85°F and a rainfall that totalled 4.6 inches

over the period. However, bales of high initial moisture content eventually dried to low levels with no apparent loss in fuel value.

Theoretical analysis of combustion efficiency and flue gas drying of solid fuels

C. M. Kinoshita. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 74 - 75.

Studies showed that, provided no air leaked into a flue gas dryer, the amount of bagasse drying per unit change in flue gas temperature across the dryer rose as the inlet gas temperature fell and the fuel moisture:dry matter ratio and excess air increased. However, leakage of air into the system caused a reduction in gas temperature per unit of air entrained that fell roughly inversely with increase in the excess air and also fell slightly with increase in the fuel moisture content, but reduction in the fuel moisture:dry matter ratio across the dryer per unit fall in gas temperature was quite insensitive to the moisture content of the undried fuel. In an efficient dryer of sufficient surface area and retention time and where the temperature of the discharge gas approaches the wet-bulb temperature, the quantity of air leaking into the system should not have any substantial effect on the final bagasse moisture content, although it could considerably reduce the drying efficiency by decreasing the temperature of the flue gas and thus increasing the surface area requirements. Reduction in flue gas temperature across a dryer is not of itself an accurate indicator of the effectiveness of heat recovery, since much of the temperature reduction may be due to mixing of the hot gas with cold leaked air rather than to adiabatic humidification of the gas by the moist bagasse.

Processing of burned and unburned cane in Hawaii

C. M. Kinoshita. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 80 - 81.

See *I.S.J.*, 1988, 90, 34 - 37.

Study of saccharolytic germs

E. M. Missbah and M. Saghi. *Sucr. Maghrebine*, 1988, (34), 8 - 12 (*French*).

The number of bacteria in samples of juice taken from various points between No.1 mill and clarification as well as in pressed juice, syrup and massecuite samples were determined and the findings discussed. An enormous number of bacteria was found in the cane at reception. Pressed juice disinfection experiments showed that 97% inhibition of bacterial activity was achieved after 3 hours' contact with 40 ppm formalin, whereas 30 ppm formalin gave only 60% inhibition.

Sugar cane impurities and their effect on theoretically recoverable sugar

- Mkhairi and S. Chabaa. *Sucr. Maghrebine*, 1988, (34), 14 - 23 (*French*).

After determining the contents of leaves, tops and sand in cane samples at two Moroccan factories (one supplied with manually and the other with mainly mechanically harvested cane), each type of impurity was added to clean cane to determine its effect on sugar recovery; the results were then evaluated statistically. Results showed an expected fall in recovery with increased impurity content and demonstrated the need for farmers to supply clean cane. The much greater sand content in the mechanically harvested cane would cause increased wear of equipment and tube blockage; the overall impurity content of this cane was greater than that of the manually cut cane, which did have more tops and leaf trash.

An annular centrifugal separator for purification of sugar cane juices

P. P. Esteves, P. M. Fabregat and A. P. Nikolaev. *Izv. Vuzov, Pishch. Tekh.*, 1988, (2), 138 (*Abstract only*).

Equipment is proposed for separation of solid insoluble particles from cane juice. A special form of channel and the presence of an aperture for discharge of the mud in the annular separator reduces the probability of intermixing of the layer of mud and the purified juice. Operation of an experimental model of the separator under factory conditions reduced the quantity of solid insoluble particles in limed juice by 30% at a 2:1 ratio between clear juice and mud.

Experiments on the use of the mechanism of selective transmission with different bronze-lubricant pairings

R. Rodriguez. *Schmierungstechnik*, 1987, 18, (4), 112 - 114; through *S.I.A.*, 1988, 50, Abs. 88-617.

Laboratory tests are described, the aim of which was to find a way of decreasing the wear on bronze bearings of mills under the operating conditions in the Cuban sugar industry. Frictional wear between six bronzes of stated compositions and a steel cylinder in the presence of four lubricants was measured. In general, wear was greatest with the mineral oil lubricant, least with hexanetriol, and intermediate with polyethylene glycol or polypropylene glycol. A tin-free bearing metal containing 3% silicon and 15% zinc is considered preferable to the one currently in use which contains 10% tin and 10% lead.

Recent developments in extraneous matter testing in Barbados

M. Biddlestone and S. A. Forde. *Proc. 1985 Meeting West Indies Sugar Tech.*, 53 - 59.

Details are given of the method used to sample cane and determine the amount of extraneous matter at testing stations in Barbados. The data are used to assess payment for nett clean cane, and the system has contributed to reasonably low levels of trash.

Determination of boiler efficiency - a comparison of methods

E. Findlay. *Proc. 1985 Meeting West Indies Sugar Tech.*, 60 - 73.

Boiler performance can be assessed (i) by a direct method in which the amount of steam produced by a specific amount of bagasse is determined, or (ii) indirectly by analysis of the flue gas to determine combustion efficiency. The two methods are compared and details given of the equipment and techniques available for flue gas analysis. In the absence of a continuous system for determining the quantity of bagasse fed to an individual boiler, method (i) is prone to greater measuring error than (ii). Problems associated with bagasse combustion are discussed.

The development of a water balance at Andrews factory as an aid to water conservation

M. Biddlestone. *Proc. 1985 Meeting West Indies Sugar Tech.*, 74 - 81.

A water balance for Andrews sugar factory in Barbados is analysed to show how efforts have been made to reduce water consumption. (See also Biddlestone: *I.S.J.*, 1985, 87, 90A.)

A scale inhibitor for cane sugar multiple-effect evaporators in Barbados

S. A. Brooks, R. C. Maloney, R. A. M. Pilgrim, W. H. A. Pugh and P. D. Smith. *Proc. 1985 Meeting West Indies Sugar Tech.*, 82 - 93.

The use of a low molecular weight polymer of acrylic acid as evaporator scale inhibitor is discussed; at two factories it has proved successful, while at a third factory the results have been mixed.

The quantity and quality of bagacillo required for rotary vacuum filters and means for collecting it

J. G. H. Badley. *Proc. 1985 Meeting West Indies Sugar Tech.*, 94 - 98.

See *I.S.J.*, 1985, 87, 89A.

An evaluation of double purging of low-grade massecuite at Blairmont factory

G. H. E. James and M. Lafleur. *Proc. 1985 Meeting West Indies Sugar Tech.*, 99 - 107.

Details are given of the low-grade double purging system introduced which solved the problem of viscous A-molasses, eased A-massecuite boiling, improved exhaustion and increased sugar recovery. It saved money earlier spent on pan aid chemicals, which balanced the installation costs within one season.

Dextran level in Jamaican sugar and proposed corrective program

J. Jadoo. *Proc. 1985 Meeting West Indies Sugar Tech.*, 108 - 117.

Recommended measures to reduce the dextran content in raw sugar and thereby avoid penalties imposed by refiners are discussed and methods of dextran analysis compared.

Computers - a tool of the sugar industry

H. Farabi, S. Thomas and W. A. Mellows. *Proc. 1985 Meeting West Indies Sugar Tech.*, 169 - 174.

The application of computers for process control and simulation is discussed.

An application for a personal computer in sugar factories

D. H. West. *Proc. 1985 Meeting West Indies Sugar Tech.*, 175 - 178.

The use of computers in the Barbados sugar industry for accounting, analysis of extraneous matter data and compilation of chemists' weekly reports is outlined.

Microcomputer applications in the cane sugar factory

A. C. Pilgrim and R. E. Weekes. *Proc. 1985 Meeting West Indies Sugar Tech.*, 229 - 237.

A brief survey is presented of possible microcomputer applications in the cane sugar factory, including data handling, automatic sampling and analysis and process automation.

Computer analysis of evaporator safety performance in a sugar factory

H. Farabi and W. A. Mellows. *Proc. 1985 Meeting West Indies Sugar Tech.*, 238 - 250.

The application of computer analysis for critical examination of evaporator operation as a means of identifying potential malfunctions beforehand and remedying them is described, covering steam pressure and flow in the 1st effect, pressure in the final effect, juice level, condensate and incondensable gas removal, vapour bleeding, entrainment, final juice Brix and scale formation.

Information systems planning

K. Byrne. *Proc. 1985 Meeting West Indies Sugar Tech.*, 251 - 258.

Development of an information systems plan at Caroni (1975) Ltd. is described.

Application of spreadsheet-type software to the calculation of factory performance statistics

K. Maharaj. *Proc. 1985 Meeting West Indies Sugar Tech.*, 269 - 274.

The use of a spreadsheet, report generator and graphics package to create standard factory daily and weekly statistical reports is described.

Optimizing the use of imbibition

M. D. Sullivan. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, O-4 - O-11.

See *I.S.J.*, 1985, 87, 167 - 171.

Bagasse-fired boilers emission control study

K. T. S. How. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, A-44 - A-48.

A survey is presented of equipment and methods for control of particulate emission.

Western States Model CC6 centrifugal operating experience at Oahu Sugar

W. F. Dang. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-1 - F-2.

The performance of a low-grade Western States CC6 continuous centrifugal is reported; in performance, power consumption and repairs it compares favourably with a batch and a Silver Engineering machine.

Evaluation of Western States CC6 continuous low-grade centrifugal at Oahu Sugar Company factory

T. Moritsugu and B. J. Somera. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-3 - F-11.

A more detailed appraisal is made of the centrifugal (see preceding abstract). Serious problems with considerable screen wear and tearing between slots, leading to high molasses purities, are discussed.

Hilo Coast Processing Company shredder

A. J. Schoemaker. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-12 - F-15.

Details are given of a modification of the Tongaat shredder design built to HCPC specifications which replaced a Gruendler model and brought about a number of benefits including improved cane preparation, increased extraction and reduction in bagasse moisture.

Hot liming

J. W. Bersch. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-16.

The advantages of hot over cold liming as found at Haina sugar factory are discussed.

Cane cleaning

J. W. Bersch. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-17 - F-18.

The wet cleaner at Haina is described and its performance outlined.

Application of reverse osmosis for partial concentration of clarified juice at elevated temperatures

T. A. Hsu. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-19 - F-24.

A tubular reverse osmosis module fitted with a high-temperature membrane was tested on clear juice concentration; it was found that four single-pass stages would raise the refractometric dry solids from 12% to a final 25.7% (with 30% RDS being considered technically feasible) at a pol loss of 0.05 per pass. The rate of water removal was linearly related to juice temperature and initial concentration as well as pressure. The permeate would not be suitable for use as boiler feedwater.

Factory improvements at HC & S Paia mill

R. Kwok. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-25 - F-27.

The improvements described cover cane cleaning, use of microprocessors and other electronic equipment for monitoring and control purposes, clarifier conversion to a trayless design, lubrication systems, etc.

Heat recovery systems

J. F. Mullen. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-28 - F-34.

Economizers and air heaters for use in bagasse boilers are discussed.

Advances in sugar crystallization and massecuite handling using continuous pans

P. W. Rein. *Rpts. 43rd Ann. Conf. Hawaiian Sugar Tech.*, 1984, F-35 - F-40.

See *I.S.J.*, 1987, 89, 28 - 34.

Agitation of massecuite in the pan

Anon. *Bull. GEPLACEA*, 1988, 5, (7), 4 pp.

The system developed by the Spanish company, Air-Gut S.A., for massecuite agitation by compressed air is described. The air, heated to 90°C before it enters the vacuum pan, is injected intermittently at short intervals into the massecuite from a number of special nozzles placed at the bottom of the pan. The system provides for control of the nozzle opening time and frequency (both parameters being adjustable during the boiling process) and for washing of the nozzles with hot water at the end of each cycle (generally at the same time as the pan is cleaned). The system, which is suitable for any type of pan, reduces the boiling time and steam temperature (thus contributing to energy saving), decreases colour formation, improves crystal quality and, because of the greater heat exchange produced, allows pans to be built with smaller calandrias so that the volume of footing may be reduced. A list is presented of sugar factories in six countries where the system has been installed.

