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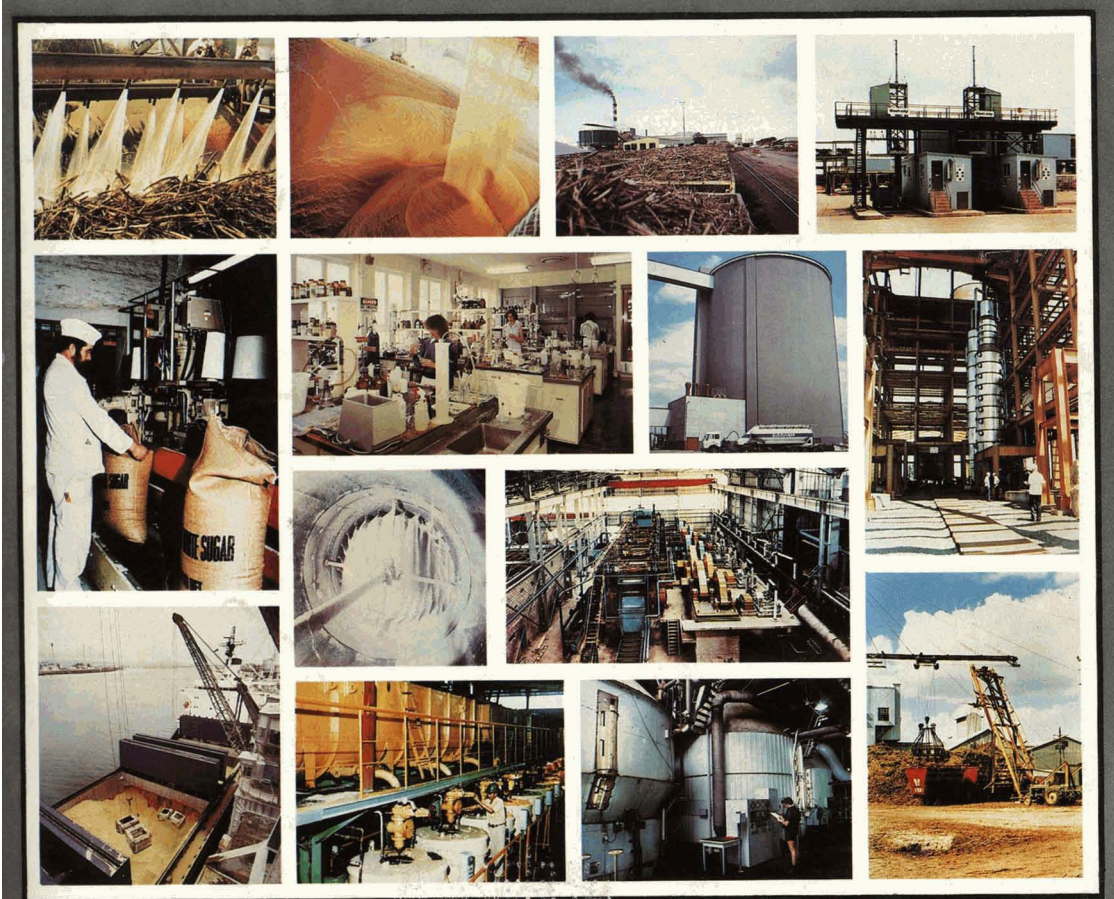

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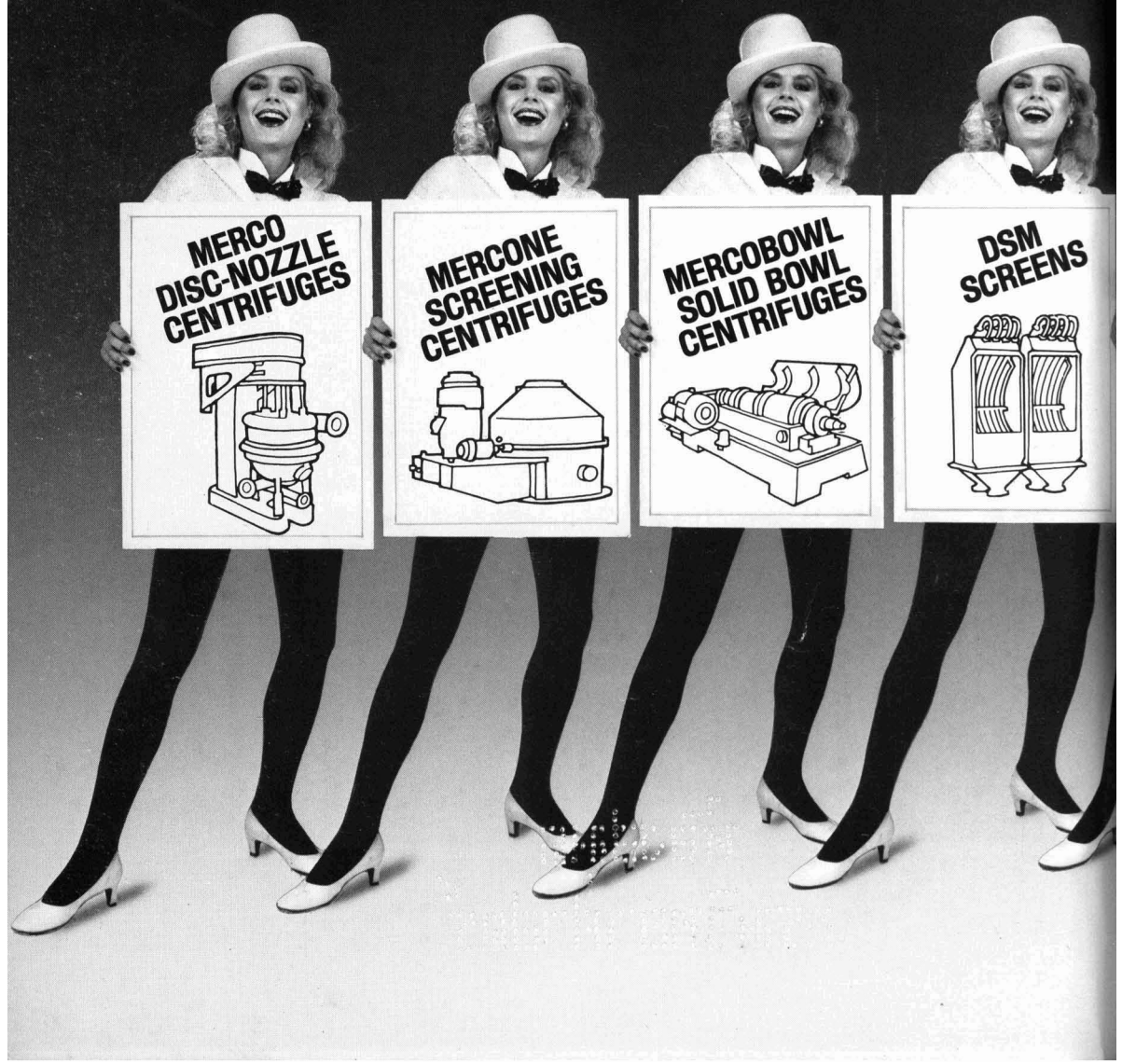

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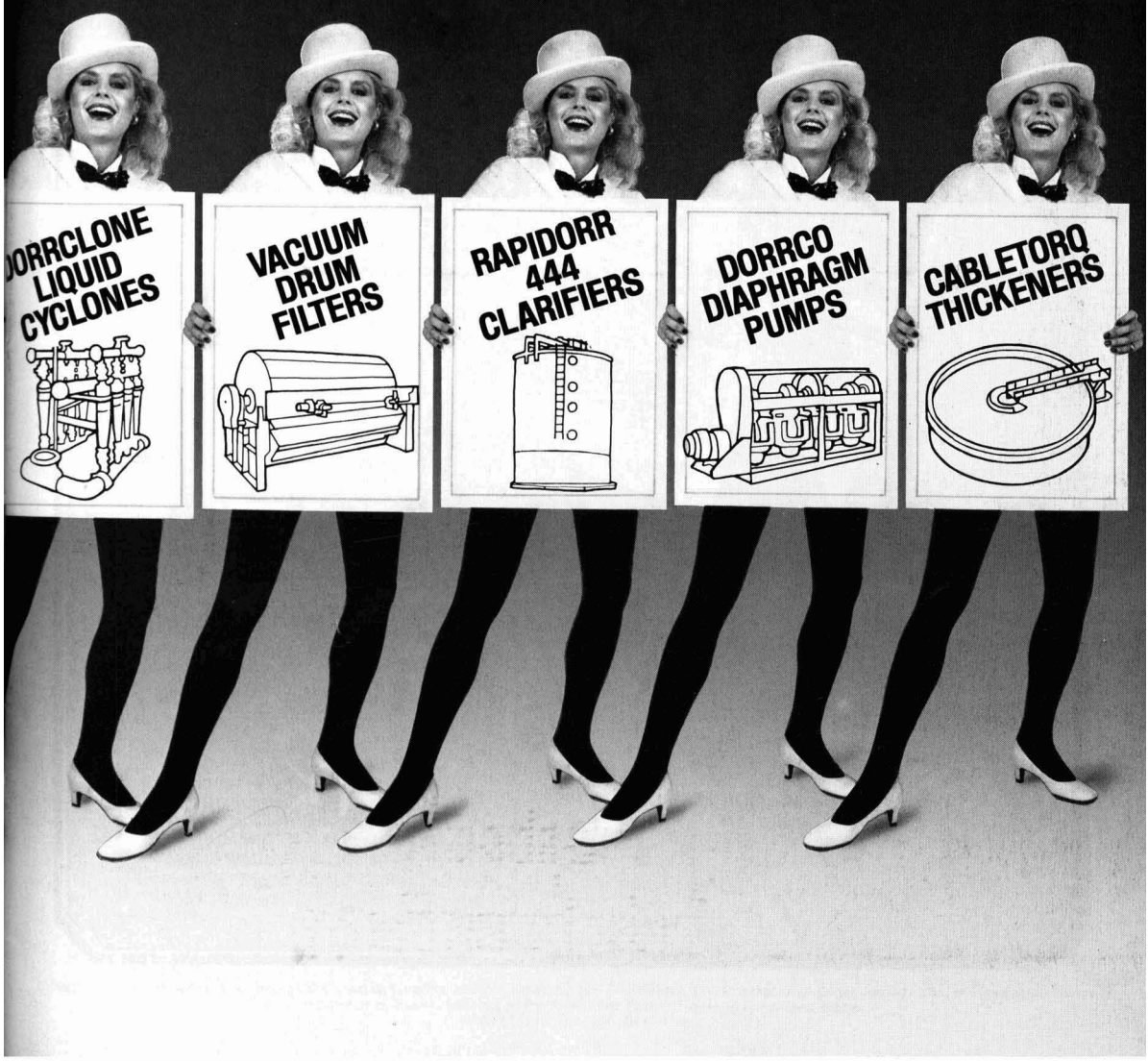

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NOTES AND COMMENTS

International Sugar Agreement[1]

Informal discussions were held at the beginning of July by the Consultative Group set up at the May International Sugar Conference and consisting of 12 leading exporters and 6 leading importers. Their meeting closed with the Chairman, Sr. Jorge Zorreguieta of Argentina, putting forward a paper giving a broad outline of a regulatory mechanism for a new ISA which in his view was likely to find the widest degree of acceptance among delegates. The paper draws upon elements and suggestions from several delegations; both Australia and Brazil had put forward proposals to be considered by the Group and it was interesting that the former had more or less accepted that prices should be controlled by a stocks mechanism, as proposed by the EEC, rather than by the quota mechanism of previous Agreements.

The Chairman's draft indicated that small producers which currently comprise the Annex II group of the present ISA and receive an export entitlement of 70,000 tonnes, raw value, per annum are to maintain their status, although it seems likely that the entitlement would be increased in a new Agreement whereupon more countries would be encompassed by the group.

Recognizing the gradual acceptance of the EEC's insistence upon stocking procedures, it is proposed that all exporters larger than those in this first group will be subject to stock control measures. There is the proviso that, of this group of exporters, those in an intermediate category should not as a result of the proposal have any worse terms than they enjoy at present. Presumably this refers to those countries in the middle group in the EEC scheme which currently export up to 500,000 tonnes a year and which, it was envisaged, would have been granted export quotas similar to those existing at present.

It is proposed that there will be a range of trigger points, yet to be negotiated. These will encompass a zone in which no specific ISA action is called for although there would be urgent discussions with a view to initiating cooperative action to halt the market trend should prices approach the limits of this zone.

A Reference Export Availability (REA) is to be established for each exporter in this group and in a falling market, when the ISA price falls to the first trigger point below the zone of inaction, exporters are to withdraw from the market any sugar in excess of their REA. Such sugar is to be designated "surplus stock" or may be channelled into non-food uses.

If the market falls to a second trigger point further stocks are to be put aside. These will be called "security stocks" and could be removed in stages but the obligations are to be based upon set proportions which will need to be negotiated by the conference in Geneva. At a third and lower trigger point "additional stocks" are to be removed from the market. In total these will be based on a collective decision but the amount decided will be shared on the same basis as security stocks.

In a rising market the first two trigger points above the zone of inaction each call for release of half the security stocks and half the additional stocks, if any. At the third and highest trigger point any surplus stocks are to be released.

It is understood that these proposals for a regulatory mechanism were well received and delegations will now be reporting back to their respective governments. The foundations of a new International Sugar Agreement could well have been laid at the meetings in London in July but a successful outcome will depend upon the same spirit of cooperation noted by Sr. Zorreguieta carrying through the full negotiating session or sessions in Geneva. It has been announced that these will take place between September 12 and 30.

If a single approach can be adopted at an early stage in these negotiations, work should be able to proceed much more rapidly than during the first session in May. In fact negotiations will need to be conducted in parallel with final drafting work if an agreement is to be achieved by September 30, though it is understood that UNCTAD has provisionally earmarked a further session should it be needed.

The ISA Secretariat is currently drawing up draft articles for a new Agreement. Some of these can presumably be put into a definitive state, though others will have to allow for possible alternatives which will emerge through the course of negotiations.

There have been suggestions that the ISA year should be changed and, indeed, if a further session is required it would surely be advantageous to commence a new ISA as soon as possible thereafter without waiting for the start of a new calendar year, quite apart from the fact that this would eliminate all the intrinsic faults which are entailed in the use of a calendar year, which cuts across so many sugar crops, as the ISA year.

India and the EEC[2]

The Indian Commerce Minister announced in Parliament that India has requested the EEC to restore the 25,000-tonnes preferential sugar quota which has been suspended since 1980/81. The Minister said that the EEC, which suspended the quota because India failed to sell its allotted quota because of the steep fall in 1979/80 domestic production, had not yet taken a decision on the Indian request.

World sugar prices

India returned to the world market during the first half of July and disposed of a considerable quantity of white sugar. It was packed in 100-kg jute bags for the most part, however, and these are not a popular form of packing, so the prices obtained were on the low side. This, generally quiet conditions and a lack of confidence resulted in a slide in sugar prices, whereby the LDP fell from £172 on July 1 to £153.50 by July 19 with the LDP(W) dropping from £200 to £181 per tonne in the same period. The US administration's permission for tolling operations and so a greater availability of white sugar was a further contribution as were reports that the USSR beet crop was in better condition than in recent years at the same time of year.

Having reached such low levels, the price awakened new buying interest and the price started to climb again. The current dry spell in Western Europe was reported to be having a harmful effect on the beet crop, which further strengthened the market as did reports of purchases of both raw and refined sugar by the USSR to replace shortfalls in Cuban supplies. Further disquieting reports of beet crops in Europe probably lower than expected

[1] C. Czarnikow Ltd., *Sugar Review*, 1983, (1657), 125-126.
[2] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 247.

again sent the market up while the existence of large stocks was counterbalanced by optimism over a new International Sugar Agreement so that, apart from a small reduction when news came of rain which had broken the South African drought, the LDP rose steadily to finish the month at £180 and the LDP(W) at £202.25 per tonne.

Syria sugar situation[1]

1982 official statistics show that Syrian sugar consumption increased from 336,000 tonnes in 1981 to 350,000 tonnnes in 1982. Imports of white sugar were 200,000 tonnes last year, against 203,000 tonnes in 1981, while imports of Cuban sugar rose from 73,000 to 80,000 tonnes. The Cuban sugar was refined at the local beet sugar factories of Adra, Homs, Jisr el-Shoughour, Tal Salhab, Deir al-Zor, Meskeneh and Raqqa, while 60,000 tonnes of white sugar was produced locally from beets. The beet crop harvested, at 850,000 tonnes, represents a useful advance on the 750,000 tonnes harvested in 1981/82, but the outturn implies an extraction rate of only 7% against an average of 10% and a target of 12%. Problems at the factories cannot be ruled out since the last four of those mentioned above have only recently been commissioned, while the other three have been in the throes of expansion programs. However, a more likely cause is the poor quality of the beet itself; sugar beet is a comparatively new crop for Syrian farmers and, agronomically speaking, conditions are not ideal for its cultivation.

Morocco sugar import problem[2]

It is reported that Morocco is unable to buy sugar from leading international traders who are refusing supplies while an arbitration award against it is not honoured, although there is no danger of Morocco running out of sugar.

The Moroccan National Office of Tea and Sugar has not paid $10.6 million plus interest at 18.5% a year, to Philippine Sugar Trading (London), the British office of the Philippine government company. The Council of the Sugar Association of London, acting as arbitrator, found in April last that Morocco had refused in April 1981 to take delivery of three cargoes, totalling 33,000 tonnes of sugar. This was part of a 100,000-tonne contract agreed in May 1980 and the Office argued *force majeure,* claiming it had been instructed by the Moroccan government not to take delivery. The argument was rejected by the arbitrators and court appeals in both Britain and Morocco also failed.

Sugar trade sources say that the real problem was that, by the delivery date, sugar prices had fallen well below those contracted, e.g. from $890 to $456 for the first cargo. Because Morocco buys a long time ahead, currently outstanding contracts could be stretched out, and Morocco's own crop is available between April and September. But the traders have closed ranks against agreeing to new contracts and no offers were made in reply to a recent Moroccan tender for 14,000 tonnes.

EEC sugar marketing policy and sugar prices

Cie. Commerciale Sucres et Denrées S.A. of France (SUCDEN) published a report recently in which they assessed factors which had affected sugar prices over the past year and considered future prospects. They predict a fall of some 5 million tonnes in world sugar production but put consumption at about the same in the coming year as in the past one, because availabilities have stimulated considerable increases in India and Pakistan which offset the reduction in North America and Japan sugar consumption because of inroads made by HFCS. Raw sugar is expected to be in approximate balance between supply and demand, but demand for white sugar is expected to rise in countries such as Indonesia, Nigeria, Iran, Algeria and others, while the poor prospects for the European crop indicate a shortfall of some 1,700,000 tonnes. India is not likely to help since its exports are limited by high cost of production and by the ISA quota.

The shortfall could be met by release of C-sugar by EEC producers and by release of sugar withheld by the Brussels authorities. However, whether this is likely is a different matter since the stocks were established in an effort to improve prices. Further, the EEC is in negotiation with other exporters over a new ISA and, as C. Czarnikow Ltd. point out[3], any suggestion that the Community was not itself prepared to hold its fair share of stocks (an important part of the EEC's own proposals for a new Agreement) might lead to an erosion of confidence on the part of the other countries as to the real acceptance by the Community of the need for sacrifices to achieve a new ISA. This in turn might lead to a failure in the negotiations.

Thus retention of the EEC's stocks could promote higher white sugar prices as would an early successful conclusion of an agreement at the next conference session in Geneva in September.

Brazil sugar sales to Venezuela[4]

The Brazilian Sugar and Alcohol Institute has announced that Brazil will re-start sales of 173,000 tonnes of raw sugar to Venezuela by December. This quantity is part of a 600,000-tonne sale which was negotiated two years ago and which was to extend over three years; however, sales were suspended in February last because Venezuela had not paid for the sugar. Recently, Interbras, the semi-government-owned trading company, intervened in the negotiations and managed to obtain $100 million in back-payments, leaving $80 million unpaid.

The original contract negotiated in 1980 involved a fixed minimum price of 25 cents/lb but Brazil has agreed to renegotiate with a new minimum price of 20 cents/lb and payment may be made by means of Brazilian purchases of Venezuelan petroleum.

South African drought

It is ironic that after a season which produced record results, the South African sugar industry has been suffering from severe drought which has been estimated to reduce the likely 1983/84 crop to well below 2,000,000 tonnes and a figure of even as low as 1.5 million tonnes has been suggested. In order to meet its export commitments, South Africa has bought 100,000 tonnes of raws from Swaziland and has also bought the same quantity of white sugar from Brazil, South Korea and elsewhere so that domestic consumption does not reduce availability of its own high-quality raws. Customers have been asked to accept supplies from other origins, in addition. Fortunately, rains were reported to have fallen but too late to save the devastated crop in Zululand.

Bangladesh sugar production increase[5]. — The Bangladesh Food and Sugar Industries Corporation has again exceeded its target for sugar production this year, passing the target of 177,800 tonnes in early April by more than 3500 tonnes.

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1 F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 256.
2 *The Times,* July 15, 1983.
3 *Sugar Review,* 1983, (1658), 129-130.
4 F. O. Licht, *International Sugar Rpt.,* 1983, **115**, 400-401.
5 *Standard Chartered Review,* June 1983, 23.

Calculated form of the sucrose crystal

By MICHAEL SASKA
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Georgia 30332, USA)

Introduction

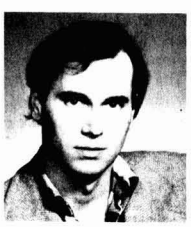
The equilibrium form of a crystal at constant pressure and temperature is that which minimizes the total Gibbs free energy of the system. If we assume that the (solid) volume free energy does not change much with the crystal shape (keeping the crystal volume constant) — and such changes would be difficult to estimate — the equilibrium shape will minimize the sum

$$\sum_i \gamma_i S_i \qquad (1)$$

where γ_i is the surface free energy and S_i the area of a face i and the summation extends over all faces. Forms complying with the condition (1) have actually been observed and some instances are described by Kern[1, 2], among others.

Crystals, though, are almost always products of a finite rate growth accounted for by the deviation of the system solvent-crystal from the thermodynamic equilibrium. It is therefore not surprising that the actual crystals differ markedly from those predicted by condition (1), usually exhibiting fewer faces and of less isometric habit in general.

The crystal growth mechanism consists of several consecutive steps starting with diffusion of growth units towards the solid-liquid interphase, (partial) desolvation (and diffusion of the freed solvent back into the volume) followed by a series of processes taking place in the (adsorbed) layer in the immediate vicinity of the growing crystal, with the growth unit incorporation into the lattice as the final step. Since none of these consecutive processes can be by-passed it is the slowest one which determines the overall rate. In the surface-diffusional theory of Burton, Cabrera & Frank such a step is the mobility of growth units in the adsorbed layer; the model leads to the growth rate (cm.sec^{-1}) $R \sim \sigma^2$ for small supersaturations σ (%) and $R \sim \sigma$ for large values of σ. Even though the effects of the volume diffusion cannot be completely neglected, particularly at high temperatures, as found in the case of sucrose[3, 4], the mechanism described above was found[4] compatible* with the data on sucrose crystallization rate[5, 6] for a wide temperature range.



M. Saska

A relationship was demonstrated recently[7] between the growth velocity R (cm.sec^{-1}) of a crystal plane and a parameter E, the so-called attachment energy of that face which (with some approximation) can be taken as equal to half the energy required to split the crystal along the particular plane. Such a parameter can be calculated (again approximately) knowing the crystallographic structure of the substance (sucrose) and a (potential) function describing the force field between two atoms as a function of their distance. The surface free energy can be calculated as

$$\gamma = ZE/M \qquad (2)$$

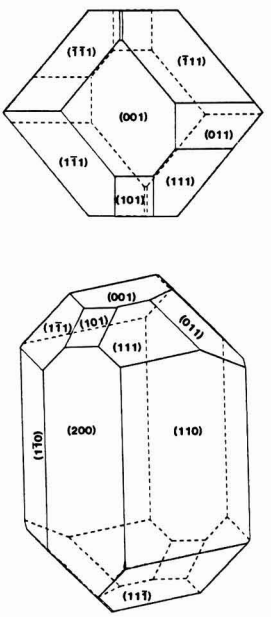


Fig. 1. Equilibrium form of the sucrose crystal

* A contradicting report has also been published[3] but the supporting evidence does not seem convincing.

1 Kern: "Growth of Crystals," Vol. 8 Ed. N. N. Sheftal, 1969.
2 Bienfait & Kern: *Bull. Soc. Franç. Miner. Crist.*, 1964, **87**, 604.
3 VanHook: *J. Crystal Growth*, 1969, **5**, 305.
4 Bennema: *ibid.*, 1968, **4**, 331.
5 Smythe: *Australian J. Chem.*, 1967, **20**, 1087.
6 Idem: *Proc. 10th Congr. ISSCT*, 1959, 323-336.
7 Hartman & Bennema: *J. Crystal Growth*, 1980, **49**, 145.
8 Saska & Myerson: to be published.
9 Kitaigorodski & Ahmed: *Acta Cryst.*, 1972, **A28**, 207.
10 Hartman: *J. Crystal Growth*, 1980, **49**, 157.
11 Idem: *ibid.*, 166.

where Z is the number of formula units per unit cell (2 for sucrose) and M, the mesh area of the face. More detail on the method and approximations involved can be found in the literature for sucrose[8], anthracene[9], tin tetraiodide and orthorhombic sulphur[10] and corundum[11] among others.

It is our purpose here to present the results of our recent calculations[8] for sucrose and compare the resulting shapes with the familiar sucrose forms.

Results and discussion

The equilibrium form (taking $R \sim \gamma$) of a sucrose crystal is shown in Figure 1. The crystal is elongated along the c direction with prominent (110) and $(1\bar{1}0)$ faces comprising almost 40% of the total surface (Table I). The faces (111), $(1\bar{1}1)$, $(11\bar{1})$ and (011) are large by comparison with those observed in practice†. The calculated surface energies γ are listed in Table II. Those corrected for solvent adsorption (see later) agree reasonably well with the estimates[12] based on various physical properties of the sucrose-water system.