Coal firing at Hilo Coast Processing

E. A. Kennett. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, O-10 - O-14.

Details are given of the power plant at HCPC and of the reasons for the decision to use coal instead of oil to supplement bagasse as fuel; operation of the Babcock & Wilcox boiler on coal and the monetary savings that result are discussed.

Coal characteristics

J. F. Mullen. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-1 - F-6.

The characteristics of coal and factors to be considered in its use as fuel in a sugar factory are examined.

Beet sugar manufacture

Continuous boiling at Fermo sugar factory

P. I. G. Cerolini. *Ind. Sacc. Ital.*, 1988, 81, 58, 60, 62 (Italian).

At Fermo, five 5-tonne batch pans with massecuite stirrers above the floating calandria were linked together by pump to form a continuous system, automatic control of supersaturation being based on conductivity in the first three pans and on radio frequency measurements¹ and/or rheometry in the last two pans, with digital back-up of the control hardware and use of two VDU's in parallel for monitoring A- and B-strikes. No difficulties were encountered in operation of the system, and crystals averaging 0.74 - 0.80 mm were easily obtained. The system used is the typical Italian scheme with one finished product (white sugar) boiled on a standard liquor prepared from B-sugar and C-masse-cuite.

Agents for reducing massecuite viscosity

H. Gruszecka. *Gaz. Cukr.*, 1988, 96, 43 - 45 (Polish).

The requirements of a suitable surface-active agent for reduction of massecuite viscosity are listed and data from the literature and manufacturers cited. In preliminary trials with 10 surfactants added to model aqueous molasses solutions, some of the preparations reduced sucrose polarization to a greater or lesser extent, depending on temperature (20° or 50°C) and/or time of contact (0 or 1 hr), while Glanapon DS 98 (of Austrian manufacture) increased it by 0.5 units. This surfactant, Amylase AG 150L (from Switzerland) and two Polish surfactants (Glukopol and Pektopol PT) failed to reduce the viscosity of a 84°Bx molasses solution as much as dilution with 0.2% water, which gave 38.8% reduction. The best performance was given by Sucrotensor S-35 at 0.2% concentration (71% reduction), followed by Rexolin Mazu 100, a Swedish product (54.8% reduction at 0.2%

concentration), while the others gave reductions in the range 40.3 - 46.8%.

Assessment under laboratory conditions of preparations reducing massecuite viscosity

H. Gruszecka. *Gaz. Cukr.*, 1988, 96, 45 - 47 (Polish).

Laboratory tests on a number of Polish and other surfactants in the treatment of an artificial massecuite are reported. Three Polish preparations based on maleic acid monoester and ethylene glycol gave 14 - 45% reduction in viscosity at doses of 50 - 200 ppm and were selected for trials under factory conditions during the subsequent campaign; non-Polish surfactants that also gave positive results included Glanapon DS 98, Poem Z-200 from Japan, Sucrotensor S-35 and Sucrotensor S-100 from Cuba and Pep 76 from Bulgaria. The results are tabulated. (See also preceding abstract.)

Electricity applications in agro-food industries

Anon. *Sucr. Franç.*, 1988, 129, 179 - 181 (French).

Brief reference to the use of electricity in the sugar factory and distillery relates to mechanical vapour compression in the evaporator station, in continuous boiling (where the specific energy consumption is approx. 14% of that with normal vapour heating), in pulp drying with superheated steam (with a specific energy consumption 20% that of a rotary drum and an oil-fired furnace), in vinasse concentration (where vapour compression consumes only 14% of the energy used in multiple-effect evaporation), and in alcohol distillation (with only 10% energy consumed by comparison with normal steam usage).

Ultrasonic interactions in electro-acoustic dewatering

N. Senapati, H. S. Muralidhara and R. Beard. *Paper presented at Tech. Conf., British Sugar plc*, 1988, 37 pp.

Ultrasonic waves interact with solid-liquid materials to help agglomerate the particles and fibres and enhance the separation of liquid trapped in pore and capillaries bound to the surface, and are also believed to reduce the effective viscosity and surface tension. Electro-acoustic dewatering (EAD) is a patented process based on the synergistic interaction of electro-osmotic force, ultrasonic force and pressure or vacuum which has been found to lead to a significant increase in the rate and degree of water removal. The theory of solid-liquid equilibrium and the action and effects of ultrasonics are examined and the mechanisms and applications of EAD described. Beet pulp is among products subjected to EAD on a laboratory scale; treatment increased the solids content by 3 units to 26.7%, representing 18% increased water separation by comparison with conventional handling.

Liming of sugar beet tissue

J. M. Randall, R. H. Edwards and W. M. Camirand. *Paper presented at Tech. Conf. British Sugar plc*, 1988, 32 pp.

Research conducted by the US Dept. of Agriculture on liming of cossettes as an aid to pulp pressing is described. Two methods were used: mixing the cossettes with dry, powdered Ca hydroxide or dipping them in a thin juice slurry of lime (2-4% as CaO) for 1 - 10 minutes and then draining. After both treatments, the cossettes were weighed, placed in wire baskets and suspended in a tank of hot running water for a given time, then dried in an oven at 105°C for 16 hr; the weight of the pulp was determined after subtraction of the Ca and sucrose. In batch tests with a hydraulic press, it was possible to achieve a pulp solids content after Ca subtraction which was 10 - 25% greater than from unlimed cossettes (lime in pressed pulp used as fodder could be of benefit); the diffusion rates were 20 - 30% lower than for normal cossettes at 75°C but higher than for untreated cossettes at 80°C. The juice from limed cossettes was of much lower

¹ Radford et al.: *I.S.J.*, 1988, 90, 6A.

colour and particulates content while purities were about the same for treated and untreated cossettes but the lime salts content rose with treatment. Replacement of diffusion with 2-stage treatment in a twin-screw press allowed up to 95 - 96% sucrose recovery at a juice draft equivalent to about 95 - 100%; up to 45% total solids was obtainable by this means, while 3-stage pressing could raise sucrose recovery to 97 - 98%. The potential energy savings are discussed.

The alkaline extraction of sugar beet

J. Ponant, S. Foissac and A. Esnault. *Paper presented at Tech. Conf., British Sugar plc.*, 1988, 70 pp.

The effects of cossettes liming on diffusion, juice purification and pulp pressing were determined in a stainless steel pilot plant having a cossettes capacity of 1 tonne/hr and consisting of a De Smet diffuser, screw press for exhausted cossettes and all the juice purification processes up to 2nd carbonation juice filtration. Results showed that sugar losses in diffusion of limed cossettes (which lasted only 44 min as against 70 min in the conventional process) were higher than normally, despite a much higher juice draft, and juice purity was lower; however, purification was better, with a clear juice colour 20% lower than normally, while a reduction in the lime consumption caused a decrease in the amount of 1st carbonation mud. Pulp dry solids rose with retention time in the screw press, with an upper limit of approx. 50%. At a solids content of 38 - 42%, a 50% saving in energy consumed for pulp drying was estimated. The alkaline pulp gave a significantly higher daily growth rate in lambs by comparison with conventional pulp. The economic benefits of the process are indicated.

The reduction of crystal aggregation (agglomeration) in sugar boiling

D. Schliephake and T. Frankenfeld.

Paper presented at Tech. Conf., British Sugar plc., 1988, 33 pp.

The theory of formation of aggregates is examined in the case of separate particles whereby it is shown how they have to grow faster than the speed at which they move in order to form aggregates, so that the determining factors are growth rate, differences in velocity and distance at the start of the boiling process; in the case of two particles already in contact and forming an agglomerate, separation will depend on a shearing stress that is greater than the van der Waals forces that bind them together, the number and size of the aggregates thus falling with increased dissipated power of the massecuite stirrer and hence shearing stress within a given volume. Comparison of the tensile strength of agglomerates relative to their size and number of single particles with the shearing stress in a seed slurry allows the sizes of the surviving agglomerates to be determined. The greatest risk of agglomerate formation appears to occur during feeding of seed slurry or during shock nucleation but is greatly reduced by the action of a stirrer. Pretreatment of a slurry in a small stirred vessel was followed by addition to a slightly supersaturated 75°Bx solution in a cooler where the temperature was reduced to 25°C. The final product had a size of 0.10 - 0.13 mm and was suitable as crystal feed for boiling to a product of 0.3 - 0.5 mm which could also be used as crystal seed in continuous boiling. Agglomeration was greatly reduced, the crystals were of excellent appearance, centrifugal yield and cycle times were considerably improved and the wash water requirements reduced.

Increasing the utilization of supplementary energy resources

Zh. N. Kituev and V. G. Nekrasov. *Sakhar. Svekla*, 1988, (3), 27 - 28 (Russian).

A sample energy balance indicates the quantity of supplementary energy that is available in the form of condensate,

cooling water, flue gas from beet pulp dryers, vapours from an evaporator station and filter cake and how much it is under-utilized in the Soviet Union. A number of possible applications are indicated.

Lime consumption in raw juice purification

R. Ya. Gurevich, L. D. Shevtsov and V. V. Panov. *Sakhar. Svekla*, 1988, (3), 51 - 54 (Russian).

Two methods are described for determining the output of a lime kiln and hence, on the assumption that all of it is used in process, i.e. the lime consumed in juice purification. One method is based on calculation of a daily material balance which includes the amount of limestone fed into the kiln and its Ca carbonate content, and the quantities of CaO and Ca(OH)₂ obtained; the other method, based on analysis of the kiln gas as conducted twice per shift, is reliable only for a kiln operating under standard firing conditions.

Improving the reliability of automatic controls for carbonation

V. N. Antonovskii, A. G. Babak, M. A. Marushchenko and Z. S. Voloshin. *Sakhar. Svekla*, 1988, (3), 54 - 57 (Russian).

Steps that need to be taken in the upgrading of carbonation automatic control systems at Soviet sugar factories and the instrumentation and control devices involved are examined.

Plant for heating the juice-cossettes mixture

M. A. Totkailo, V. N. Sanov, V. A. Kapulov-Kulikov, V. N. Usyuchenko and N. S. Karpovich. *Sakhar. Svekla*, 1988, (3), 57 - 58 (Russian).

The system installed in a tower diffuser at Khmel' nitskii factory comprises a closed circuit which includes an external contact steam heater to which juice is withdrawn from near the bottom of the tower and is heated from 60 - 62°C to 85

- 87°C, a holding tank for the heated juice and a pump which returns the juice to the diffuser; 25% of the diffuser juice content is reheated by this means (30 - 35 m³/hr), ensuring a juice-cossettes mixture having a temperature of 72 - 75°C and reducing sugar losses by 0.07 - 0.10 units by comparison with diffusion without the system.

ANS centrifugal pump

N. K. Rzhebaeva, L. I. Shekunov and A. V. Semenikhin. *Sakhar. Svekla*, 1988, (3), 58 - 59 (Russian).

Details are given of centrifugal pumps in the ANS series which have a semi-open radial impeller to allow them to pump alkaline and neutral liquids containing up to 5% suspended particles and having a density of up to 1.25 g/cm³. They have already successfully undergone commissioning trials in sugar factories.

Investigation of the operation of sulphitation plants

J. Gebler, E. Sarka and K. Vrskova. *Listy Cukr.*, 1988, 104, 102 - 107 (Czech).

The performances of the sulphitation stations at two Czechoslovak sugar factories were investigated. At Hodonin (equipped with Polish sulphitation equipment) the daily beet slice of 3000 tonnes calls for an hourly SO₂ output of 25 kg to treat diffusion water and thin juice, and the sulphur burner can produce 21 - 86 kg/hr; however, if beet quality is such that thin juice sulphitation is not advisable, it is not possible to reduce the output sufficiently, and excess SO₂ has to be vented to the atmosphere. The authors therefore call for much smaller units to be made available. Criticism is also made of the system of automatic sulphitation control provided. At Cejetický factory (equipped with Czechoslovak sulphitation plant) it would be better economically to install two smaller sulphur burners or one having a wider output range for water and thin juice treatment, since it is not recommended to treat thin

juice when alkalinity falls in evaporation (as happens in some years).