Table I. Relative areas of individual faces on the average Kukharenko crystal (Figure 4) and the calculated forms. 1. Equilibrium sucrose crystal form. 2. Equilibrium sucrose form corrected for water adsorption. 3. Growth form ($R \sim E$).

Face	Kukharenko	1	2	3
$(\underline{2}00)$‡	15.21	8.40	4.63	18.02
(200)	14.44	8.40	4.63	18.02
(001)	8.74	4.20	6.90	11.57
$(00\bar{1})$	8.94	4.20	6.90	11.57
$(\underline{1}0\underline{1})$	1.42	0.90	4.20	–
$(\bar{1}0\underline{1})$	2.13	0.90	4.20	–
$(1\bar{1}0)$	5.38	10.01	4.96	9.69
$(\bar{1}10)$	8.22	10.01	4.96	9.69
$(\underline{1}\underline{1}0)$	8.48	11.05	5.95	9.84
$(\bar{1}\underline{1}0)$	7.62	11.05	5.95	9.84
$(0\bar{1}1)$	1.47	–	–	–
$(01\bar{1})$	1.08	1.94	2.54	0.68
$(\bar{1}\underline{1}\underline{1})$	1.75	–	5.79	–
$(\bar{1}\bar{1}\underline{1})$	0.45	2.20	3.75	–
$(\bar{1}0\underline{1})$	7.13	0.04	1.25	–
$(10\bar{1})$	7.55	0.04	1.25	–
(011)	–	1.94	2.54	0.68
(111)	–	2.20	3.75	–
$(\bar{1}11)$	–	4.28	5.22	0.21
$(1\bar{1}\bar{1})$	–	4.28	5.22	0.21
$(\bar{1}1\bar{1})$	–	3.83	5.79	–
$(11\bar{1})$	–	3.14	4.81	–
$(\bar{1}\bar{1}1)$	–	3.14	4.81	–

‡ Since the sucrose structure parallel to the (100) plane is composed of two alternating planes which we may call the glucose and fructose planes depending on which unit is exposed predominantly it was assumed that only the former ones (of a lower surface energy) are to be found on an equilibrium crystal. The glucose planes are the (200) planes for which the distance from the axial origin $h = n\,d_{200}$, where d_{200} is the interplanar spacing (5.3 A) and n = 1, 3, 5, . . . It is possible that for a growth form ($R \sim E$) the attachment energy E should be taken as an intermediate value between E_{100} and E_{200}.

Table II. Calculated surface energies (erg.cm^{-2}) of the sucrose crystal faces. 1. Equilibrium sucrose crystal. 2. Equilibrium sucrose crystal form corrected for water adsorption

Face	1	2
(200)	567.78	644.17
(001)	811.31	485.34
(110)	549.79	604.73
$(1\bar{1}0)$	549.79	604.73
(011)	763.91	570.36
$(0\bar{1}1)$	879.46	666.38
$(10\underline{1})$	782.97	496.80
$(10\bar{1})$	1007.85	691.88
(111)	718.24	532.51
$(\bar{1}11)$	751.59	588.26
$(1\bar{1}1)$	714.22	527.02
$(11\bar{1})$	835.13	630.24

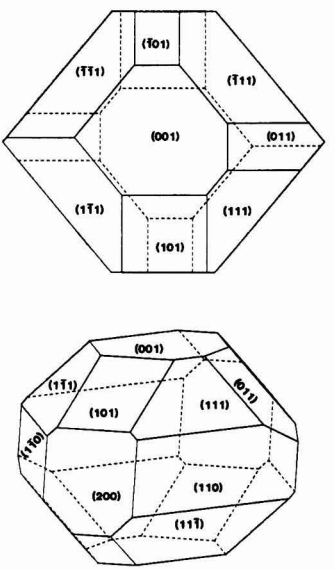
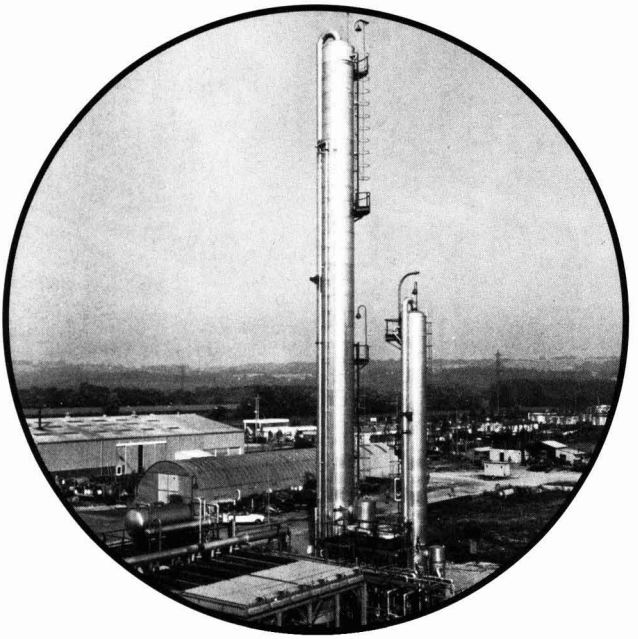


Fig. 2. Equilibrium form of the sucrose crystal considering water adsorption

Since solution growth is invariably the way to crystallize sucrose we attempted to estimate the effects of solvent which must be substantial by analogy with similar systems. The adsorbate (solvent, impurity or the growth units themselves) will effectively lower the interfacial tension (Gibbs adsorption isotherm). We assumed that the change is proportional to the number of hydrogen bonding sites n per unit cell on that particular face and the energy E_{WS} of the water-sucrose surface interaction

† Even though some of the faces have never been observed on a sucrose crystal [i.e. $(\bar{1}11)$, $(\bar{1}1\bar{1})$ and $(\bar{1}\bar{1}1)$[11,12] we considered it rigorous to calculate the energy parameters for all possible low index combinations and thus explain or question their absence.

12 VanHook & Kilmartin: *Z. Elektrochemie,* 1952, **56**, 268.



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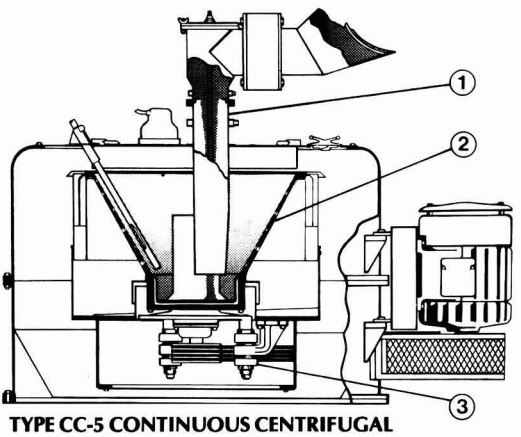

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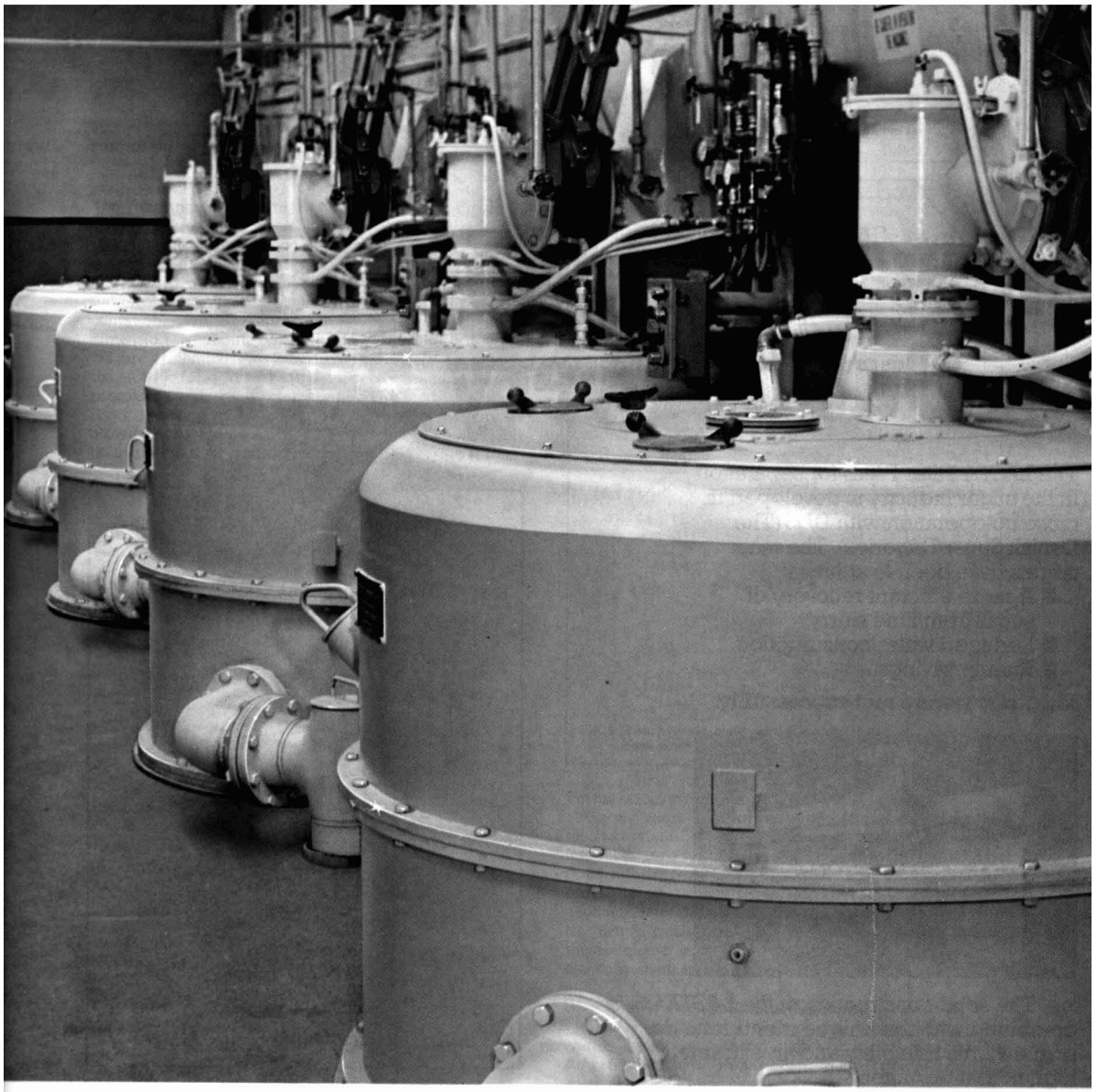

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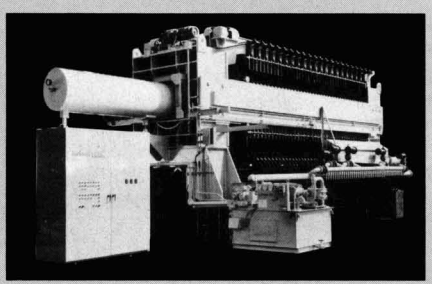
- Energy savings.

The targets were met successfully.



The solid construction of the LASTA combined with the unique membrane design ensures reliability and an extremely high utilization factor.

Residual sugar in lime cakes: less than 0,5% at cake dry substance app. 70%.

For further information, please contact:

GV-Separation/Møller & Jochumsen A/S
International House, 5, Center Boulevard,
DK-2300 Copenhagen S. Denmark.
Phone: +45-1-52 02 11. Telex: 31 124 ihstm

nielsen & theilade

The LASTA Filter Press

The Danish Quality Separation System

estimated as 14.3 kcal/mole (a value found for water adsorption on several oxides)

$$\Delta\gamma = n\, E_{WS}/M \qquad (3)$$

The resulting form (with $R \sim \gamma - \Delta\gamma$) is in Figure 2. The γ values have been substantially equalized; the ratio of dimensions along the crystallographic axes is now close to the observed values.

The growth form (growth velocity $R \sim E$) of the sucrose crystal is given in Figure 3. The a:b axial ratio is compatible with experimental values (Figure 4); the c dimension is about twice the average observed value (Figure 4). Similarly to lowering of interfacial tension on the (001) faces it can be assumed that the surface processes will be preferentially hindered on these faces, resulting in reduction of the relative velocity of growth along the c-axis. Such a mechanism would result in crystals closely resembling the familiar sucrose forms.

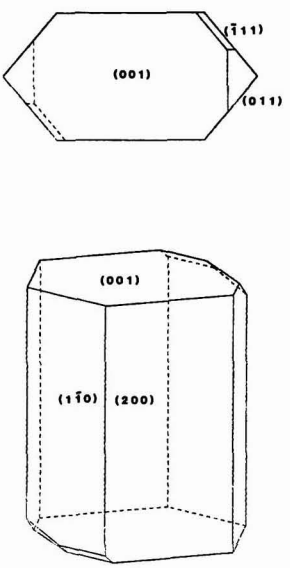


Fig. 3. Growth form ($R \sim E$) of the sucrose crystal

We anticipate that these calculations will permit a quantitative estimate of impurity effects. It is also hoped that the prediction of the equilibrium habit will inspire a search for their experimental confirmation.

Acknowledgement

I wish to acknowledge the support of the Audubon Sugar Institute in Baton Rouge, Louisiana, where most of the work was done.