Heat transfer, residence time distribution and colour formation in evaporators

G. Witte and T. Cronewitz. *Zuckerind.*, 1988, 113, 479 - 487 (German).

See *I.S.J.*, 1987, 89, 104.

Aspects of juice purification plant

J. Tschersich. *Zuckerind.*, 1988, 113, 488 - 491 (German).

The fundamentals of preliming in a Brieghel-Müller trough are restated and the development of vertical prelimers as a consequence of the considerable space requirements of the horizontal trough mentioned. A BMA vertical prelimer is described which is divided into sections from top to bottom with a centrally located stirrer in each plus a variable-delivery propeller pump for transfer between sections; the performance and advantages of the unit are discussed. Of the factors governing the chemical reactions that take place in liming, viz. alkalinity, reaction temperature and residence time, it is only the last parameter that concerns the designer of a suitable vessel; two possible arrangements are: (1) vessels in the form of a multi-stage stirred vessel cascade, and (2) vessels without stirrers but with fixed inserts that force the juice to flow through in the shortest possible time. Tracer experiments conducted by BMA on variants of a vertical model are described which demonstrated the validity of the design of a new limer which has an inner cylinder into which the juice flows tangentially, then following a downward path as the vessel rotates; when the juice reaches the conical bottom, it leaves the cylinder and flows up through the space between it and the outer wall of the vessel while this continues to rotate, and is discharged tangentially. An annular CO₂ distributor for a carbonation vessel manufactured by BMA is also described which is centrally located at the bottom

of the tank; it receives the gas from above and discharges it evenly via a bottom flexible serrated edge piece which provides a fine gas stream in a vessel of up to 6 m diameter.

Aspects of Putsch juice purification plant

R. Hies. *Zuckerind.*, 1988, 113, 492 - 493 (German).

Lime is fed at only one point in the Putsch vertical prelimer in which back-mixing is provided by adjustable elements. Troughs of the Brieghel-Müller type are also still available if required; they are constructed with basically no intermediate bearings on the main shaft. The vertical limer produced by Putsch contains an inner cylindrical section of such diameter that juice and mud are not separated under flow conditions, while sand and grit settle to the conical bottom for subsequent discharge. The juice level is adjustable to allow the residence time to be matched to the particular requirements of the juice; creation of forced flow by the Putsch system gives a much better residence time distribution than in other non-stirred vessels or those having only simple stirring means. Juice and lime are thoroughly mixed by a stationary mixer before entering the limer. Juice is fed into 1st and 2nd carbonation vessels in the Putsch system via a central distributor which spreads it evenly across the vessel, while the gas enters through a large distributor which breaks it up into the smallest possible bubbles for greatest utilization. Features of the Putsch juice purification system as introduced at Lage sugar factory are described; the resultant juice colour is so low that sulphitation and injection of air are not needed while adding pre-carbonation can overcome any difficulties encountered in processing juice from badly frosted beet.

Use of bisulphites in diffusion plants as disinfectants, pulp pressing aids and for decolorization

G. Vaccari, G. Mantovani and G. Sgualdino. *Zuckerind.*, 1988, 113, 501 - 505.

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

Experiments on increasing the amount of sugar extracted from beet

K. Vukov and I. Sipos. *Cukoripar*, 1988, 41, 66 - 69 (Hungarian).

See *I.S.J.*, 1989, 91, 5A.

Automatic membrane filter-press at Hajdusag sugar factory

B. Viczián and F. Gál. *Cukoripar*, 1988, 41, 69 - 72 (Hungarian).

Details are given of the Lasta automatic filter-press (made by DDS under licence from a Japanese firm) as installed at Hajdusag for carbonation mud treatment at a nominal daily capacity of 160 tonnes of filter cake of 67% dry solids content. At an average cake loss of 0.4 - 0.6%, the three units at the factory are calculated to yield an extra 200 - 250 tonnes of sugar per year by comparison with rotary filters, which consume 13 - 17% water on beet per cycle for sweetening-off compared with only 5 - 7% for the filter-press.

Factors in the development of the sugar industry

P. Wertán. *Cukoripar*, 1988, 41, 72 - 75 (Hungarian).

Reasons for the relatively high energy consumption in Hungarian sugar factories are examined and possible future developments that would take into account the need for greater fuel economy are discussed. These include increasing the average factory size (the average slicing capacity in 1986/87 was 3440 tonnes/day) and restricting the campaign to 80 - 85 days with as late a start as practical to ensure that the beets are fully mature; greater centralization of factories would cut the distance to be covered by beet transport and hence decrease fuel consumption. Other

energy-saving measures include reducing the water content of juice e.g. by using dry lime and so reducing the evaporation requirements, improving beet quality and hence decreasing the non-sugars (thus reducing the need for supplementary processing such as demineralization by ion exchange), restricting the temperature level in diffusion, making greater use of continuous processes, boiling syrup of higher Brix, and using efficient heat insulation.

Investigation of the mechanism of redistribution of the crystallizate during mass crystallization in the case of sucrose

V. K. Kudrik, V. O. Shtangeev, V. K. Maidanyuk and L. F. Luk'yanchuk. *Izv. Vuzov, Pishch. Tekh.*, 1988, (2), 15 (Abstract only).

Investigations conducted with radioactive sucrose labelled with ^{14}C and ^{11}C demonstrated that crystal growth during massecuite boiling was due to the sugar in the initial solution and syrup drinks (independent of the boiling period) before and after attainment of the critical crystal concentration in the massecuite. During the boiling process the crystals were redistributed between phases as a consequence of recrystallization by an oscillating mechanism.

Monitoring low-grade massecuite crystallization

I. P. Mel'nik and A. P. Kozyavkin. *Izv. Vuzov, Pishch. Tekh.*, 1988, (2), 83 (Abstract only).

Errors were found in determination of the values of saturated molasses dry solids and purity when converting from high saturation temperatures to the centrifugalling temperature. A more rapid and accurate method for determining standard purity is suggested.

Effect of the concentration of additives for raw juice purification on lime solubility

V. A. Loseva, I. S. Naumchenko and

V. M. Perelygin. *Izv. Vuzov, Pishch. Tekh.*, 1988, (2), 125 - 126 (Russian).

Increase in the solubility of Ca hydroxide in the presence of ammonium chloride and HCl, respectively, was characterized by a curve of solubility vs. solvent concentration which differed between water and aqueous sugar solution; in water, the solubility rose with every increase in solvent concentration, whereas in sugar solution there was an initial increase after which solubility dropped to an ultimate level that was only just above the value in the absence of the solvents.

Purification of sugar solutions with colloidal aluminium hydroxide

A. Mihaliakova, I. Jancl and V. Tibensky. *Listy Cukr.*, 1988, 104, 125 - 127 (Czech).

Laboratory experiments are reported in which model thin juice was treated for 10 minutes at room temperature and at 55°C with colloidal Al hydroxide at 0.141 g/100 cm³. The precipitate formed was filtered off, mixed with a fresh batch of juice and the clarification process repeated; this re-use of the precipitate raised colour removal from 43% to 51% at room temperature, while a second recycle raised it to 55%, after which further recycling had no effect. The use of a higher process temperature raised the decolorization efficiency to 59% in the 1st cycle and to 63% after one recycle, but further recycling at this temperature gave no further improvement. The same pattern was obtained for lime salts and α -amino N removal, which rose to 34% and 27%, respectively. Addition of acetone at a volumetric ratio of 2.5:1 after the Al hydroxide increased the non-sugars removal from both thin and raw juice. Despite the positive results achieved with Al hydroxide, the method is not considered suitable for normal factory application because of the costs of the Al hydroxide and other chemicals involved (although economies are being sought) and because of the dilution of the juice.

Laboratory studies

Determination of inorganic anions in beet and process juices by ion chromatography

K. Sayama and T. Muratsubaki. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1988, 35, 19 - 25 (Japanese).

Ion chromatography was applied to quantitative determination of inorganic anions in beet, concentrated 2nd carbonation juice and molasses. Deproteinization using Toyo Pak IC-SP was effective in the case of press juice analysis. Cl^- , NO_2^- , NO_3^- and PO_4^{3-} could be determined without the intervention of organic acids, whereas the SO_4^{2-} peak overlapped with those of malic, succinic, malonic, maleic and tartaric acids. High correlation was found between the ion chromatographic method of determining NO_2^- and NO_3^- and the AOAC method. Cl^- , NO_3^- , PO_4^{3-} and SO_4^{2-} were found in press juice, Cl^- , NO_2^- , NO_3^- and SO_4^{2-} in carbonation juice and Steffen molasses, but only Cl^- was found in molasses from ion exchange treatment and then only to a small degree.

Analysis of dextran in the beet sugar factory. II. Determination by a gel filtration method

K. Sayama and T. Kamata. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1988, 35, 59 - 67 (Japanese).

A gel filtration method is described that, coupled with dextranase treatment, determined dextran more rapidly and with greater simplicity than a previous dialysis method and was found to be suitable for routine analysis. Process juices were filtered through a glass fibre filter (pore size 2.7 μm) after dilution, if necessary. Dextranase was added at 20 IU per mg dextran and reacted with the juice at pH 5.1 and 55°C for 10 minutes. Gel filtration was then used for both control and dextranase-treated samples after treatment with a 0.45 μm membrane filter. Toyopearl HW-40S gel was used in a 1.76 cm \times 20 cm (gel volume 40 ml); deionized water filtered through a 0.2 μm membrane was used as eluent

at 1 ml/min flow rate and room temperature. The phenol/sulphuric acid method was used for detection of dextran in 1 - 2 ml samples. The high molecular fraction recovered constituted 74% of standard dextran T-10 after 72 hr dialysis, and the dextran content was obtained from the difference in total polysaccharides between the control and the enzyme-treated sample. Recovery and hydrolysis of a standard dextran T-2000 added to juice were 94.7 - 98.2% and 94.4 - 96.5%, respectively. The gel filtration method determined 99.2% of the dextran found by dialysis in press and raw juice and 99.8% of that found in molasses.

Determination of betaine in sugar factory samples

A. Stechova, L. Svobodova, S. Korkakova and P. Kadlec. *Listy Cukr.*, 1988, 104, 121 - 124 (Czech).

A GLC method is described that has been developed outside Czechoslovakia and determines betaine together with mono- and disaccharides by passage through a 300 \times 8 mm column filled with ion exchange resin in Na^+ form; sodium sulphate is used as mobile phase and detection is by refractometer. Sample size is 20 μl itre. Results are given for beet, molasses, raw and thin juice in the form of tables and chromatograms; the method is also applicable to massecuite and sugar analysis after concentration of the ion exchange-treated sample by evaporation.

Comparison of the content of melassigenic substances in sugar beet between Czechoslovakia and some West European countries

J. Chochola. *Listy Cukr.*, 1988, 104, 135 - 138 (Czech).

Comparison of the K, Na and α -amino N contents in beet samples from a number of West European countries and East Germany with values for beets in Czechoslovakia shows that the averages for beets in the last-named country are much higher, particularly the Na content (11.8 meq/100 g as against 3.78 meq/

100 g). As a result, it is calculated that 7.3% (on sugar) more molasses is produced in Czechoslovakia, equivalent to a white sugar loss of 10% on pol (4% on beet). The methods used to calculate sugar yield and possible reasons for the higher K and Na contents are discussed.

Alternatives to use of heavy metal compounds in factory control

R. R. Tamaye. *Rpts. 44th Ann. Conf. Hawaiian Sugar Tech.*, 1985, F-68 - F-70.

Instead of using mercuric chloride to preserve juice samples, at HSPA mixed juice is passed through two coils (each of small-bore copper tubing) in series which are immersed in hot and cold water baths; the juice is heated to about 80°C and then cooled to ambient temperature. Tests at Oahu factory showed no difference in purity between samples treated by this method and those preserved with the chloride. Tests on clarifying agents as possible alternatives to lead subacetate showed that none, including Al sulphate, Ca carbonate and Ca hydroxide, was a satisfactory substitute, mainly because of poor decolorization. Trials were also conducted with an infra-red, dark-solution polarimeter; the instrument was able to give readings unobtainable with an Autopol IIS saccharimeter and showed lower pol values for unleaded than leaded samples.

Determination of organic acids in sugar cane process juice by high-performance liquid chromatography: improved resolution using dual Aminex HPX-87H cation exchange columns equilibrated to different temperatures

J. D. Blake, M. L. Clarke and G. N. Richards. *J. Chromatogr.*, 1988, 398, 265 - 277; through *Anal. Abs.*, 1988, 50, Abs. 7F19.

The organic acids were first isolated on DEAE-Sephadex A-25 anion-exchange resin equilibrated with 0.5M isobutyric acid and then eluted with 0.5M sulphuric acid and separated by HPLC on two

columns (30 cm × 7.8 mm) of Aminex HPX-87H cation-exchange resin connected in series, the first and second columns being operated at 35°C ± 0.5° and 85°C ± 0.5°, respectively. The mobile phase (0.5 ml/min) was 5mM sulphuric acid, and refractive index detection was used. Simultaneous determination was achieved of oxalic, *cis*- and *trans*-aconitic, citric, phosphoric, malic, succinic, glycollic, lactic, formic and acetic acids; isobutyric acid was also separated. Resolution was improved by the two-column system; the detection limit was 50 µg/ml.

Influence of non-sugars on the refractometric determination of dry substance content

K. Wagnerowski. *Zuckerind.*, 1988, 113, 585 - 590 (German).

While refractometric determination of dry solids gives values that are identical to gravimetric measurements for pure solutions, this is not so with impure samples for which indirect methods such as refractometry are unreliable because of the difference between non-sugars and sucrose in their effect on refraction and on volume reduction caused by dissolution or dilution, particularly where the sample is highly diluted; as a consequence, indirect methods give higher values than gravimetry. Statistical analysis of results of laboratory experiments carried out on molasses samples in 1970 showed that the proportionality factor F of Hitzel (non-sugars content determined gravimetrically / non-sugars content determined refractometrically) could be redefined to represent the total effect of non-sugars on volume reduction and refraction: $F = 1/(k - a \cdot w_{\text{nds}})$, where k and a are empirical constants dependent on non-sugars composition and w_{nds} = measured refractometric dry solids (as against RDS calculated from measurements after allowing for the dilution factor N which may be defined as the weight ratio of solution to solute or as the ratio of sugar content in the solute to that in the solution). The method used to find

the values of a and k is described and a number of correlation equations derived for gravimetric and refractometric values are presented.

Events in sugar crystallization

A. VanHook. *Zuckerind.*, 1988, 113, 591 - 593.

The author gives a brief account of the work he has conducted over the last 50 years on sucrose crystallization, especially his interpretation of the crystal growth curves constructed by Kukhar-enko. Investigation of the action of surfactants has shown that while they prevent conglomeration they do promote secondary grain formation; the reduction in boiling time associated with their use is probably a result of these two effects plus increased massecuite fluidity. Surfactants also help to reduce inclusions, as does slow, steady and uninterrupted growth with stirring and, preferably, slow cooling. It is suggested that the formation of triangular crystals results from adsorption or inclusion and is governed by the impurity:water and impurity:sugar ratios; ash is not responsible for the phenomenon, but fructose may be implicated and possibly a combination of impurities. Low molecular weight components (<3500) but not those of high M.W. promote their formation. Repeated wetting and recrystallization or temperature cycling seems to change triangular crystals to rod-shaped crystals and ones of normal shape. Only one of a number of enzymes prevented the formation of triangular crystals.

Evaluation of the CSC-Cenco moisture balance

R. R. Tamaye. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 63 - 64.

A CSC-Cenco moisture balance, manufactured by CSC Scientific Inc. and tested on bagasse and filter cake samples, is a torsion-type manual instrument in which heat for drying is provided by an infrared lamp and the

loss in sample weight is read directly off a scale of moisture % graduated in 0.2%. The balance tested was equipped to dry 5-g samples, but the initial sample weight may be 5, 25 or 100 g, depending on the diameter of the torsion wire; 5 g was approximately the weight of the maximum quantity of bagasse that could be placed in the sample chamber. Drying to constant weight took about 15 minutes for bagasse and 30 min for filter cake, as against 30 - 60 min for bagasse with a Dieter moisture teller and about 3 hr for bagasse or filter cake in an oven. The balance was found to be suitable for rapid moisture determination provided a sensitivity of ± 0.2% was adequate. The balance may possibly be used to determine chopped or shredded cane moisture, although several sub-samples of bagasse or cane would probably have to be dried and an average value obtained because of the limited sample chamber capacity.

Evaluation of laboratory refractometers

R. R. Tamaye. *Ann. Rpt. Hawaiian Sugar Planters' Assoc. Expt. Sta.*, 1987, 64.

A Bellingham & Stanley RFM-81 automatic refractometer was tested to see if it would be suitable for sugar factory control purposes; it has a range of 0 - 90% dry solids (displayed as Brix), a readability to 0.02% and automatic temperature compensation. The instrument gave slightly lower values than a Bausch & Lomb refractometer when applied to 5, 10, 15, 20 and 40% sucrose solutions but slightly higher values for diluted evaporator syrup. The temperature compensation function worked very well. However, if the refractometer is used in a factory laboratory, sample solutions will have to be clear before being placed on the prism, since this is horizontal and allows insoluble material in a sample to settle out, thus affecting the measured value; in all other aspects, the instrument appeared to be suitable for factory control.

By-products

The contribution of sugar beet feeds to livestock nutrition

J. I. Harland. *Paper presented at Tech. Conf., British Sugar plc, 1988, 38 pp.*

The properties of beet pulp and molasses as animal fodder are discussed and their nutritional monetary values per tonne compared with those of other commonly used feeds. Their interaction with other ration constituents that must be added to make a complete feedstuff is examined; the high digestibility of pulp and its almost complete fermentation in the animal encourage growth and multiplication of fibre-digesting bacteria which thus lead to improvement in the digestibility and intake of straw, a greatly under-utilized feedstuff, as has been found in experiments with sheep. While a trial with lactating dairy cows showed no difference in animal performance between pressed or dried pulp, rumen protein degradability of dried pulp has proved to be considerably lower, indicating an adverse effect of drying on protein availability. Horses fed on gradually increased levels of beet or cane molasses up to a maximum at which they were changed over to cane or beet molasses, respectively, seemed to tire of cane molasses more quickly, so that it was difficult to sustain high levels of intake for the entire feeding period; these results demonstrated that animals do not necessarily prefer cane molasses despite the more pleasant taste of the molasses for humans. Comparison between the two forms showed that, weight for weight, beet molasses is of higher digestible energy and contains more crude protein and less ash than cane molasses which, however, contains slightly more digestible crude protein. Recommended levels of molasses inclusion for different animals are listed. Trials are reported in which molasses was added to pulp fed to lactating dairy cows; while molasses reduced milk yield it increased the fat concentration. The highest feed intake and liveweight gain by calves in comparative tests showed best results with molasses + pulp, followed by barley and then dried pulp.

Because of its ability to take up considerable quantities of moisture and retain it, pulp has proved valuable as an adsorbent for grass silage effluent, thus enhancing the feed value and helping to solve environmental problems relating to seepage. The question of the effect of molasses addition to dried pulp on protein degradability and digestibility is discussed; so far, results have been inconclusive.

Application and value of by-products from the sugar and alcohol industry in animal nutrition

J. Haaksma. *Paper presented at Tech. Conf., British Sugar plc, 1988, 42 pp.*

While pressed and dried pulp are similar in composition there are major differences in that pressed pulp needs to be ensiled (because of its high water content) if not used straight away, whereas dried pulp is easy to store and handle. Dried pulp contains sugars and has a pH >5 as against a pH of approx. 4 for pressed pulp in which the sugars are converted to acid; the protein content and degradability in the rumen are low for both types, but vinasse (high in protein) is a valuable additive, although its high K content may cause grass tetany and diarrhoea in ruminants. Feeding trials conducted on pigs, dairy cows and beef cattle are reported. Because of its pH and fibrous components, pressed pulp proved beneficial with pigs, particularly in terms of the reduction in water intake and total manure and slurry production. The preservation of pressed pulp containing <20% dry matter results in a higher rate of conversion to acids and increased pectin degradation; experiments showed that digestibility rose with the dry matter content. Replacement of concentrates with pressed pulp in iso-nitrogenous rations fed to high-yielding dairy cows resulted in increased milk yields, particularly in the first 10 weeks of lactation, although the fat content fell slightly when large quantities were fed. Daily weight gains in beef cattle were

markedly better when they were fed on a combination of pressed pulp and maize silage than with pulp or maize silage alone. Incorporation of 6% vinasse in pulp silage increased palatability and protein degradability without causing any statistical difference in milk production or milk fat and protein contents. Replacement of 50% soyabean protein with vinasse protein (equivalent to addition of 4% to pulp) in rations fed to beef cattle gave a marginally better performance, while replacement of all of the soyabean protein with vinasse caused a slight drop in daily gain and in energy conversion efficiency; however, vinasse protein gave a higher daily gain and energy conversion efficiency than urea and ammonium monophosphate. Pressed pulp ensilage was improved by adding 6% vinasse.

Effect of incorporating molassed sugar beet in grass silage

R. Jones and D. I. H. Jones. *Paper presented at Tech. Conf., British Sugar plc, 1988, 32 pp.*

Although wilting is the cheapest and most effective method of reducing the amount of effluent emanating from silage, current agricultural practices combined with increasing summer rainfalls in the UK reduce the opportunity for wilting, so that any effluent produced must be held in tanks (which need emptying several times a day during peak effluent production such as in the first 7 days of ensilage) and/or absorbed *in situ*. As an alternative, the use of absorbents to retain grass juices within the bulk of the silage has been investigated, and details are given of tests with various additives including molassed pulp. While total effluent production was unaltered by incorporation of the pulp in autumn grass silage, in the case of spring-cut grass there was a 17% fall in the total amount of silage and a particularly sharp reduction in the first 2 days. Inclusion of the pulp in both autumn and spring silage increased mean intake of silage dry matter and mean liveweight gain in beef cattle.

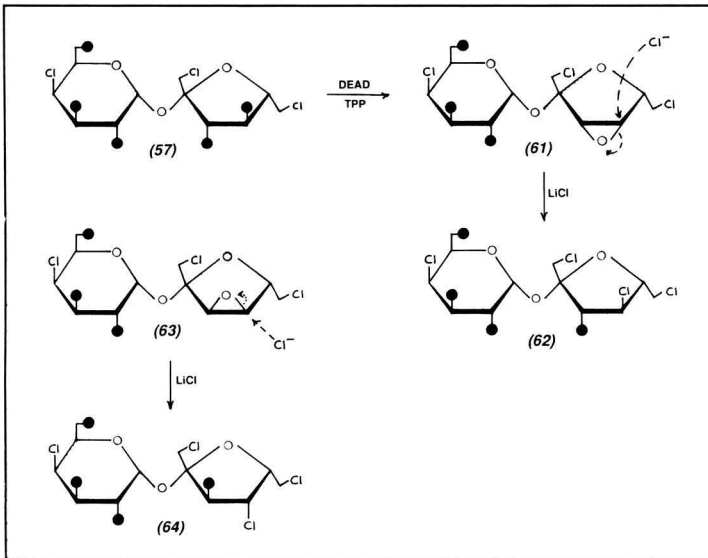


Fig. 5

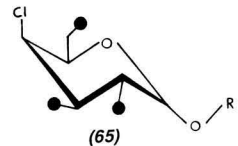
the molecule. This is a significant factor since the isomeric *sorbo*-tetrachloride (64) in which the 4'-chloro group has the opposite configuration, below the plane of the ring, was greatly reduced in comparison to a sweetness only 200 times that of sucrose. The *sorbo*-tetrachloride (64) was synthesized via the 3',4'-*ribo*-epoxide (63) by nucleophilic ring opening, again selectively at carbon-4' with chloride anions⁴⁸.