Summary

A hypothetical form of the sucrose crystal has been estimated under several assumptions employing solid-state interatomic potential functions of the atoms constituting the sucrose crystal. The resulting shapes are elongated along the c-axis. From the discrepancy between the calculated and observed habits, the effects of solvent (sucrose solution) on the sucrose crystal habit are hypothesized.

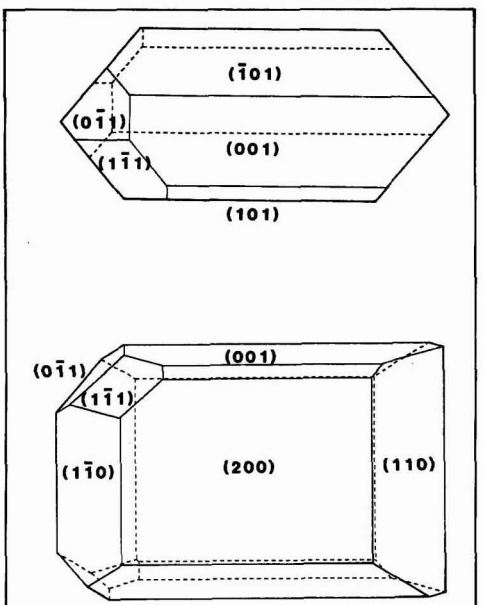


Fig. 4. The average Kukharenko crystal drawn according to data given by Kelley & Mak[13]

Forme calculée du cristal de saccharose

On a estimé une forme hypothétique du cristal de saccharose en faisant différentes assomptions dans lesquelles on utilisait les fonctions d'état solide des potentiels inter-atomiques des atomes faisant partie du cristal de saccharose. Les formes qui en résultent sont allongées sèlon l'axe c. Aux dépens des différences entre les formes calculées et observées, on formule des hypothèses quant aux effets du solvant (la solution de saccharose) sur la forme du cristal de saccharose.

Berechnete Form des Saccharosekristalls

Eine hypothetische Form des Saccharosekristalls wurde berechnet anhand mehrerer Annahmen durch Anwendung von Funktionen des festen Aggregatzustandes des interatomaren Potentials der Atome, die das Saccharosekristall bilden. Die sich ergebenden Formen werden entlang der c-Achse gestreckt. Aufgrund der Diskrepanz zwischen der berechneten und der beobachteten Form werden die Einflüsse des Lösungsmittels (Saccharoselösung) auf den Saccharosekristallhabitus hypothetisch angenommen.

La forma calculada del cristal de sacarosa

Una forma hipotética del cristal de sacarosa se ha estimado sobre varias asunciones empleando funciones en estado solido de potenciales entre-atómicos de los átomos constituendo el cristal de sacarosa. Las configuraciones que resultan se prolongan a lo largo del eje c. De la discrepancia entre los hábitos calculados y observados el autor hipoteca sobre los efectos del disolvente (solución de sacarosa) sobre el hábito del cristal de sacarosa.

[13] "The sucrose crystal and its solution" (Singapore University Press), 1975.

A flexible computer program for four-component material balances in sugar industry boiling houses

By R. G. HOEKSTRA
(Hulett Sugar Limited, Mount Edgecombe, South Africa)

PART II

The solution procedure

A facility is provided which will, if required, print out the entire matrix of equations which the sub-routines had set up. This feature is extremely valuable for tracing errors.

If more relationships were provided than unknowns, a least-squared-error fit is performed. This is described in Appendix 2, with further details given by Neter & Wasserman[8].

The next step is to call the routine for solving simultaneous linear equations, which is based on disc storage. Each row is read from the disc into memory, the necessary manipulations done on it, and then written back to disc.

The Gaussian elimination method of solving the linear equations, described by Stark[9], was used in preference to matrix inversion, because it requires fewer reading and writing operations to the disc file, and because there is no need for knowing the inverse as such.

Output

Instead of using some convergence criterion to determine the required number of iterations, it was decided to print out the results after each iteration, so that the user could judge the convergence for himself. If the initial estimates are sufficiently close, three iterations should be adequate. On the final iteration, the computer prints out all the stream values as well as all the derived values, such as purities, crystal growth factors, etc. Fig. 6 shows an example.

Notes on the computer

The computer used is a Data General Eclipse S/140, with 0.5 Mb of memory and 25 Mb of disc storage. The language used is PL/1, chosen for the following reasons:

(i) Being a structured language, the absence of GO TO instructions enables tidier, easier-to-follow and less error-prone programs to be written.
(ii) It has superior file handling properties to most FORTRAN versions, which is important for the disc-based method of solving the linear equations.
(iii) Through the provision of entry points into sub-routines, the program can be made more compact and orderly.
(iv) It has superior character-handling facilities.

The program is big, and exceeds the capacity of a user partition on the computer, so that overlays had to be used. Because of the large number of simultaneous linear equations which have to be solved, and that via disc file rather than entirely in memory, execution is relatively slow: A matrix of 80 x 80 requires about 10 minutes per iteration.

A bigger (and therefore more expensive) computer should provide a faster execution time, particularly because the solution procedure could then be performed entirely in memory rather than through using disc storage.

Concluding remarks

The flexibility of this program allows its application to less common arrangements as well, such as molasses back-blending, massecuite pre-curing or molasses classification.

A set of up to 120 variables can be handled with that particular computer and programming language in use; this provides ample margin for arrangements which might be more complicated than the given example, involving 84 variables.

By including water as a component, vapour consumptions can automatically be calculated while, by including crystal sucrose as a component, factory concepts such as nutsch purities can be applied, and more realistic performance criteria specified. For example, the degree of exhaustion which can be achieved in *A*- and *B*-boilings is usually limited by the crystal content (crystal % solids) of the massecuite, which is a measure of its "tightness". For such boilings, the crystal content rather than the exhaustion could be specified in the input data.

Although the assumption of steady-state operation is a simplification of what really happens, the trend has been towards continuously-operating equipment in the boiling house, so that the steady-state model will become more and more realistic.

Future improvements to the model could be the development and incorporation of process relationships which express the performance of a unit in terms of its design and/or the way it is operated, instead of using assumed performance values. For example, the work of Rein & Lionnet[10] could be applied to provide empirical relationships to express the *C*-massecuite nutsch purity as a function of the reducing sugar:ash and the non-sucrose:water ratios.

Appendix 1. Solution of non-linear equations by the Newton-Raphson method

Let there be n unknowns : $x_1, x_2, \ldots, x_n$, of which the values still have to be determined, and let there be m equations arranged in the function form:

[8] "Applied Linear Statistical Models" (Irwin, Homewood, Illinois), 1974, Chapter 6.
[9] "Introduction to Numerical Methods," 4th Ed. (MacMillan, London) 1971, Chapter 5.
[10] *Proc. 17th Congr. ISSCT,* 2328-2350.

BOILINGHOUSE OPERATIONS OVERALL BALANCE. DATE:07JUN82 TIME: 09:06:52

RUN NO: 2 MILL: TMD PROJECT OBJECT: PARTIAL REMELT 3-BOILING SINGLE CURING SYSTEM

RESULTS OF RUN. ITERATION 3 OF 3

DATA ON PROCESS STREAMS.

STREAM NO.	DESCRIPTION	TONNAGES TOTAL MASS	TOTAL SOLIDS	TOTAL SUCROSE	TOTAL NON-SUC	WATER IN SOLN	XTAL SUCROSE	QUALITY PURITY (%)	SOLIDS% TOTMASS	XTAL % SOLIDS	NUTSCH PURITY	NON-SUC/WATER
1	SYRUP FROM EVAPORATORS	153.85	100.00	87.70	12.30	53.85		87.70	65.00			.228
2	SYRUP + RECYCLE FEED TO A-PAN	188.25	124.09	109.19	14.89	64.17		88.00	65.91			.232
3	A-MASSECUITE FROM PAN TO XTALLISER	139.74	129.96	114.65	15.30	9.78	77.80	88.22	93.00	59.87	70.66	1.565
4	A-MASSECUITE FROM XTALLISER TO CENTR.	139.74	129.96	114.65	15.30	9.78	83.17	88.22	93.00	64.00	67.29	1.565
5	A-SUGAR PRODUCT	81.25	81.13	80.72	.41	.12	79.80	99.50	99.85	98.36	69.49	3.328
6	A-MOL.FROM A-CENTR.TO A-BLOW-UP TANK	58.83	48.83	33.93	14.90	10.00		69.49	83.00			1.490
7	A-MOLASSES FROM A-BLOW-UP TO B-PAN	55.86	39.10	27.17	11.93	16.76		69.49	70.00			.712
8	A-MOLASSES FROM A-BLOW-UP TO C-PAN	13.90	9.73	6.76	2.97	4.17		69.49	70.00			.712
9	B-MASSECUITE FROM PAN TO XTALLISER	41.38	39.10	27.17	11.93	2.28	15.23	69.49	94.50	38.94	50.03	5.242
10	B-MASSECUITE FROM XTALLISER TO CENTR.	41.38	39.10	27.17	11.93	2.28	17.20	69.49	94.50	44.00	45.51	5.242
11	B-SUGAR TO MINGLER	18.80	18.62	17.31	1.30	.19	16.10	93.00	99.00	86.47	48.25	6.930
12	B-MOL.FROM B-CENTR.TO B-BLOW-UP TANK	24.98	20.48	9.86	10.63	4.50		48.12	82.00			2.363
13	B-MOLASSES FROM B-BLOW-UP TO C-PAN	29.26	20.48	9.86	10.63	8.78		48.12	70.00			1.211
14	C-MASSECUITE FROM PAN TO XTALLISER	30.99	30.21	16.62	13.60	.77	7.58	55.00	97.50	25.07	39.94	17.550
15	C-MASSECUITE FROM XTALLISER TO CENTR.	30.99	30.21	16.62	13.60	.77	9.62	55.00	97.50	31.84	33.97	17.550
16	C-SUGAR TO REMELTER	11.51	11.34	9.64	1.70	.17	8.64	85.00	98.50	76.20	36.97	9.850
17	C-MOLASSES PRODUCT	23.59	18.87	6.98	11.89	4.72		36.97	80.00			2.521
18	REMELT TO BLENDING WITH SYRUP	34.41	24.09	21.49	2.59	10.32		89.23	70.00			.251
19	MINGLER TO REMELTER	14.16	12.75	11.85	.89	1.42		93.00	90.00			.630
20	FOOTING FROM MINGLER TO A-PAN	6.52	5.87	5.46	.41	.65		93.00	90.00			.630
21	WATER OR CJ DILUTION TO MINGLER	1.88				1.88						

DATA ON PROCESSING UNITS.

UNIT NO.	DESCRIPTION	SUCROSE RECOV %	M/CUITE EXH.%	XTAL GR FACTOR	PURITY RISE %	VAP.USE %SOLIDS	WASH % SOLIDS	VAPOUR (TONS)	WASH (TONS)	RATIO/SPLIT
1	A-PAN				-17.57	52.35	10.00	68.03	13.00	.050
2	A-XTALLISER			1.069	-3.37					
3	A-CENTRIFUGAL		69.60	.959	2.20		.26		.34	
4	A-MOLASSES BLOW-UP TANK						22.38		10.93	4.020
5	B-PAN				-19.46	47.04	10.00	18.39	3.91	
6	B-XTALLISER			1.130	-4.52					
7	B-CENTRIFUGAL		59.27	.936	2.61		6.16		2.41	
8	B-MOLASSES BLOW-UP TANK						20.91		4.28	
9	C-PAN				-15.06	50.29	10.00	15.19	3.02	.475
10	C-XTALLISER			1.270	-5.97					
11	C-CENTRIFUGAL		52.00	.898	3.00		13.62		4.12	
12	MINGLER									2.171
13	REMELTER						36.26		8.73	1.124
14	MERGE OF REMELT & SYRUP TO A-PAN									.241
15	OVERALL SYSTEM	92.04	91.77							

TOTAL WASH WATER CONSUMPTION = 50.73 TONS/HR TOTAL VAPOUR CONSUMPTION = 101.62 TONS/HR

Fig. 6. Output results from a run

$$\begin{aligned} f_1(x_1, x_2, \ldots, x_n) &= 0 \\ \ldots\ldots\ldots\ldots\ldots & \\ f_i(x_1, x_2, \ldots, x_n) &= 0 \qquad (1) \\ \ldots\ldots\ldots\ldots\ldots & \\ f_m(x_1, x_2, \ldots, x_n) &= 0 \end{aligned}$$

For a function of the form $f_i(x_1, \ldots, x_n)$ the Taylor expansion states:

$$f_i(x_1,\ldots,x_n) = f_i(x_1^\circ,\ldots,x_n^\circ) + (x_1-x_1^\circ)\left(\frac{\partial f_i(x_1,\ldots,x_n)}{\partial x_1}\right)^\circ + \ldots$$
$$+ (x_n-x_n^\circ)\left(\frac{\partial f_i(x_1,\ldots,x_n)}{\partial x_n}\right)^\circ + \text{higher-order terms}, \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where superscript $^\circ$ refers to a set of known values $[x_1^\circ, \ldots, x_n^\circ]$, either from an initial estimate or from a previous iteration, which is near the true but unknown solution to the variables $[x_1, \ldots, x_n]$.