The 6,1',6'-trichloro derivative of sucrose (51) is 25 times as sweet as sucrose and, as we have observed, when the 4-hydroxyl is replaced by a chloro group in the 4,6,1',6'-tetrachloro derivative (49), the sweetness increases to 200

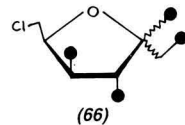
times²⁸. However, replacement of the 2-hydroxyl group in (51) by chloride with inversion of configuration gives the 2,6,1',6'-tetrachloro *manno*-sucrose derivative⁶², which is as bitter as quinine. This observation supports the view that the equatorial 2-hydroxyl is essential for sweetness, combined with the 3'-hydroxyl, as a triangular array of saporophoric groups with lipophilic substituents at specific positions in the molecule, preferably on the upper face²⁸.

Similar attempts to enhance the sweetness of other carbohydrates such as D-glucose, maltose and trehalose by the insertion of chloro substituents, as for example 6-chloro-6-deoxy-D-glucose,

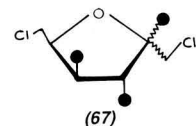
4',6'-dichloro-4',6'-dideoxymaltose and 4,6-dichloro-4,6-dideoxytrehalose, were unsuccessful, the majority of the halogenated derivatives being less sweet than the parent and many bitter⁶³. Likewise, 4-chloro-D-galactose and its simple glycoside derivatives (65) are not sweet⁶⁴, emphasising the unique role of the 2- and 3'-hydroxyl groups in the sweetness of the sucrose molecule (23).



The observation that 6-chloro-6-deoxy-D-fructofuranose (66) is sweet (<1x), and the 1,6-dichloro derivative (67) slightly sweeter (1x) was unexpected since the parent D-fructofuranose is in all probability not a sweet compound.



Whilst they do not compare in sweetness to sucralose (650x), or 1',6'-dichloro-sucrose (80x), this unit (67) was sug-

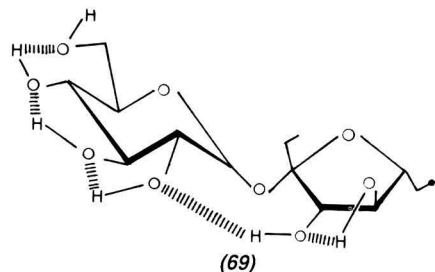
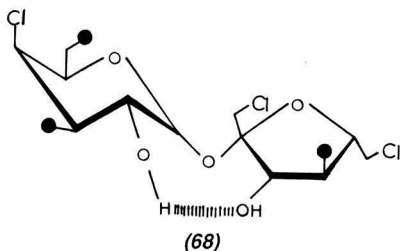


(continued on page 35)

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63 Dziedzic & Birch: *J. Sci. Food Agric.*, 1981, 32, 283.

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Mist eliminators in evaporators and pans

By Ronald D. Belden
(Koch Engineering Co. Inc., Wichita, Kansas)

Entrainment is a common problem with evaporators and pans. In fact, entrainment is an inescapable phenomenon in almost any process that has gas and liquids mixed together. If the two come together, some of the liquid will be trapped in the gas stream. And when that liquid consists of sugar juice and syrup, there can be lots of trouble. The liquid in the gas stream fouls process equipment, reduces heat exchanger efficiency, cuts capacity, and increases energy costs.

The liquid carry-over eventually has to be removed as a pollutant rather than sold as a product, so the challenge is to recover the liquid from the gas, before it gets downstream, and put it back into the process. This recovery is usually done by passing the vapours from the evaporator through some type of entrainment separator. The separator collects the entrained liquid and directs it back to the evaporator.

The basic design and operation of evaporators and pans has not changed in decades, so there has been little change in the quantity and size of the entrainment droplets they produce. But we have seen two major advances in our ability to recover that entrainment. First, new designs of entrainment separators are now available. And second, we are now better able to predict the performance of that equipment.

There are basically five different mechanisms available to collect entrainment – centrifugal force, inertial impaction, interception, electrostatic attraction, and Brownian diffusion. There are also five major types of separators, each one using one or two of the above mechanisms as its primary collection method. These are cyclones (centrifugal), chevrons (impaction and interception), mesh pads (impaction and interception), electrostatic precipitators (electrostatic attraction) and fibred pads (Brownian diffusion). All these mechanisms and separators have one thing – they coalesce small entrained droplets into larger droplets which will drain back into the process.

Entrainment droplets produced by evaporators and pans range in size from

20 microns to about 300 microns (see Table I). They are large enough to be visible to the naked eye but still small enough to be carried along with the gas stream. Without getting into an esoteric discussion of what is a mist and what is a spray, all this entrainment separation equipment will be called "mist separators". Although technically some of the entrainment from evaporators may be large enough to be called sprays rather than mists, we are more concerned with recovering the entrainment, not naming it.

effective only for removing very small (sub-micron) particles.

Mesh pads can be designed to collect particles as small as about 5 microns at 99% efficiency while a chevron can collect particles down to about 10 microns at 99% efficiency. But since 99% of the entrainment droplets from sugar evaporators and pans are larger than 2 microns, chevrons are not at a disadvantage in this application. So, at least for sugar evaporators, there is no significant difference in collection efficiency between mesh pads and

Table I. Particle size comparison

Particle diameter, μm	0.01	0.1	1	10	100	1000
Electro-magnetic waves		Ultraviolet	Visible		Infrared	
Technical definitions	Solid	Fumes			Dust	
	Liquid	Mist			Spray	
Typical particles		Oil smokes			Fly ash	
		Tobacco smoke		Coal dust	Pollen	
	X-ray diffraction		Permeability		Visible to eye	
Evaporators with 25 in disengaging space		1% < 20 μm		20	50	
		10% < 50 μm			130	
		50% < 130 μm			240	
		90% < 240 μm			300	
		99% < 300 μm				
Elimination with 99% removal efficiency		Mesh (impaction or interception)				
		Chevron (impaction)				

Cyclones are generally limited to collecting relatively large particles, between 50 and 100 microns, and so they are usually not effective for evaporators and pans. Electrostatic precipitators would work well, but since their unique capabilities are not required for this application, their high cost is not justified. And fibred pads are cost-

chevrons, and this paper will concentrate on these mist eliminators.

It is relatively easy to select a mesh pad or chevron that will coalesce entrained droplets. But mere coalescing ability is only one of many factors that determine the effectiveness of mist eliminators. Mist eliminators must be

Paper presented to Sugar Industry Technologists, 1988

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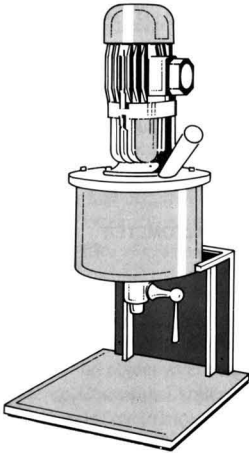
1. Report of Crystallographic Laboratory University of Utrecht, Holland.

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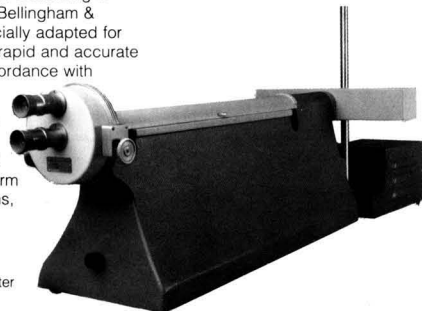


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2. E. Hugot - Handbook of Cane Sugar Engineering, 1960, p. 517

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selected on a basis of their total effect on the evaporation process. In fact, a mist eliminator can cause more harm than good if it is not correct for the application. So, in addition to entrainment collection efficiency, evaluation criteria for mist eliminators must also include:

- * Pressure drop (new and after time in place)
- * Capacity
- * Resistance to fouling
- * Ease of cleaning
- * Initial installed cost
- * Frequency, ease and cost of replacement

Entrainment collection

Any mist eliminator is merely a device that forces entrainment droplets to hit a solid object where they can coalesce. Centrifugal collectors use centrifugal force to move the drops to a wall. Impingement collectors use the gas velocity itself. If a gas stream containing liquid droplets has to turn a corner quickly, the droplets, having more inertia than individual gas molecules, will not make the turn as quickly; they will hit the corner, coalesce with other drops, and flow back down the duct.

That is exactly how mesh pads and chevrons work. They offer a tortuous path to the gas stream and lots of surface area for liquid coalescence. But they do it in different ways. Chevron (also called vane or baffle) mist eliminators consist of a labyrinth of flat surfaces. Many different configurations of surface size, shape, spacing and number of passes are available, each having different operating characteristics (Figure 1). Mesh mist eliminators are porous blankets of metal (or plastic) wire. Although they may look impervious to flow, their very small (0.006 - 0.01 in dia.) wires provide them with a void space as high as 98% (Figure 2).

There are two ways to specify the efficiency of an entrainment separator. You can measure the size and concentration of droplets in the evaporator's vapour stream and then specify the required collection percentage of each size range. Knowing the gas flow and allowable pressure drop, a mist eliminator can be guaranteed to meet

that performance specification.

However, measuring droplet size distribution, especially in the size range of 20 - 300 microns, is quite difficult, costly, and prone to inaccuracies. It is usually practical to develop such data only in the laboratory or pilot plant. More frequently, an experience-based performance specification is used. Based on the performance of various types of mist eliminators in a specific service (e.g. sugar evaporators), we can predict overall collection efficiency and pressure drop.

Pressure drop

Any mist eliminator naturally adds pressure drop to the vapour line. Unless minimized, this pressure drop can reduce evaporator efficiency and capacity.

In general, the more open the

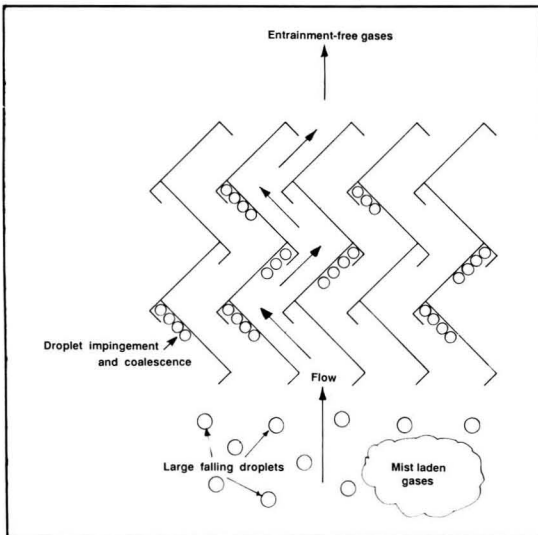


Fig. 1. The Chevron impingement principle

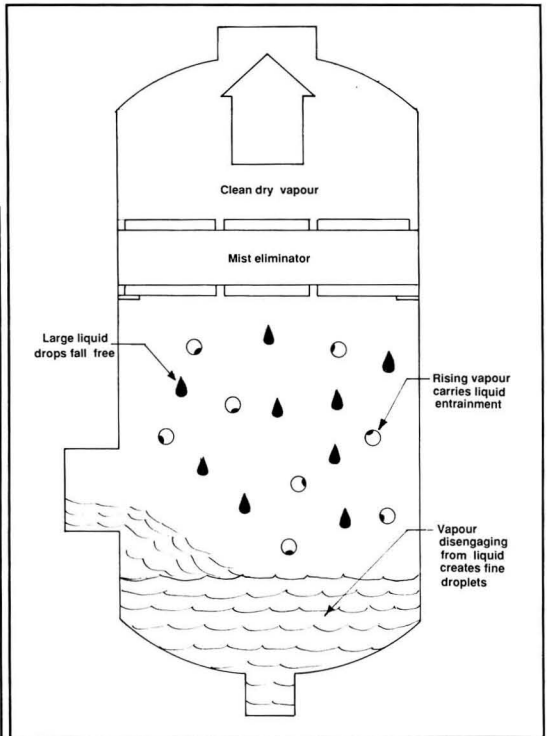


Fig. 2. How Fleximesh mist eliminators work

structure of a mist eliminator, the less its efficiency and pressure drop, the greater its resistance to fouling, and easier it is to clean. Chevrons generally have a more open structure than mesh pads, so they have a lower pressure drop at any design collection efficiency within their capacity range.

Theoretically, the pressure drop across a chevron should be proportional to the square of the gas rate, and operating experience does match the theory (Figure 3).

Capacity

Mesh pads act somewhat like a packed tower in that they can flood. Chevrons do not display this phenomenon. However, if the gas velocity is too high, (or liquid flow too high), the gas flow will inhibit liquid drainage. This causes additional liquid hold-up which further reduces the area for gas flow, causing further increases in gas velocity, pressure drop, and re-entrainment of the liquid. The level of liquid loading that causes this phenomenon can be predicted accurately for chevrons and, with less accuracy, for mesh pads as well. It is the maximum loading that determines the capacity of a mist eliminator. Since collection efficiency and pressure drop depend on liquid loading and velocity, efficiency curves have been developed as a function of gas velocity, loading and droplet size for various types of chevrons. Because chevrons depend on inertia to collect particles, higher gas velocities can increase collection efficiency so long as the liquid and gas flow rates are below maximum or critical conditions. In fact, at high gas velocities, some chevrons can capture 99% of small (10.0 micron) droplets as well as a mesh pad.

Fouling and cleaning

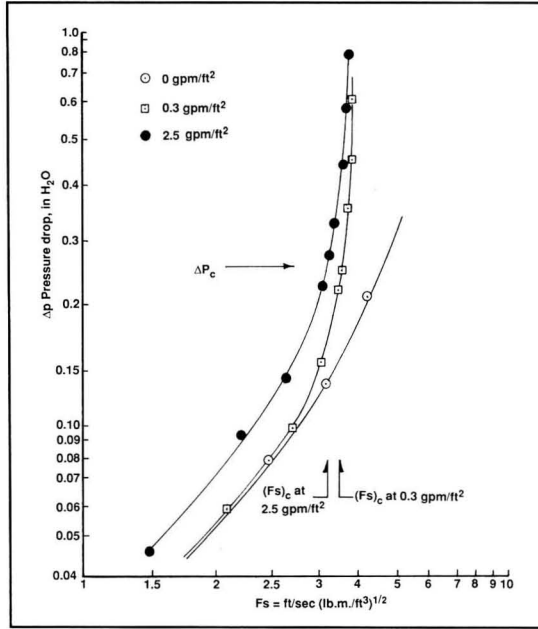


Fig. 3. Pressure drop vs Fs for typical chevron

Fouling of either a mesh pad or a chevron will increase pressure drop and eventually reduce collection efficiency as the internal gas velocity gets high enough to re-entrain coalesced liquid. Because of their open design, essentially

all designs of chevrons mist eliminators are more resistant to fouling than mesh pads. Even more important than fouling resistance is the cleanability of an entrainment separator after it has become fouled. Again, the more open the design, the easier a mist eliminator is to clean. Chevrons are not only more resistant to fouling than mesh pads, but they can be cleaned more easily. Also, their rigid structure makes them less susceptible to damage during installation, operation and maintenance. Mesh pads are not so readily cleaned because of the small maze of gas pathways. Some chevron designs are more resistant to fouling than others, however. Those with very tortuous gas paths and "hooks" – protrusions used to increase impingement and collect liquid –

are especially prone to fouling and are difficult to clean. And chevrons with textured surfaces foul more readily than those with smooth surfaces.

Predicting fouling is often futile, since one short-term process upset could plug an otherwise fouling-resistant mist

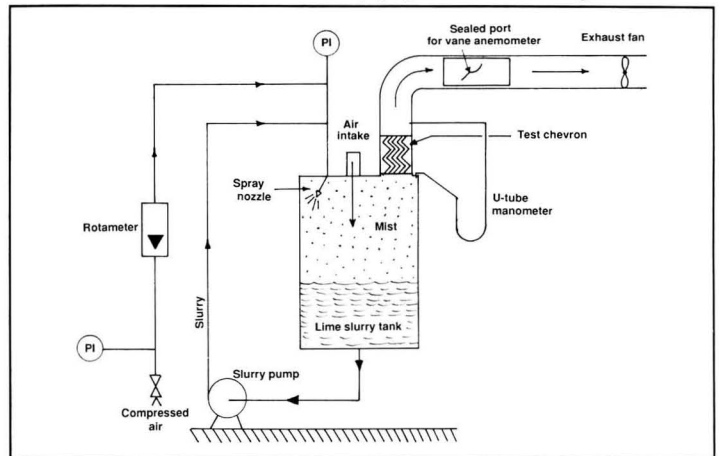


Fig. 4. Test systems for checking plugging resistance of chevrons

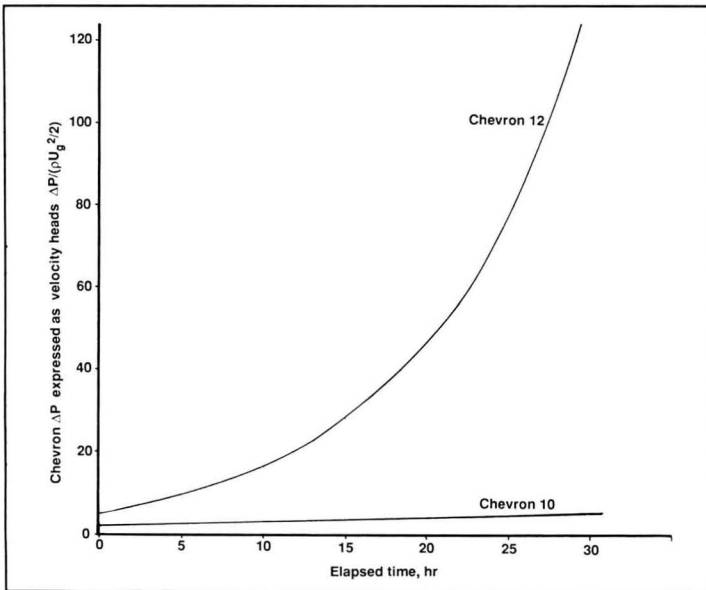


Fig. 5. Typical plugging test results

eliminator. However, the relative fouling tendencies of a mist eliminator can be determined experimentally using a standard test method (Figure 4).

Cost and maintenance

The installation costs of chevrons and mesh pads are about the same. They are both relatively simple to install and

in fact will often use an identical support system. But their first cost and life cycle costs differ significantly.

Mesh pads have the lower first cost, but their poor cleaning characteristics and high replacement frequency often result in a much higher life cycle cost. Chevrons have a considerably higher first cost than mesh pads, but

their ease of cleaning, the ability to inspect them to assure cleanliness, and their longer life can result in their having a lower life cycle cost than mesh pads for evaporator and pan applications.

Recommendations

Since overall collection efficiency and pressure drop can be quantitatively determined and guaranteed, it is easy to compare the value of various mist eliminator designs on those criteria. But fouling resistance is not so quantitative. However, relative fouling can be determined, and should be evaluated for each type of mist eliminator being considered for an installation.

This is because a fouled mist eliminator can cause product loss, pollution problems, reduced capacity, increased energy consumption, and even an unscheduled shut-down for cleaning or replacement.

Both chevrons and mesh pads are available that can provide equally high collection efficiencies for sugar evaporators and pans. But if fouling is a factor in selecting entrainment separators for a plant, then chevrons should probably be selected.

The cost of initial installation should be evaluated with the longer term cost of cleaning, maintenance and replacement to select the most appropriate mist eliminator for application.

Sucrose, sweetness and sucralose.

continued from page 31

gested as a possible contributor to the glucophore(s) in sucralose. A detailed investigation of the conformation of crystalline sucralose (57) using x-ray analysis⁶⁵ demonstrated an intramolecular hydrogen bond between the 2-hydroxyl and the 3'-hydroxyl (68). SIMPLE ¹H-n.m.r. spectroscopy⁶⁶ of four 1'-chloro-1'-deoxysucrose derivatives, including sucralose (57), in dimethyl sulphoxide, revealed the presence of an intramolecular 3'-OH.....O-2 hydrogen bond, in which the 3'-OH is the donor and 2-OH is the

acceptor hydroxyl group. This hydrogen bond stabilizes co-operative bonding in both glucosyl and fructoside units (3-OH ... 2-OH ... 3'-OH ... 4'-OH) (69).

The internally hydrogen bonded conformation (68) of these sucrose derivatives closely resembles the glucophore proposed for sucralose and sucrose (23) and would require the minimum energy to transform the sweetener to the doubly external hydrogen-bonded form attaching the sweet compound to the sweet sensitive protein (12). Suami¹⁹ has examined molecular models of this type of interaction, assuming that the protein is an α -helix

which is N-terminated by L-serine or L-threonine, a chiral receptor with NH₃⁺- and OH- groups acting as AH and B, respectively. The hydrophilic group then appears on the fourth amino-acid unit from the N-terminal of the protein. The models show quite clearly that under these circumstances the glucophoric groups (AH/B/X) must be clockwise on the sweet compound to match the similar array on the receptor protein; otherwise they do not engage in a three-point interaction.

continued on page 36

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ICUMSA News

Editor: R. Pieck

Twentieth Session, 1990

Members attending the 19th Session at Cannes in 1986 would be aware that the United States National Committee extended an invitation to our Commission to hold the 20th Session in their country. We have now been advised by Mr. John A. Richmond, Chairman USNC, that they propose to hold this meeting in Colorado Springs, Colorado, from 3rd to 8th June, 1990. The chairman of national committees have been asked to provide Mr. Richmond with an estimate of the numbers of members and accompanying spouses expecting to attend that meeting to assist planning. Readers contemplating attending the Colorado Springs meeting are urged to advise their national committee chairman.

General Referee G9 "Starch derived sweeteners"

Following extensive discussions with people engaged in the starch derived sweetener industry, the President is pleased to announce that the position of General Referee for Subject G9 has been offered to Dr. Brian Whitehouse, Manager Quality Assurance, Cerestar, Gruppo Ferruzzi. Dr. Whitehouse was nominated by the International Federation of Glucose Industries following discussions between their President, Mr. J. P. Anemaet, and Dr. G. Rens and Mr. J. Huberlant, representing ICUMSA. It is hoped that Dr. Whitehouse will be able to create a good working environment permitting collaboration between the various organizations with an interest in this subject. We look forward to his contributing his thoughts on how this can be done in a future issue of ICUMSA News.

Adoption of new sugar scale

Members will be aware that extensive publicity was given to the change in sugar scale from "degrees S" to "degrees Z" effective July 1, 1988. In addition to the press release published in most sugar journals, letters were sent to

the heads of international organizations affected by the change. There have been some instances where organizations using the sugar scale have been slow to make changes, either because of technical difficulties or an unwillingness to address the issues involved. National Committees and individual members are urged to do whatever they can to promote the adoption and understanding of the new scale. It would indeed be unfortunate if we have two scales, the old and new, in widespread use after a reasonable transition period. Those who know their history would not wish to see a repeat of the experience with the 1932 International Sugar Scale and the Ventzke scale it replaced.