For brevity, write:

f_i for function $f_i(x_1,\ldots,x_n)$, where $i = 1, \ldots, m$

$\frac{\partial f_i}{\partial x_j}$ for partial derivative $\frac{f_i(x_1,\ldots,x_n)}{\partial x_j}$, where $j = 1, \ldots, n$

and $\{x\}$ for $\{x_1,\ldots,x_n\}$.

For the correct values of [x] the left-hand side (LHS) of equation (2) = 0, because it is given that $f_i = 0$.

The correct values of [x] will therefore be a solution to the equation:

$$f_i + (x_1-x_1^\circ)\left(\frac{\partial f_i}{\partial x}\right)^\circ + \ldots + (x_n-x_n^\circ)\left(\frac{\partial f_i}{\partial x_n}\right)^\circ + \text{higher-order terms} = 0 \ldots\ldots \quad (3)$$

But if the approximate values $[x^\circ]$ are close to the true but unknown solution for [x], the higher-order terms become small. If we re-write equation (3) without the higher-order terms, the values of [x] which satisfy it will no longer be the true solution to the original equations (1), but it can be shown that they will be closer to it than the previous set $[x^\circ]$.

Equation (3), without the higher-order terms, can be re-written as

$$x_1\left(\frac{\partial f_i}{\partial x_1}\right)^\circ + \ldots + x_n\left(\frac{\partial f_i}{\partial x_n}\right)^\circ = x_1^\circ\left(\frac{\partial f_i}{\partial x_1}\right)^\circ + \ldots + x_n^\circ\left(\frac{\partial f_i}{\partial x_n}\right)^\circ - f_i^\circ \ldots\ldots\ldots \quad (4)$$

The entire RHS of equation (4) can be calculated, because the $[x^\circ]$ are known and can be substituted into the partial derivatives to determine their values.

The same partial derivatives on the LHS are known, leaving only the [x] as the unknowns.

Equation (4) thus is equivalent to the linear form

$$a_1x_1 + \ldots\ldots + a_nx_n = b,$$

where b = RHS of equation (4)

and $a_1, \ldots, a_n = \left(\frac{\partial f_i}{\partial x_1}\right)^\circ, \ldots\ldots, \left(\frac{\partial f_i}{\partial x_n}\right)^\circ$

In BOOB, each of the m equations (1) is converted to the linear form in (4) if it is non-linear, or is retained in its original form if it already is linear, thus giving m linear equations which are then directly solved by a standard computer program if m = n, or by the least-squared-error method explained in Appendix 2 if $m > n$.

The solution will, as already explained, not be exact, but will be a step closer to the true solution. It can then become the new "previous iteration value" $[x^\circ]$, the equations of type (4) updated with it, and the procedure for solving linear equations once more invoked. If the latest solution is sufficiently close to the previous solution, it is deemed to be the solution to the original set of equations (1).

Appendix 2. Solution of over-specified system of linear equations by least-squared-error method

In general, a system of m linear or linearized equations with n unknowns arising out of BOOB could be represented as:

$$\left.\begin{aligned} a_{11}x_1 + a_{12}x_2 + \ldots\ldots + a_{1n}x_n &= b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots\ldots + a_{2n}x_n &= b_2 \\ \ldots\ldots\ldots\ldots\ldots & \\ a_{m1}x_1 + \ldots\ldots\ldots + a_{mn}x_m &= b_m \end{aligned}\right\} \ldots\ldots\ldots\ldots \quad (1)$$

In matrix form, the equations can be represented as:

$$Ax = b, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where A is an m X n coefficient matrix, with $m \geqslant n$

x is an n-component column vector representing the solution, and b is an m-component column vector representing the RHS coefficients, i.e.

$$A = \begin{pmatrix} a_{11} & a_{12} & \ldots\ldots & a_{1n} \\ a_{21} & a_{22} & \ldots\ldots\ldots & \\ \ldots\ldots\ldots\ldots\ldots & & & \\ a_{m1} & \ldots\ldots\ldots & & a_{mn} \end{pmatrix},$$

$$x = \begin{pmatrix} x_1 \\ x_2 \\ . \\ . \\ x_n \end{pmatrix}, \qquad b = \begin{pmatrix} b_1 \\ b_2 \\ . \\ . \\ b_m \end{pmatrix}$$

If there are n relationships for the n unknowns (i.e. m = n) and there is no under-definition of the system within the n relationships, there will be a unique solution to (1) or (2), which will be exact to each and every equation. Here the usual methods of solving simultaneous linear equations can be directly applied.

If there are more relationships than unknowns (i.e. $m > n$), there will usually not exist a solution which satisfies all m relationships exactly, i.e. the LHS and RHS of any one of the equations (1) will not necessarily balance.

It is obviously desirable to find a solution which will result in a minimum overall error to the set of equations.

Let A' be the transpose of matrix A, that is, the matrix A with rows and columns exchanged to have dimension n X m, thus:

$$A' = \begin{pmatrix} a_{11} & a_{21} & \cdots\cdots & a_{m1} \\ a_{12} & a_{22} & \cdots\cdots & \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & \cdots & \cdots & a_{mn} \end{pmatrix}$$

Pre-multiplying matrix equation (2) by A' gives:

$$A'Ax = A'b \quad \ldots\ldots \quad (3)$$

The resulting matrix A'A on the LHS of (3) has dimension n X n, and on the RHS the A'b represents an n-component column vector; X is still the n-component column vector representing the solution.

The matrix equation (3) therefore represents a system of n linear equations in n unknowns, which can be solved by the usual means.

It can be shown that this method produces a least-squared-error solution, meaning that, when it is substituted into the equations (1), the sum of the squared errors will have a minimum value.

Mathematically, this is expressed as:

$$(a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n - b_1)^2 + (a_{21}x_1 + \ldots + a_{2n}x_n - b_2)^2 + \ldots + (a_{m1}x_1 + \ldots + a_{mn}x_n - b_m)^2 = \text{Minimum.}$$

Summary

A computer program is described which bases boiling house material balances on the components, crystal sucrose and water, in addition to the usual total solids and sucrose, thus enabling useful process variables such as crystal % solids, nutsch purities and vapour consumption to be considered. The program can be used for any boiling scheme. Each configuration has its own master segment, and uses sub-routines which are common to all master segments. The program sets up and solves a set of simultaneous equations. The user can choose which variables are to be the given input and which the unknowns to be calculated. If required, the system may be over-specified, in which case a least-squared-error solution is calculated.

Un programme flexible d'ordinateur pour des bilans de matières à quatre composants dans l'atelier de cristallisation de l'industrie sucrière

On décrit un programme d'ordinateur dans lequel les bilans de matières de l'atelier de cristallisation sont basés sur les composants, notamment le cristal de saccharose et l'eau, à côté des valeurs habituelles pour les matières sèches totales et la teneur en saccharose. Cela permet de considérer des variables utiles du processus, tels que la teneur en cristaux % solides, les puretés des sucettes et la consommation de vapeur. N'importe quel schéma de cuisson peut utiliser le programme. Chaque configuration possède son propre segment principal et utilise des subroutines communes à tous les segments principaux. Le programme établit et résoud une série d'équations simultanées. L'utilisateur peut choisir quels variables doivent devenir les données à rentrer et quels autres les inconnues à calculer. Si nécessaire, on peut rentrer trop de données dans le système, ce qui conduira au calcul d'une solution établie au moyen de la méthode des moindres carrés.

Ein flexibles Computerprogramm für die Stoff-Bilanz von vier Variablen in Kochstationen der Zuckerindustrie

Ein Computerprogramm für die Kochstation wird beschrieben, das auf den Stoff-Bilanzen der Komponenten kristallisierte Saccharose und Wasser sowie dem üblichen Trockensubstanzgehalt und der Saccharose beruht und somit ermöglicht die nützlichen Prozeßparameter wie Kristallgehalt in % der Trockensubstanz, Nutschsirupreinheit und Dampfverbrauch zu berücksichtigen. Das Programm kann für jedes Kochschema verwendet werden. Jede Gestaltung hat ihr eignes Leit-Segment und verwendet Unterprogramme, die für alle Leit-Segmente gleich sind. Das Programm stellt eine Reihe von simultanen Gleichungen auf und löst sie. Der Benutzer kann wählen, welche Variablen eingegeben werden und welche Unbekannten berechnet werden sollen. Auf Wunsch kann das System überspezifiziert werden, so daß die Lösung nach der kleinsten Fehlerquadrate-Methode ermittelt wird.

Un programa flexible de computadora para balances de materias con cuatro componentes en casas de cocción en la industria azucarera

Se describe un programa de computadora para hacer balances de materias en la casa de cocción basados en los componentes sacarosa cristalina y agua además de los sólidos totales y sacarosa. Permite consideración de variables útiles de elaboración como cristales % sólidos, purezas "nutsch" (es decir, del madre-licor) y consumo de vapor. El programa puede usarse para cualquier esquema de cocción. Cada configuración tiene su proprio segmento-maestro y usa sub-rutinas que estan común a todos segmentos-maestros. El programa inicia y soluciona un juego de ecuaciones simultáneas. El operador puede escoger cuales de las variables estarán los dados de entrada y cuales los desconocidos a calcularse. Si es necesario, es posible sobre-especificar; en este caso, se calcula una solución por minimización de los errores cuadrados.

Greece sugar production, 1982[1]. — The five factories of Hellenic Sugar Industry produced 297,000 tonnes of white sugar in the 1982 campaign, against 321,589 tonnes in the previous year, although covering domestic requirements. The beet crop of 2,547,000 tonnes was harvested from 40,300 ha, whereas in 1981, 2.6 million tonnes of beet were grown on 45,000 ha. For 1983 HSI plans an area of 40,000 ha and a sugar outturn of 290-300,000 tonnes.

Hawaii sugar production, 1982[2]. — Final adjusted production of sugar in Hawaii in 1982 was 982,913 short tons (891,699 tonnes), raw value, less than initially expected, owing to the wettest weather experienced this century. Estimated production for 1983 is 1,050,000 short tons (952,560 tonnes). By means of area and personnel reductions, operating losses were reduced from $83.5 million in 1981 to only $1.5 million in 1982. The industry is again looking into the possibility of producing alcohol from molasses for use as fuel, and an increase of 57% was achieved in sales of electricity to power utilities, reaching 337.6 million kWh.

1 *Sugar y Azúcar,* 1983, **78**, (4), 64.
2 *Zuckerindustrie,* 1983, **108**, 394.

Effect of oils and fatty acids on the tolerance of distiller's yeast to alcohol and temperature

By DEEPAK SAIGAL and L. VISWANATHAN
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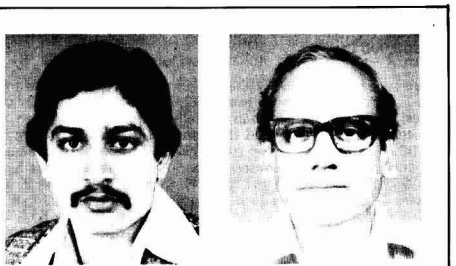
Introduction

High temperature, high alcohol concentration and high sugar concentration, all tend to inactivate yeast cells[1, 2, 3]. In tropical and subtropical regions the temperature rises to 40°C or more during fermentation in summer and this results in the loss of activity of the yeast and leads to inefficient fermentation. As the fermentation progresses, the alcohol concentration increases, further reducing the activity of the yeast. If the resistance of yeast to alcohol were increased, media with high sugar concentration could be fermented, resulting in improved economy. Therefore the effect of some supplements on the tolerance of yeast to temperature and alcohol was studied.

Materials and methods

Saccharomyces cerevisiae (N.S.I. Strain No. 113) used in this investigation was maintained on yeast extract peptone dextrose slants by subculturing at monthly intervals. Two levels of inoculum were used. For high inoculum, cells grown for 24 hours on 100 ml of 20°Bx molasses were centrifuged and suspended in 50 ml of the fresh experimental medium in a 100 ml conical flask. For low inoculum, the growth from 10 ml of 20°Bx molasses was centrifuged and suspended in 100 ml of the experimental medium in a 250 ml conical flask. The low and high inoculum had turbidities of 300 and 6000 units, respectively, on a Klett-Summerson colorimeter with blue filter. The flasks were incubated at 30°, 40° or 45°C, as required, for 72 hours. Samples were drawn for cell counts at 0, 6, 24, 48 and 72 hours from the start.

Molasses obtained from the Experimental Sugar Factory of the National Sugar Institute was diluted to 30°Bx concentration and centrifuged for 15 minutes in a Remi T24A centrifuge at 5000 rpm using a 6 x 50 ml angle head. To study the effect of temperature, this was diluted to 20°Bx concentration and supplemented with 0.2% ammonium sulphate and 0.02% potassium dihydrogen orthophosphate. Spent wash was taken to represent molasses medium without sugar. The pH of the media containing sugar was adjusted to 4.8. The media were sterilized by autoclaving at 15 psig for 15 minutes.



D. Saigal L. Viswanathan

The effect of alcohol concentration was assessed at 30°C in medium without sugar (spent wash). Ethyl alcohol was added at 5% and 10% to the medium after autoclaving. Both these media were supplemented with 0.5% of oils (linseed oil, mustard oil) or 0.5% of mixed fatty acids derived from these oils by saponification. The latter involved refluxing 25 g of oil with 75 ml of 20% KOH in 40% alcohol for 2 hours in a flat-bottomed flask using a Remi 2LH stirrer cum hot plate. After cooling, concentrated HCl was added with stirring to bring the pH to 2.0, when the fatty acids separated and rose to the surface. They were filtered and dried overnight at 60°C. In the case of linseed oil, the fatty acids did not solidify and were separated using a separating funnel.

Counting of active and inactive cells

5 ml aliquots of the broth were withdrawn, centrifuged and suspended in 5 ml of phosphate buffer (pH 6.5). Methylene blue dye was added to give a final concentration of 0.002%. The ability of the cells to reduce and thus decolorize the dye was the criterion for their being considered active. The active and inactive cells were counted using a Levy-Hausser counting chamber.

Results and discussion

The cells remained active at 30°C in both low and high inoculum experiments up to 72 hours (Table I). On supplementation, yeast growth (total number of cells) was greater than in the control. Uptake of fatty acids by yeasts has been demonstrated[4]. The increased growth could be attributed to the utilization of oils and fatty acids particularly during the later growth period[5, 6].

High temperature had a detrimental effect on the activity of yeast. At 40° and 45°C, cells declined in activity in the control at 48 hours and 24 hours, respectively. At the higher temperature all the cells were inactive after 24 hours (Tables II and III). The addition of oils or fatty acids clearly protected the cells from thermal injury. At 40°C, 92 to 95% cells were active at 48 hours as against 61% in the control in the case of high inoculum (Table II). With low inoculum, 53% cells were active in the control whereas all the cells remained active in the supplemented media at 48 hours. The protective effect could be observed clearly even at 72 hours. Among the supplements tested, linseed oil fatty acids were the most effective and mustard oil was the least effective. Mustard oil appears to have some harmful substances which are removed during fatty acid preparation.

1 Rose & Harrison: "The yeasts", Vol. 2. 1971, pp. 124, 130.
2 Aiba *et al.: Biotech. Bioeng.*, 1968, **10**, 845.
3 Orszaghova *et al.: Zentralbl. Bakteriol. Parasit. Infekt. Hyg., Abt. 2*, 1972, **127**, 545.
4 Oura: *Antonie van Leeuwenhoek*, 1969, **35**, (Supp. 3rd Int. Symp. Yeast), G25.
5 Suomalaineu & Keranen: *Biochim. Biophys. Acta*, 1963, **70a**, 403.
6 Idem: *Chem. Phys. Lipids*, 1968, **2**, 296.

At 45°C, the cells of *S. cerevisiae* in the control experiment showed very poor growth and all were inactive by 24 hours of incubation (Table III). The supplement markedly influenced growth, maintained the cells in active condition and also protected the cells to a significant extent from thermal injury up to 24 hours at 45°C. The fatty acids yielded better growth and protection against thermal inactivation than the corresponding oils. Since the supplements were added on a weight basis, oils provided less fatty acids by weight. Fatty acids, particularly unsaturated fatty acids, appear to be of greater significance for yeast metabolism than the glycerol moiety which is the other major component of the oil.

The inactivation of cells at 40° or 45°C is a slow

Table I. The effects of oils and fatty acids on yeast at 30°C

	0 hour	6 hour	24 hour	48 hour	72 hour
Low inoculum			Cell count in millions per ml		
Control (without supplementation)	4.2	6.3	28.5	47.5	57.0
0.5% Linseed oil	5.6	13.7	30.0	65.5	78.0
0.5% Linseed oil fatty acids	4.9	6.7	42.5	57.5	66.0
0.5% Mustard oil	4.7	6.7	26.0	32.5	47.5
0.5% Mustard oil fatty acids	4.8	8.9	34.5	57.0	68.0
High inoculum					
Control (without supplementation)	38.5	61.5	109.0	144.0	141.0
0.5% Linseed oil	38.0	119.0	157.0	144.0	213.0
0.5% Linseed oil fatty acids	37.0	184.5	214.0	204.5	231.0
0.5% Mustard oil	36.5	69.0	78.5	148.0	135.0
0.5% Mustard oil fatty acids	35.0	115.5	205.0	201.0	255.0

Table II. The effect of oils and fatty acids on inactivation of yeast at 40°C

	0 hour		6 hour		24 hour		48 hour		72 hour	
	Cell count*	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells
Low inoculum										
Control (without supplementation)	4.6	100.0	6.5	100.0	21.0	100.0	32.0	53.1	30.0	13.4
0.5% Linseed oil	4.5	100.0	9.5	100.0	24.0	100.0	41.0	100.0	53.7	90.3
0.5% Linseed oil fatty acids	5.1	100.0	11.5	100.0	30.0	100.0	56.0	100.0	68.0	95.6
0.5% Mustard oil	5.6	100.0	7.2	100.0	18.0	100.0	32.0	100.0	49.5	86.8
0.5% Mustard oil fatty acids	4.9	100.0	9.7	100.0	24.5	100.0	51.0	100.0	65.0	89.2
High inoculum										
Control (without supplementation)	43.5	100.0	56.0	100.0	91.0	100.0	113.0	61.0	112.0	14.3
0.5% Linseed oil	42.0	100.0	92.0	100.0	124.0	100.0	147.0	95.2	156.0	74.4
0.5% Linseed oil fatty acids	39.5	100.0	125.0	100.0	185.0	100.0	177.2	98.7	182.5	82.2
0.5% Mustard oil	40.2	100.0	75.0	100.0	111.0	100.0	147.5	92.2	180.0	66.7
0.5% Mustard oil fatty acids	38.0	100.0	85.0	100.0	162.0	100.0	173.5	95.1	186.0	75.8

* *Millions per ml.*

Table III. The effect of oils and fatty acids on inactivation of yeast at 45°C

	0 hour		6 hour		24 hour		48 hour	
	Cell count*	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells
Low inoculum								
Control (without supplementation)	5.0	100.0	5.8	100.0	6.5	0	†	0
0.5% Linseed oil	4.1	100.0	8.8	100.0	19.5	82.0	26.5	0
0.5% Linseed oil fatty acids	5.3	100.0	8.5	100.0	17.0	88.2	38.2	0
0.5% Mustard oil	4.7	100.0	7.6	100.0	19.0	65.8	22.0	0
0.5% Mustard oil fatty acids	4.9	100.0	8.9	100.0	23.5	80.8	36.0	0
High inoculum								
Control (without supplementation)	33.0	100.0	47.0	100.0	54.0	0	†	0
0.5% Linseed oil	36.5	100.0	83.0	100.0	96.0	54.2	114.0	0
0.5% Linseed oil fatty acids	38.0	100.0	81.0	100.0	95.0	65.3	126.0	0
0.5% Mustard oil	40.0	100.0	76.0	100.0	93.0	58.0	117.0	0
0.5% Mustard oil fatty acids	35.5	100.0	72.0	100.0	100.0	63.0	135.0	0

* Millions per ml.
† *The cell count was not done since all the cells were inactive at 24 hours.*

process. The effect is not observed at 6 hours of incubation. In the experiments reported in Tables II and III, similar results were obtained with low and high inocula. This is in contrast to the report by Rudenok & Konev[7] of greater resistance to thermal injury when the cell concentration was higher. The discrepancy may be due to differences in yeast strains and experimental conditions.

The effect of alcohol varied depending on the concentration of the inoculum. At low inoculum, there was an immediate inactivation of about half of the cells both in the control and the supplemented medium (Tables IV and V). The proportion of active cells increased gradually and significantly in the supplemented media, resulting in about 90% active cells at 24 to 72 hours. In the control there was no improvement in the situation except for a slightly higher percentage at 24 hours. By contrast, there

Table IV. The effect of oils and fatty acids on inactivation of yeast by 5% alcohol

	0 hour		6 hour		24 hour		48 hour		72 hour	
	Cell count*	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells
Low inoculum										
Control (without supplementation)	14.1	60.2	22.5	63.6	52.0	67.3	57.0	59.6	70.0	60.0
0.5% Linseed oil	16.8	53.0	23.8	76.0	48.0	91.7	51.5	93.2	57.4	94.0
0.5% Linseed oil fatty acids	14.8	52.7	21.3	71.8	45.9	87.1	53.2	92.1	60.8	93.7
0.5% Mustard oil	14.2	50.3	29.1	63.2	65.5	87.0	46.0	93.5	50.2	93.6
0.5% Mustard oil fatty acids	17.0	49.1	27.3	68.5	72.0	94.4	89.0	94.4	95.0	95.8
High inoculum										
Control (without supplementation)	98.5	100.0	114.0	100.0	119.0	87.4	151.4	76.6	149.5	74.9
0.5% Linseed oil	102.5	100.0	156.0	100.0	172.0	100.0	197.4	92.7	207.0	89.4
0.5% Linseed oil fatty acids	95.0	100.0	161.0	100.0	192.0	100.0	219.2	96.7	216.5	93.3
0.5% Mustard oil	98.5	100.0	138.0	100.0	156.2	95.4	170.2	89.9	188.5	83.8
0.5% Mustard oil fatty acids	95.0	100.0	172.0	100.0	190.0	95.2	244.8	95.6	242.1	94.6

* Millions per ml.

Table V. The effect of oils and fatty acids on inactivation of yeast by 10% alcohol

	0 hour		6 hour		24 hour		48 hour		72 hour	
	Cell count*	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells	Cell count	% Active cells
Low inoculum										
Control (without supplementation)	11.1	54.9	17.2	60.5	28.2	74.5	33.9	73.7	39.7	73.0
0.5% Linseed oil	10.7	52.5	18.3	67.2	32.6	82.8	39.0	87.2	49.0	89.8
0.5% Linseed oil fatty acids	11.1	47.0	18.7	72.2	38.7	88.4	53.3	91.9	62.0	93.5
0.5% Mustard oil	11.9	51.3	19.0	64.7	27.1	81.2	34.2	84.8	39.0	87.2
0.5% Mustard oil fatty acids	11.7	54.7	20.0	72.5	37.4	85.6	48.0	89.6	59.7	92.1
High inoculum										
Control (without supplementation)	79.5	100.0	87.0	100.0	88.0	86.4	91.0	75.8	101.0	55.4
0.5% Linseed oil	82.0	100.0	95.0	100.0	102.0	90.2	113.5	82.8	111.5	75.3
0.5% Linseed oil fatty acids	87.2	100.0	102.0	100.0	108.0	96.3	115.5	93.5	122.5	89.8
0.5% Mustard oil	83.2	100.0	92.0	100.0	95.7	94.0	113.5	83.7	127.0	73.2
0.5% Mustard oil fatty acids	79.0	100.0	110.0	100.0	122.0	96.7	124.5	96.4	132.2	96.8

* Millions per ml.

Both enzyme destruction and cell membrane damage occur at higher temperatures. The significance of cell membrane composition and function in heat injury to yeast cells has been highlighted by earlier workers[8]. Temperature can be expected to exert a profound effect on all aspects of growth, metabolism and survival of yeasts. A deficiency of sterol and unsaturated fatty acids has been implicated in the inactivation of yeast cells during incubation in the absence of a carbon source[8]. There is evidence of the impairment of unsaturated fatty acid biosynthesis by yeast at higher temperatures[9,10]. A definite relationship between the optimum growth temperature range of yeast strains and the unsaturated fatty acid content of yeast lipid has also been reported[11]. Unsaturated fatty acids provided as supplements can be incorporated into the yeast membrane and can thus overcome the deficiency of unsaturated fatty acids at higher incubation temperatures. This may be an important factor in the protection observed with fatty acid supplements.

is no immediate inactivation by alcohol when a high inoculum of cells was used. However, in this case, from 24 hours onwards the proportion of active cells in the control decreased. The supplements gave a clear protection from inactivation (Table IV and V). With high inoculum, the fatty acids provided a greater amount of protection against inactivation than the corresponding oils.