ICUMSA represented at other meetings

At a conference on sugar and diversification, sponsored by UNIDO and held in Havana, Cuba, from 26th to 30th September 1988, ICUMSA was officially represented by Vice President Dulce Martinez who described the latest developments of our Commission. Dr. Roger Wood of the UK Ministry of Agriculture, Fisheries and Food presented a report on the analysis of sugars at the Inter-Agency meeting in Budapest on 10th and 11th November. The President, Dr. Murray Player, represented ICUMSA at the Eighth International Conference on legal metrology in Sydney on 23rd to 28th October.

Working Group's review of methods

By Mary An Godshall

In 1987, ICUMSA's Working Group on Collaborative Studies recommended that all existing ICUMSA methods be reviewed to determine which ones met the collaborative testing requirements. The group also recommended adopting IUPAC guidelines for collaborative tests as the criteria for reviewing the methods. The guidelines were published in the September 1987 and February 1988 issues of ICUMSA News.

The Methods Review Committee is under the purview of Subject 3 and

includes Mary An Godshall (USA), Chairman, Albert Emmerich (Germany), Guenter Pollach (Austria), Charles Ivin (Australia) and Roger Wood (England). Several General Referees have contributed suggestions and conducted their own reviews, which have been very helpful to this study and are gratefully acknowledged.

Schneider's "Sugar Analysis: ICUMSA Methods" served as a basis for the review, and every attempt was made to update all methods on subsequent recommendations that appeared in the 1978, and 1982 and 1986 Proceedings. It became evident during the review that some methods have been subjected to much higher standards of acceptance than others. The Working Group also believe that ICUMSA should adopt a formal numbering system for its methods to obviate the difficulties caused by using a variety of names for the same method.

The review showed that only sixteen methods fulfilled all the requirements for international recognition. Twelve of these are official ICUMSA methods and the other four enjoy tentative status and would be candidates for elevation to official status at the next session in 1990. Of the official methods which have been adequately tested are some of great commercial significance, namely the international sugar scale¹ and the polarization of raw sugar². Lane & Eynon reducing sugar methods³ were also approved though the working group commented that repeatability and reproducibility should be calculated and reported for the constant volume method. The Schäffler GLC method for sucrose in molasses⁴ was approved and this, together with the United Molasses modification of the Lane & Eynon method for determining total sugars, are important to the molasses trade.

Collaborative testing of methods for ash determination⁵ have been satisfactorily conducted though the test data were not presented in the referees' report. The method for lactic acid⁶ still requires the reporting of repeatability

and reproducibility data. The methods for citric acid⁷, visual appearance of white sugar⁸ and direct determination of pH⁹ were the official methods found to meet the IUPAC requirements.

The four tentatively approved methods which met international requirements for collaborative testing will be examined by general referees so that a case can be made for official recognition. They are the Dutton double polarimetric method for sucrose¹⁰, the transamination method for lactic acid¹¹, calcium phosphate in powdered sugar¹² and moisture in raw sugar¹³.

The remainder of the methods examined failed to meet international requirements either through there being insufficient collaborative test data or none at all. It was also thought that some methods should be deemed outdated on grounds that they have been replaced by other methods or have held tentative status beyond the allowed twelve years.

References

References are cited in abbreviated form. S-xx refers to page in Schneider, F. ed., (1979) "Sugar analysis: ICUMSA methods", ICUMSA, Peterborough. The other notation refers to the Proceedings year/page/recommendation that pertains to the method.

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- 11 1982/236/2
- 12 1986/230/5
- 13 1986/348/4

Subject 12. Rheology

By Ross Broadfoot
(Sugar Research Ltd., P.O. Box 689,
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Introduction

There are a number of areas where the measurement and definition of the rheological properties of materials within the sugar industry are of importance. For example, the rheology of molasses, syrup, invert sugar, etc. may influence its market acceptance and traded product value. Furthermore, in

factory processing, viscosity is a prime consideration in flow design of pipe-work for massecuite and molasses, in crystallizer operation and crystal-molasses separation in centrifugals. It is also of importance in mathematical modelling of process steps such as evaporation, crystallization, centrifuging and drying. The generally non-Newtonian nature of massecuites and molasses makes the measurement and specification of the rheology of these materials more complex than would be the case for Newtonian solutions.

Viscosity measurement of sugar solutions

Instruments for viscosity measurements in sugar solutions and massecuites involve four principles of measurement:

- (i) torque required to rotate an element at a fixed angular velocity in the sample; this is the basis of the rotating cylinder viscometer and is the only measurement procedure which has been officially adopted by ICUMSA. The method is an official procedure for molasses (not massecuite). Other rotational viscosimeters include those using the cone and plate configuration in either a rotating or oscillating mode;
- (ii) rate of fall of a calibrated sphere through the sample;
- (iii) damping effect of the viscous medium on the vibration of a thin plate element within the sample; and
- (iv) rate of flow of the material under pressure through pipeline and orifices.

Because massecuites and molasses often exhibit pseudoplastic flow behaviour, i.e. the viscosity of the material reduces as higher rates of shear are applied, it is necessary to define the shear conditions under which the viscosity is measured.

The flow behaviour of a material under a shear force is generally presented graphically as a plot of shear stress against rate. For Newtonian fluids a constant proportionality exists between the shear stress θ and the shear rate γ in laminar flow:

$$\theta = \mu \gamma$$

where: μ = viscosity of the fluid with SI units of Pa.s.

Work for the 20th Session

The main objective being pursued is to provide standard techniques for obtaining rheological data of interest to the sugar industry. At this time the General Referees involved with defining analytical methods for the various sugar products have not enunciated their requirements for viscosity measurements. It is expected that techniques for measuring the viscosity of molasses and massecuite will be called for. Until needs are defined there is no case for conducting collaborative tests of any of the available measurement techniques.

The Referee proposes to pursue the recommendations of the 19th Session which are principally concerned with establishing the pipeflow method as a standard technique for measuring the viscosity of massecuites. The Referee is anxious to hear from readers on industry needs for viscosity measurements so that the future program for Subject 12 can be more sharply focused.

Sucrose, sweetness and sucralose continued from page 35

The studies on chloro-sucroses have given some insight into the obscure complexities of the structure-activity relationships amongst sweet molecules, a challenging area of research that will require an understanding of the underlying physiological and neurological mechanisms and responses.

Acknowledgements

The author is indebted to the many research colleagues cited in the references to this paper for their experimental skills, interest and enthusiasm in studying the chemistry of sucrose, and especially Dr. Dick Richardson and Dr. Riaz Khan who have been associated with this research topic for many years. The research would not have been possible but for the continuous and enthusiastic support of the International Sugar Research Foundation (now the W.S.R.O.) and Tate & Lyle plc.

Product news

A break with the past

A basic pump design no manufacturer had changed since its inception ... a database identifying users' widely differing needs ... A new capability for computer aided design and manufacture ... These were major factors behind development by SSP Pumps Limited of the new SR range of positive, rotary-lobe pumps.

SSP have therefore "broken with the past" in the design concept for the SR range and for further new positive pump ranges. They embody the first truly modular design for pumps of this type and so offer precisely the right size and cost-effective specification for each individual installation.

Traditionally, manufacturers attempted to satisfy the wide variation in users' requirements for rotary-lobe pumps by modifying their standard models, continuing a pattern of engineering compromise that frequently resulted in problems of impaired performance, unreliability and high cost. "Spot-on" selection of SSP's SR pump specification can now be made to meet requirements of displacement, the best sealing arrangement, pressure and temperature, all of which vary throughout almost every process pumping duty. Similarly, the choice of SR pump facilitates optimum volumetric efficiency in transferring fluid products and materials with their diverse characteristics of viscosity, shear sensitivity, solids inclusion, abrasion, liquid/gas mixture, etc.

The SR range of pumps have 316 type stainless steel product contact parts and fulfil the broad spectrum of process pumping duties where hygienic and anti-corrosive operation are critical. It consists of six modular pump series: SR1 to SR6, progressing in size and covering flow rates from 5 litres/min to 160 cubic metres/hour, port sizes from 25 mm to 100 mm dia. and differential pressures up to 20 bar.

Each SR pump series offer two displacements by means of two rotor-

case sizes, for higher and lower displacements, respectively. Each SR pump series also has up to *three* gearbox options which mate with either rotorcase size. A "short" gearbox accommodates all the most commonly used shaft seals of generally simple type such as "O" rings, lip seals, packed glands and single mechanical seals on 316 type stainless steel shafts.

A "long" gearbox provides the extra length necessary to fit more complex sealing arrangements such as double mechanical seals and packed glands with lantern ring flush, again on 316 type stainless steel shafts. The third gearbox option facilitates the "high pressure" pump (up to 20 bar) options in each series. These gearboxes use duplex stainless steel shafts which have improved mechanical properties to accommodate the higher loads.

Six SR pump series with a "build selection" of 12 pumphed and 17 gearbox modules gives a choice of 34 SR pump models. But the benefit to the user is in paying only for what is needed in each case, without sacrificing anything in quality or performance.

This advantage of modularity has been made possible by SSP's computer aided design and production capability. Accuracy and repeatability in machining are key factors in achieving the necessary interchangeability of components and sub-assemblies.

Further information may be obtained from SSP Pumps Ltd., Birch Road, Eastbourne, East Sussex BN23 6PQ, England.

New universal water purity monitor

A new purity monitor/controller has been designed by Kent Industrial Measurements Ltd., for the continuous monitoring and control of electrolytic conductivity. The latest in a long line of conductivity instrumentation, the Model 5180 is a universal industrial instrument whose measuring capability extends from low and medium conductivity ranges for demineralized water, steam

condensate, raw water and cooling water, through rinse and washing water to higher conductivity ranges for weak acid and alkali solutions.

The unit operates by continuously monitoring the electrolytic conductivity of the water, which is proportional to the concentration of soluble inorganic compounds present. When the concentration reaches a prescribed level contacts within the controller may operate an alarm or a solenoid valve governing water flow.

Details are available from Kent Industrial Measurements Ltd., Howard Road, Eaton Socon, St. Neots, Huntingdon, England.

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Bagasse storage silos

The Weibull Reto silo is a result of the combined expertise of Weibull in storage technology and of Cuba in utilization and handling of bagasse. It permits bagasse to be stored and reclaimed with less energy requirement and less waste on less land, to act as a buffer between the mills and the boiler whereby bagasse can be delivered to the boilers independently of the crushing operation. Typical silos are of 600 to 3000 cu.m. capacity, with filling and reclaiming capacities of 80 - 800 tonnes/day. Operation can be totally automated, and alarm systems and air circulation offer protection against fire. The silos are described in a new leaflet available from Nils Weibull AB., P.O. Box 194, S-28101 Håssleholm, Sweden.

Facts and figures

CEFS move to Brussels

The European Committee of Sugar Manufacturers (Comité Européen des Fabricants de Sucre), the organization representing the interests of sugar producers in 14 countries of Western Europe, has moved from its former offices in Paris to 182 Avenue de Tervuren, B-1150 Brussels, Belgium.

Tate & Lyle expansion in European corn sweetener industry

Tate & Lyle PLC is to double its interest in Campo Ebro, Spain's second largest producers of starch and cereal sweeteners, including HFS. Amylum N.V., a Belgian company of which Tate & Lyle holds 63.3%, will pay 8983.1 million pesetas (£43.8 million) to raise its stake in Campo Ebro from 48% to 96.9%. The Spanish company has a milling capacity of 200,000 tonnes/year and its HFS quota is the second largest in the EEC, representing 15% of the total. The expansion is the latest in Tate & Lyle's moves to diversify away from its original UK sugar refining base and confirms the company's position as the world's largest sweeteners group.

CSR cane breeding operations to end?

CSR's General Manager for Sugar, Mr. John Noble, says the Australian company intends to continue plant breeding operations for only the next three years¹. During that time they will review the program with the help of CSIRO plant breeders and a panel of independent experts.

Bihar sugar factory leasing possibility

The Bihar State Sugar Corporation owns 14 of the state's 27 sugar factories and all suffer heavy losses². The State government is considering a proposal to lease out the factories to anyone who can manage them efficiently but in the meantime has set up a high-level committee to go into the causes of the losses and establish responsibility. The

Bihar State Sugar Corporation is seeking loans from the Industrial Development Bank of India and from the World Bank to finance modernization of the plants as well as for the improvement of cane cultivation, better infrastructure, etc.

Offer of Soviet agricultural machinery to the Philippines³

The Soviet Union has offered to provide agricultural machinery for the agrarian reform program in the Philippines in exchange for sugar and copra oil. The agricultural reform program has as its goal the redistribution of 5.4 million hectares (1.3 million acres) of land over ten years.

Sugar Research Institute technical conference⁴

Dr. Warren Gellie, Director of the Sugar Research Institute, told factory managers, engineers and other industry representatives that only small increments in cost efficiency could be expected from continuing to "hone and polish" current industry methods. He told the technical conference at Mackay, Queensland, Australia, in August last that any big advances were more likely to come as a spin-off from innovative materials and techniques being developed for other industries. As part of a 5-year plan, the SRI is seeking contract research and consultancy but also had a research program focusing on ways to reduce factory staffing and maintenance costs, reduction of harvest and transport costs, continuous crushing and factory rationalization, minimization of energy and steam usage, maximizing the value of the whole cane plant, and investigation of new opportunities.

Australian sugar refinery fire⁵

The CSR sugar refinery in Brisbane was damaged by a fire which caused the loss of some 5000 - 10,000 tonnes of raw sugar. An official said that he had not been able to find out the exact losses or whether the damaged raw sugar could be salvaged.

Experimental cane alcohol plant on a South African farm⁶

The first experimental pilot plant to produce fuel alcohol from sugar cane on a farm was officially opened by the South African Minister of Economic Affairs and Technology in September 1988. The plant was built after a group of farmers received permission to build their own for manufacture of alcohol from cane to be used as fuel in their own tractors but not for resale to the general public. The local Ford tractor distributors modified a machine to use alcohol, while a production tractor was imported from Brazil to carry out further field tests. The experimental unit will allow further assessment before proceeding to construction of a full scale, 5000 litres/day plant, which will cost R 500,000.

Mozambique sugar factory rehabilitation⁷

Mozambique is to rehabilitate the Mafambise sugar factory with the help of a loan of \$45 million from the African Development Bank.

East Germany sugar deficit forecast⁸

Following the dry spring and virus yellows infection, the beet sucrose content and sugar yield this campaign are described as catastrophically low. As a consequence a deficit of 100,000 tonnes of white sugar is expected by comparison with the planned output.

Bulk sugar terminal in Holland⁹

Suiker Unie, the Dutch sugar cooperative, opened a bulk sugar export terminal in October at Eemshaven on the northern tip of the country. Previously, sugar was handled in the traditional way using pallets and bags. The new terminal is very favourably situated geographically

1 *Australian Cane Grower*, 1988, 10, (9), 1.

2 *Indian Sugar*, 1988, 38, 248.

3 *La Ind. Azuc.*, 1988, 94, (1046), 34.

4 *Australian Cane Grower*, 1988, 10, (11), 5.

5 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 594.

6 *S. African Sugar J.*, 1988, 72, 331.

7 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 592.

8 *Zuckerind.*, 1988, 113, 1004.

9 F. O. Licht, *Int. Sugar Rpt.*, 1988, 120, 607.

Make a date		
When?	Who?	Where?
February 9/10, 1989	American Society of Sugar Cane Technologists, Knapp Hall, Louisiana State University, Baton Rouge, LA 70803, U.S.A.	Bellemont Motor Hotel, Baton Rouge, LA.
February 26/March 2, 1989	American Society of Sugar Beet Technologists, Boulevard, Suite 107, Fort Collins, CO 80526, U.S.A.	Hyatt Regency Hotel, New Orleans, LA. 2301 Research
April 12, 1989	British Society of Sugar Cane Technologists, c/o Booker Tate Ltd., Masters Court, Church Road, Thame, Oxon. OX9 3FA.	Royal Commonwealth Society, London.
May 1989	Sugar Industry Technologists Inc., P.O. Box 632, Ste.-Thérèse de Blainville, Quebec, Canada J7E 4K3.	New Orleans, Louisiana
May 2/5, 1989	Australian Society of Sugar Cane Technologists, c/o Sugar Research Institute, Box 5611, Mackay Mail Centre, Queensland 4740.	Twin Towns Services Club, Tweed Heads, NSW.
June 5/8, 1989	South African Sugar Technologists Association, c/o S.A.S.A. Experiment Station, Mount Edgecombe, Natal, South Africa 4300.	Elangeni Hotel, Durban
June 14/16, 1989	American Society of Sugar Cane Technologists, Knapp Hall, Louisiana State University, Baton Rouge, LA 70803, U.S.A.	Sheraton Hotel, New Orleans, LA.
October 12/21, 1989	International Society of Sugar Cane Technologists, c/o STAB, C.P. 532, Piracicaba, SP, Brazil 13400.	São Paulo, Brazil.
November 1989	British Society of Sugar Cane Technologists, c/o Booker Tate Ltd., Masters Court, Church Road, Thame, Oxon. OX9 3FA.	London.

as far as the German market is concerned. It has a bulk sugar capacity of 100,000 tonnes and an equal capacity for packaged sugar¹⁰, and these can be handled at rates of 10,000 tonnes per day, respectively.

Distillery project for Sri Lanka

Pelwatte Sugar Company, part-owned and managed by Booker Tate Ltd. of the UK, is negotiating with the National Development Bank to set up a separate joint venture to operate a distillery. The company's sugar factory at Pelwatte, near Buttala, has accumulated a stock of about 18,000 tonnes of molasses over the past year and a half and more is expected as the factory receives more cane and can reach its sugar production capacity of 45,000 tonnes a year. The capital investment in the new venture is expected to be in the region of 250 million rupees and the Bank is reported

to be ready to help with the finance package.

PERSONAL NOTES

The death has occurred of **Dr. Ir. Karoly Hangyal** following a car accident. He was born in 1928 in Sarkad, Hungary, and studied at the University of Budapest. A chemical engineer, he worked for some years at the Ercs and Selyp sugar factories and in 1977 became General Director of the Sugar Processing Research Institute in Szolnok. He was the author of many scientific papers and also led ICUMSA activities in Hungary. In 1985, in collaboration with Professor K. Vukov, he organized a meeting of the Scientific Committee of the CITS in Budapest and in 1987 was nominated a member of that Committee. His death is a considerable loss to the Hungarian sugar industry and to the international community of sugar technologists.

Dr. Colin Ryan has been appointed Deputy Director of the Bureau of Sugar Experiment Stations in Australia, in succession to **Ken Leverington**, who recently retired after more than 44 years service. Dr. Ryan joined the Bureau in 1974 after working as a technical field officer for CSR Limited. Originally part of the plant pathology team, he was appointed research coordinator in 1986.

Brian T. Roach, CSR's Chief Field Technical Officer in the Herbert River district and a veteran expert in sugar cane breeding, retired in September. He has contributed many technical papers on his speciality to both the Australian and International Societies of Sugar Cane Technologists as well as to publications such as *Sugar Cane*.

Pete J. deGravelles, a cane farmer of Franklin, Louisiana, has been appointed General Manager of the American Sugar Cane League, succeeding **J. Kelly Nix** who recently resigned.

¹⁰ *Zuckerindustrie*, 1988, 113, 1073.

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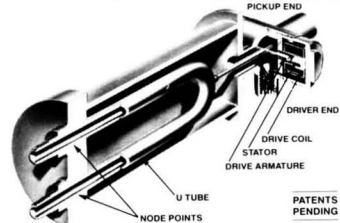
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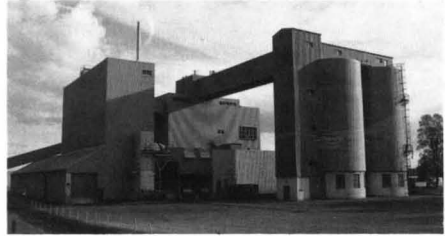
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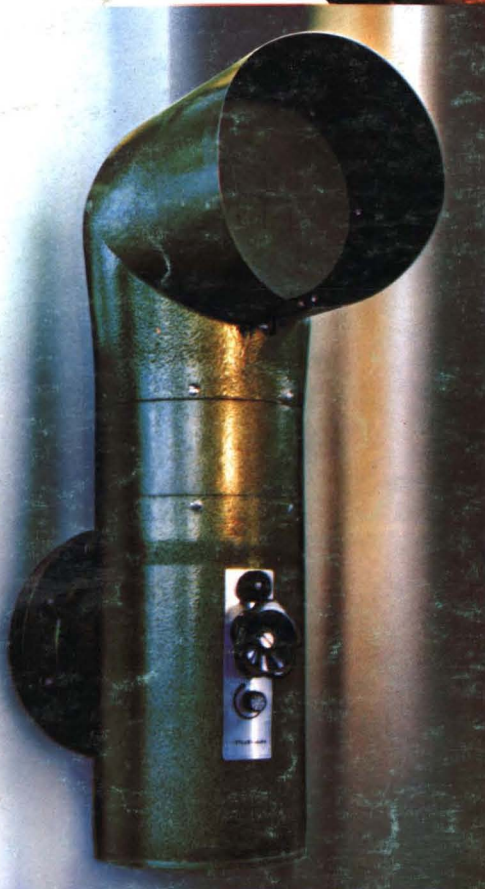
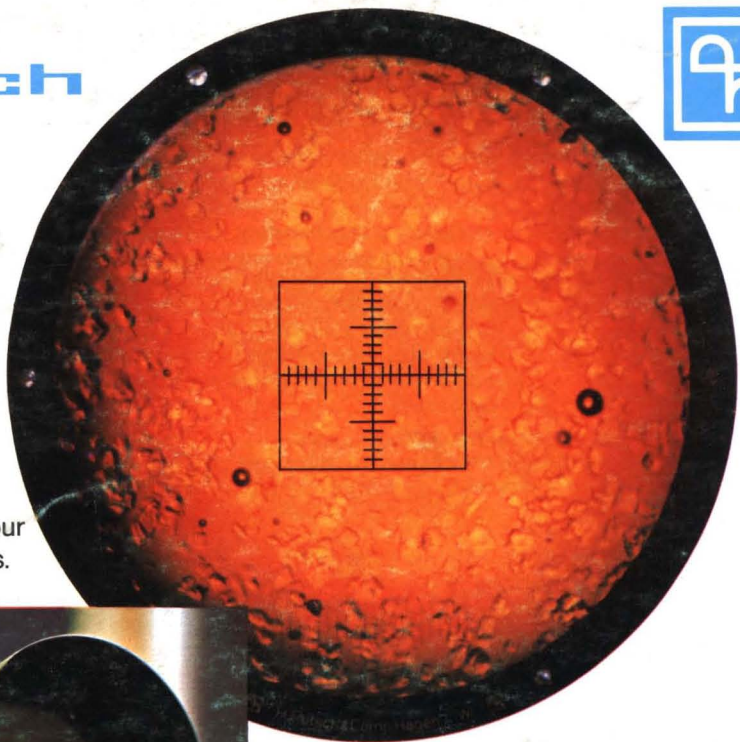
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