In many microorganisms, the size of the inoculum is well known to be an important factor in the performance of the culture. With a low inoculum, apparently some substances leak out into the medium, and also the concentration of important substances carried over by the inoculum into the fresh media is also low. The result is a slowing down of metabolic processes and a pronounced

7 *Dokl. Akad. Nauk. SSSR*, 1973, **208**, 977.
8 Lalilson & McLeod: *Antonie van Leeuwenhoek*, 1976, **42**, 397.
9 Sherman: *J. Coll. Comp. Physiol.*, 1959, **54**, 29.
10 Starr & Park: *ibid.*, 1962, **59**, 107.
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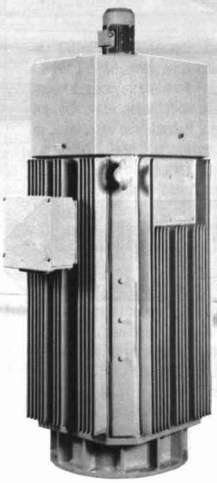

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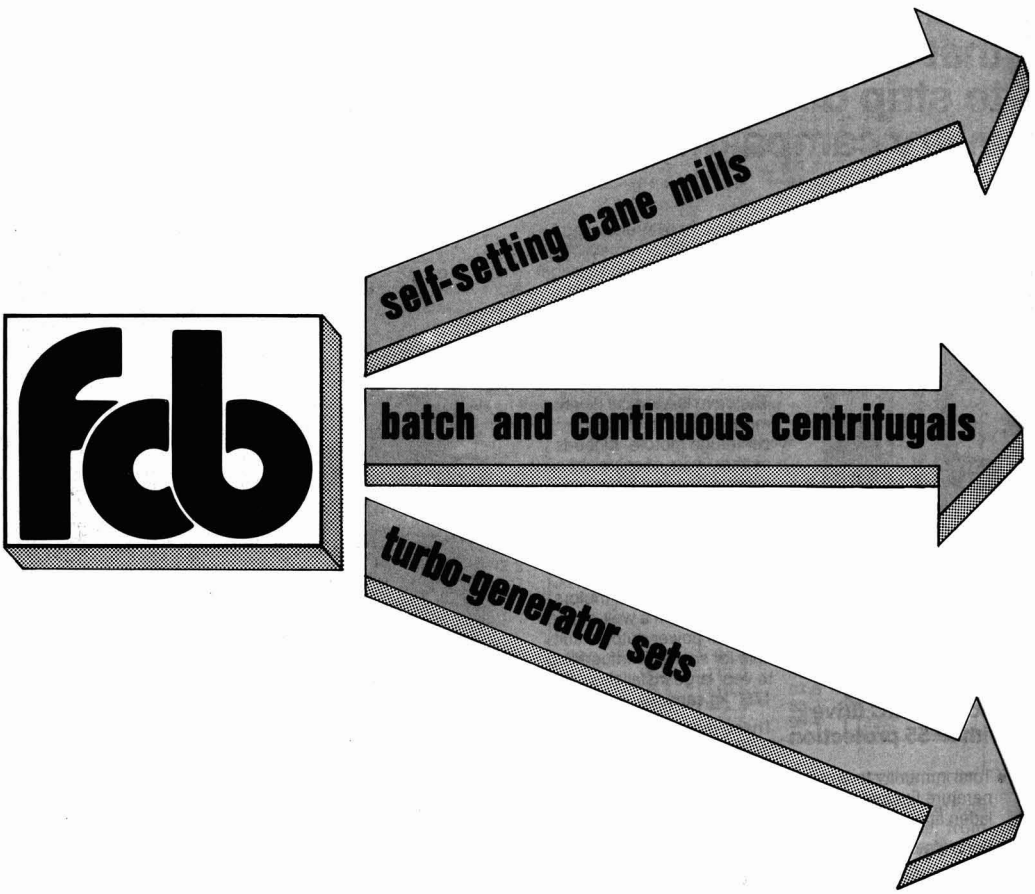

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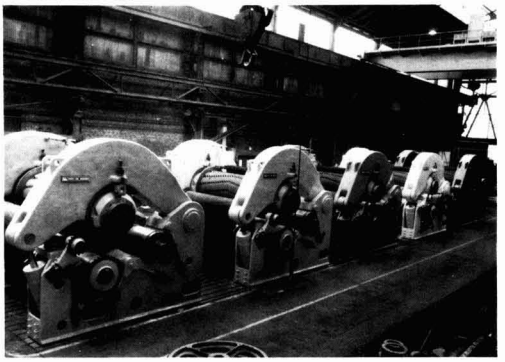

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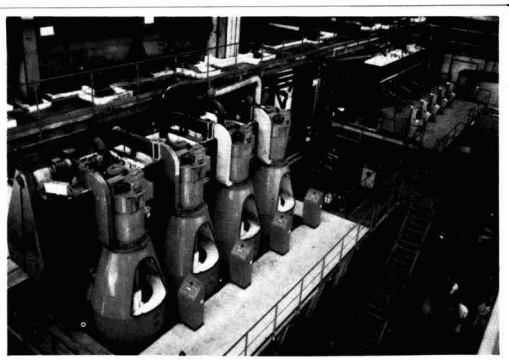

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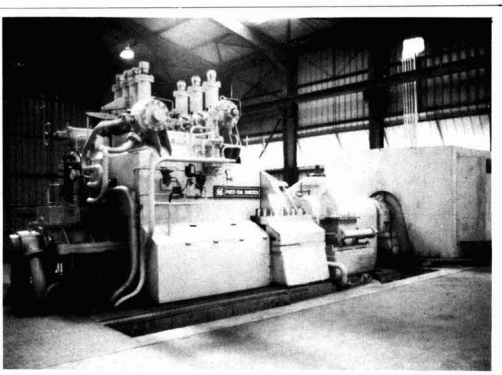

7000 kW turbo-alternator, of the condensation with regulated extraction type, at the Boroteu-Koro cane sugar factory, Ivory Coast.

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lag in the growth of the organism. It seems as if the cells are more sensitive to inactivation by alcohol under these conditions. With a high inoculum, both the substrates carried over and the physiological state of the cells in the new environment appears to provide a protective effect.

With high inoculum, at both the levels of alcohol tried, growth is superior in supplemented media, as can be seen even at 6 hours (Tables IV and V). This may be due partly to the stimulation of growth by oils and fatty acids and partly to the protection given by supplements against inactivation by alcohol. The results with the low inoculum depended on the supplements used. Mustard oil did not show any stimulation of growth. Fatty acids from mustard oil stimulated growth in the presence of 5% and 10% alcohol. Linseed oil and its fatty acids stimulated growth at 10% alcohol only.

Since in the low inoculum a large number of cells are inactivated by alcohol in the very beginning, the stimulatory effect of supplements is not as clear as with the high inoculum where there is no initial inactivation.

The inhibitory effect of alcohol on growth and fermentation of yeast is well known[12,13]. Ethanol concentration above 9.3% completely stopped the activity of *S. cerevisiae* ATCC 4123. The lipid composition of a malt wort has been reported to have an effect on ethanol tolerance of yeast[14]. A lecithin-albumin complex has been shown to increase the rate of alcohol production by sake yeast and the final yield on a synthetic medium[15]. Unsaturated fatty acids and sterol biosynthesis in yeasts is known to be slow and sensitive to a number of factors such as temperature, oxygen availability etc.[14] It is likely that alcohol affects this part of the sensitive metabolism. It has been reported that yeast cells whose membrane is enriched with certain sterols and unsaturated fatty acids are most resistant to inactivation by alcohol[15].

Acknowledgment

The authors express their sincere gratitude to Shri N. R. Khariawala, Director, National Sugar Institute, Kanpur, for inspiration and encouragement during the course of this investigation. One of the authors (D.S.) is grateful to the Council of Scientific and Industrial Research for the award of a Junior Research Fellowship.

Summary

The effect of some oils and fatty acid supplements on the tolerance of yeast to alcohol and temperature has been studied. The supplements stimulated growth, maintained the cells in active condition and also protected the cells to a significant extent against thermal injury up to 24 hours at 45°C. The effect of alcohol varied depending on the concentration of the inoculum. With low inoculum a large proportion of cells are inactivated by alcohol at the beginning of fermentation in contrast to high inoculum where there is no initial inactivation. With high inoculum growth is superior in supplemented media.

Effets des huiles et acides gras sur la tolérance de la levure de distillerie à l'alcool et à la température

L'effet de l'ajoute de certaines huiles et acides gras sur la tolérance de la levure à l'alcool et à la température a été étudiée. Les ajoutes stimulaient la croissance, maintenant les cellules en conditions actives et aussi protégeaient les cellules d'une façon significative contre les dégradations dues à la température jusqu'à 24 heures à 45°C. Les effets de l'alcool variaient dépendant de la concentration de l'inoculum. Avec un faible inoculum, une large proportion des cellules sont inactivées par l'alcool au débit de la fermentation en contraste avec un grand inoculum où il n'y a pas d'inactivation initiale. Avec un grand inoculum, la croissance est supérieure dans des milieux complémentés.

Einfluß von Ölen und Fettsäuren auf die Toleranz von Brennereihefe für Alkohol und Temperatur

Der Einfluß von einigen Ölen und Fettsäurezusätzen auf die Toleranz von Hefe für Alkohol und Temperatur wurde untersucht. Die Zusätze stimulierten Wachstum, erhielten die Zellen im aktiven Zustand und beschützten die Zellen signifikant vor thermischer Verletzung bis zu 24 h bei 45 °C. Der Alkoholeinfluß variierte in Abhängigkeit von der Konzentration des Inokulums. Mit einem kleinen Inokulum wurde ein großer Anteil der Zellen durch Alkohol bei Beginn der Fermentation inaktiviert im Gegensatz zu einem großen Inokulum, bei dem es keine Anfangsinaktivierung gibt. Bei einem großen Inokulum ist das Wachstum in Medien mit Zusatz überlegen.

Efecto de aceites y ácidos grasos sobre la tolerancia de levadura de la distilería a alcohol y temperatura

El efecto de varios aceites y ácidos grasos como suplementos sobre la tolerancia de levadura a alcohol y temperatura se ha estudiado. Los suplementos han estimulado el crecimiento de la levadura, han mantenado en condición áctiva las células y también han protegido las células a un extento significativo contra daño térmico hasta las 24 horas a 45°C. El efecto de alcohol varió dependiente de la concentración del inóculo. Con un inóculo menor una grande proporción de las células llegan a ser inactivadas al comienzo de la fermentación a causa del alcohol. Este contraste con la ausencia de la inactivación inicial con un inóculo grande. Con este mismo, crecimiento es superior en medios suplementados.

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13 Idem: *Proc. Biotech. Bioeng. Symp.*, 1977.
14 White: *Proc. Conv. Inst. Brewing (Aust. N.Z. Sect.)*, 1978, **15**, 133.
15 Ouchi *et al.: Nippon Jozo Kyokai Zassh.*, 1977, **72**, 667.

Dominican Republic sugar exports, 1982[1]

	1982	1981	1980
	tonnes, raw value		
Algeria	11,330	21,388	10,500
Cuba	73,492	0	0
Haiti	4,922	0	4,536
Morocco	15,449	0	0
Portugal	46,098	0	11,695
Senegal	25,692	6,180	28,298
US	361,036	711,247	525,084
USSR	233,871	0	9,450
Venezuela	66,787	119,297	201,191
Other countries	8,298	5,922	1,980
	846,975	864,034	792,734

Spanish government aid for the sugar sector[2]. — The Spanish Council of Ministers has approved a 1983/84 aid package for the sugar sector. Farmers will receive a 125-peseta ($0.91) subsidy per tonne of sugar beet produced and a 87-peseta ($0.64) subsidy per tonne of sugar cane. The compensation for transport expenses will be 550 pesetas ($4.00) per tonne of sugar beet and 385 pesetas ($2.80) per tonne of cane. Moreover, the government has approved grants worth 400 million pesetas ($2,910,000) for structural improvements to the sugar industry. It has agreed to provide 44,000 pesetas ($320) per hectare in low interest loans to help farmers pay for sugar beet sowings and similar loans of 30,800 pesetas ($224) per hectare for sugar cane plantings.

1 *I.S.O. Stat. Bull.*, 1983, **42**, (4), 11.
2 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 316.

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Environmental Standards Committee report. R.D.Mounts. *Proc. 40th Ann. Conf. Hawaiian Sugar Tech.,* 1981, 109-110. — Regulations concerning bagasse-fired furnace emission and polychlorinated biphenyls in transformer immersion oil are discussed.

Energy conservation practices at the Kekaha sugar factory. J. R. Albert-Thenet. *Proc. 40th Ann. Conf. Hawaiian Sugar Tech.,* 1981, 111-113. — Measures adopted with the aim of reducing steam consumption at Kekaha are described. They included decreasing the amounts of: imbibition water (which caused only a 0.5 unit fall in mill extraction to 96.3%), filter wash water (resulting in a filter cake pol increase from 0.7% to 1.1%), make-up water added to clarified juice to keep the evaporator in balance (involving lowering of the exhaust steam pressure, whereby the efficiency of all the turbines was raised and their steam consumption reduced), and movement water added to the massecuites in the pans. These reductions in water quantities and increase in high-grade molasses and low-grade remelt sugar Brix from 70° to 73° have led to a fall in steam consumption from 56.9% to 48.3% on net cane and permitted generation of excess electricity which could be sold to the public utility, thus providing a net profit despite a total loss of about 390 short tons of sugar per crop (resulting from the fall in mill extraction and rise in filter cake losses mentioned above).

Amfac's hydropower plans. N. Broadbent and B. Hatton. *Proc. 40th Ann. Conf. Hawaiian Sugar Tech.,* 1981, 123-124. — Hydro-electric generating schemes in which Kekaha Sugar Co. Ltd. and The Lihue Plantation Co. Ltd. (both members of Amfac Inc.) are involved on the island of Kauai are described.

Alexander & Baldwin hydro programs. S. Masumoto. *Proc. 40th Ann. Conf. Hawaiian Sugar Tech.,* 1981, 125-126. — The title company owns two sugar companies: Hawaiian Commercial & Sugar Co. on the island of Maui, and McBryde Sugar Co. Ltd. on the island of Kauai. Both are involved in hydro-electric power generation, details of which are given.

Application of an optimization algorithm to a quadruple-effect by the GEMCS-Powell method. H. Pérez A. and O. Jiménez. *Centro Azúcar,* 1981, **8,** (3), 37-46 *(Spanish).* An algorithm, comprising the GEMCS executive program in conjunction with the non-linear optimization method of Powell, has been used in an attempt to optimize the economy of a sugar industry quadruple-effect evaporator. The preliminary partial results are presented as well as recommendations for future work.

Topological analysis of a sugar factory. M. A. Boizán H., F. Caballero and A. Clares P. *Centro Azúcar,* 1981, **8,** (3), 47-60 *(Spanish).* — Application of topological analysis to the mathematical modelling of a sugar factory is discussed with an illustration in the form of its application to an evaporation sub-system.

Simulation of the implementation of a control system to the feeding of cane utilizing the CID 201 B. E. Martínez Ch. and M. Silva G. *Centro Azúcar,* 1981, **8,** (3), 61-71 *(Spanish).* — A new system, the Real Time System to Control and Supervise Technological Processes (STRCSPT from the title in Spanish), written in LESICA language and applied with a CID 201 B computer, reacts more rapidly and efficiently for governing and smoothing the supply of cane fed to a mill.

Method for analysing the representativeness of the calculations connected with heat balances. L. Toledo G. and H. P. de Alejo V. *Centro Azúcar,* 1981, **8,** (3), 101-108 *(Spanish).* — The work described was aimed at analysing the representativeness of the data obtained for different levels of milling in a factory, in order to calculate the heat balances. To do this, information was taken from the daily and 10-day laboratory reports and various instrument measurement which were subjected to variance analysis. The procedure followed is discussed, and it is concluded that the results vary with levels of milling and that the work should continue because of the possibilities envisaged for evaluation of different equipment and sugar factory stations.

Variation in the qualitative parameters of cooled raw sugar during its storage in bulk for a prolonged time. M. Canales and D. Esson. *Centro Azúcar,* 1981, **8,** (3), 123-140 *(Spanish).* — The effect of a fluidized-bed cooler on sugar was examined by sampling of two 960-tonne piles of sugar, one with cooling and one without. The results showed that cooling slowed the deterioration reactions and that cooling is preferable to creating special storage conditions.

High-efficiency exhaustion massecuite heater. R. de los Rios C. *Centro Azúcar,* 1981, **8,** (3), 141-152 *(Spanish).* A specification is indicated for a *C*-massecuite reheater, the main characteristic of which is a large heating surface relative to volume so that it can use, as heating medium, water with a temperature only a little above the final temperature required for the massecuite, thus providing a minimum residence time and eliminating local redissolving of crystals.

Control strategies in continuous crystallizers in sugar plant. S. Teijero P., P. Padron R. and J. J. Cabana G. *Control Cibernetica y Automatización,* 1980, **14,** (1), 33-34; through *S.I.A.,* 1982, **44,** Abs. 82-1654. — Principles of various alternatives for continuous crystallizer control are indicated and the merits of these systems evaluated. The system considered best comprises conventional control of temperature in crystallizers Nos. 2 and 5 plus digital and anticipatory control in No. 4; the conventional control on No. 2 can be made anticipatory using data from No. 1. The system has been developed using microprocessors, giving adequate decentralization together with reliability and cheapness.

Steam generation and requirements. P. A. Koopman. *Sukari,* 1982, **1,** (4), 24-26 *(French).* — The calorific value of bagasse is discussed and, on the basis of a value of 2000-2300 kcal/kg, it is estimated that 1 kg of fuel oil is equivalent to 4-5 kg of bagasse, while 1 m^3 of natural gas is equivalent to 3.5-4.0 kg. Assuming an hourly crushing rate of 70 tch and 35% bagasse on cane, it is estimated that a factory processing 300,000 tonnes of cane in a season can cover its steam generating require-

ments provided that the steam consumption is not allowed to rise. Means of avoiding excessive consumption are outlined, particularly maintenance of as high an evaporator syrup Brix as practical, preferably 65°Bx. It is shown, by calculation, that the difference between a syrup Brix of 58° and 65° represents 1.7 tonnes per hr of vapour available for bleeding to the vacuum pans (assuming an hourly crushing rate of 70 tonnes of cane, a mixed juice volume of 82% on cane and a Brix of 16°), or 0.68 tonnes of bagasse that is burnt to provide the steam for evaporation of the extra quantity of water.

Study on massecuite exhaustion at Kiliba sugar factory. K. Otelanyele. *Sukari,* 1982, **1**, (3), 27-32; (4), 27-29 *(French).* — Balances are drawn up for three boiling schemes: two 3-massecuite systems (in one of which *C*-sugar is affined and used as *A*-massecuite footing while the run-off is reboiled) and a 4-massecuite scheme. The scheme used at Kiliba is a straight 3-massecuite system, but exhaustion and sugar quality have proved unsatisfactory because of excessive recycling of run-offs; a 4-massecuite scheme is shown to be of no improvement and would involve even greater quantities of recycled run-off, whereas the 3-massecuite scheme with low-grade sugar affination would give a better *C*-sugar crystallization rate as a result of crystal washing and reduction in recycling, permitting an increase of 5.2% in sugar house capacity.

Power economy in sugar factories. P. N. R. Rao. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.1-E.9. — It is pointed out that the demand for power in Indian sugar factories has steadily increased in recent years, the requirement of plant other than mill drives being sometimes as high as 1.4 kW per tonne of cane in a sulphitation factory by comparison with a level well below 1.0 kW per tonne in the past. The problem of high steam consumption is very serious in many of the new factories, where it is difficult to reduce the consumption to below 55% on cane. The author discusses the power consumption of each process station in a factory of 1250 tcd crushing capacity, showing where there is scope for improvement.

Economical maintenance of steam turbines. G. Alexander. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.11-E.13. — The need for adequate maintenance of steam turbines used as cane mill drives is emphasized: practical experience has shown that the costs of an adequate program of annual maintenance, including inspection, repairs and spare parts, will be 4% of the installed cost of the turbine and will permit many years of operation without any fall in efficiency. Factors affecting turbine operation and maintenance are discussed, including moisture in steam, corrosive agents, lubrication and adoption of a systematic maintenance program.

Effect of pressure and capacity on turbine steam consumption. G. Kumar and A. K. Saxena. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.15-E.20. With the wider use of steam turbines as cane mill drives and power generatiors, it is important to ensure that steam consumption is kept as low as possible and that the amount gnerated does not exceed requirements. Advice is offered on selection of turbines. Allowance should be made for fluctuation in the working pressure of the boiler and in the pressure drop from boiler to turbine. Attention to boiler operation and design of steam lines will contribute to a rise in power generation efficiency by permitting use of a higher-pressure turbine. However, it is undesirable to buy a turbine of greater capacity than is required for normal conditions merely to allow for temporary fluctuations in load and future additional power requirements if and when the factory capacity is increased, since the turbine will normally be grossly underloaded. The authors show how other means can be used to meet these two requirements.

A look into milling performance. G. Selvaraj, N. N. Ahmed, K. Ramanathan and V. L. J. Ahmed. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.21-E.35. A mass balance was established for an 18-roller milling tandem by analysing the juice and bagasse from each of the six mills and calculating the analysis of the bagasse fed to each mill after imbibition. For purposes of calculation the cane was assumed to contain only Brix, fibre and water. For purposes of calculation the cane was assumed to contain only Brix, fibre and water. A factor known as the Liquid Extraction Efficiency was devised as a criterion of individual mill performance; it is dependent on the amount of liquid absorbed by the bagasse and on the quantity of imbibition, and is defined as

$$1 - \left(\frac{\text{outgoing liquid \% fibre}}{\text{incoming liquid \% fibre}}\right) \times 100.$$

Sample calculations are given, and the progress of liquid extraction in a tandem demonstrated by tabulated data and diagrams.

Interlocking system in a modern sugar plant. K. S. R. Rao, R. N. Murty and K. S. R. Murty. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.37-E.43. — The benefits of an interlocked system of cane carriers, knife sets and levellers for instantaneous stoppage in the event of a breakdown at any one point in the mill tandem and for smooth restarting are discussed with the aid of diagrams.

Reheating of massecuites — transient heating. K. S. G. Doss. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.45-E.58. — Various forms of massecuite reheating are surveyed, and details given of tests conducted on transient heating in a plate-type or a shell-and-tube heat exchanger (a rectangular duct design being preferred) in each of which the temperature of *C*-massecuite was raised by 10°C in 10 minutes with negligible rise in purity. Advantages of the method are listed.

On recirculation of maceration liquid and mill extraction. J. P. Mukherji, N. A. Ramaiah and A. P. Chinnaswamy. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, E.59-E.69. — Investigations conducted on the effect of quantity of imbibition on milling extraction in South Africa, Australia, Hawaii and India are briefly surveyed, and a system described in which the imbibition liquid is recirculated to the last two mills only in a six-mill tandem. The scheme is expected to increase extraction significantly, but involves a number of changes to the juice pumps and collection arrangements, while also requiring particular attention to drainage and roller surface maintenance in view of the considerable increase in the amount of liquid to be handled.

Continuous conditioning of *C*-massecuite. B. L. Mittal. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.19-Mg.23. — Optimum low-grade massecuite treatment to secure maximum exhaustion is discussed and types of crystallizer surveyed, including a vertical model designed by the author which consists of two concentric tanks having a common bottom plate; massecuite is fed

into the inner tank where it passes from the maturing stage to the cooling stage (brought about by fixed or rotating elements carrying water), passes into the space between the tanks, where it is ripened, and finally overflows into a peripheral gutter from which it is mechanically scraped into a massecuite reheater.

Electronic instrumentation and control in respect of the sugar industry. A. K. Verma and A. Kanodia. *Proc. 46th Conv. Sugar Tech. Assoc. India,* 1982, Mg.25-Mg.26. The Indian sugar industry has generally failed to introduce electronic controls, and the authors examine two key areas where such controls would be of benefit, viz. cane feeding to the mill, and bagasse weighing and feeding to the boilers.

A case study of a semi-Kestner — evaporation efficiency. V. K. Sharma and R. K. Shukla. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.27-Mg.37. — The performance of a semi-Kestner evaporator used as pre-evaporator with a quintuple-effect system has been evaluated. Evaporation rate was 8.33 $lb.ft^{-2}$ compared with 6-7 $lb.ft^{-2}$ in other types of pre-evaporator, while the amount of vapour bled to the raw juice heater, *A*- and *B*-pans and 2nd evaporator effect was equivalent to a steam saving of 13% on cane.

A study on the use of Pan Aid Super A-30: a surface-active additive. S. Srinivasan, N. Chinnapan, R. Lokabiraman, R. Senguttuvan, V. Devaraj and C. Srinivasan. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.45-Mg.67. — Addition of Pan Aid Super A-30 to low-grade massecuite at 50 ppm gave a 50 minute reduction in boiling time by comparison with absence of additive, and a 20 minute reduction by comparison with use of Instol surfactant; it gave a slightly better purity drop than without additive and improved massecuite purging.

Modifications to a K.C.P. Graver settler — a case study at Sonepat sugar factory. B. K. Srivastava and R. K. Jain. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.69-Mg.75. — Because of problems in clarification, a number of modifications were made to the Graver settler that had been supplied by K.C.P. Ltd. The changes involved juice feed and withdrawal, and addition of an extra tray in the flocculation compartment (thus avoiding heightening of the clarifier). Details are given of the modifications, which have permitted a daily juice throughput of up to the equivalent of 14,700 quintals of cane without any problems (which had arisen previously at a daily crushing rate of 8-10,000 quintals of cane), while juice quality has improved greatly.

A study of the working of DDS diffusers in Maharashtra. R. N. Kumar. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.77-Mg.89. — The performances of DDS diffusers at five sugar factories in Maharashtra are discussed with the aid of tabulated data. Comparison of a milling-cum-diffusion system, incorporating four mills of the same size, with a straight six-mill tandem showed that the latter gave the better performance, mainly because of the pol losses in the diffuser. Moreover, two primary mills are required with a DDS diffuser in order to achieve a primary juice extraction greater than 60% in view of the inadvisability of fine cane preparation (a view expressed by the manufacturers of the diffuser).

Cooling of final molasses to avoid spontaneous combostion during storage. N. A. Ramaiah. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.91-Mg.94. It has been stated[1] that rapid decomposition of molasses may occur if its temperature in storage exceeds 42°C. The author therefore advocates a cooling system for molasses; apart from tubular heat exchangers and the transient heater described by Doss for low-grade massecuite, the author suggests a flattened-tube cooler in which water flows counter-current to the molasses. Such a cooler could be inserted in the pipeline before the storage tank.

The Indonesian sugar industry: past, present and future. A. Goedhart. *Sugar y Azúcar,* 1982, **77,** (12), 23, 25-27. A survey is presented of the development and present state of the Indonesian sugar industry, with some details of the expansion program that is under way. Information is also provided on the price and government buying of sugar as well as on the projected total consumption and economics of sugar production.

Utilization of cane with tops and total cane in the production of sugar, alcohol and energy. G. A. Silva, J. F. Silva Jr. and R. A. Ceballos. *Brasil Açuc.,* 1982, **100,** 214-221 *(Portuguese).* — An economic analysis is made of the different quantities of recoverable sugar, alcohol and electrical energy obtained when crushing cane with and without tops, burnt and unburnt. The topped and burnt cane gives a higher recovery of sugar on weight of cane, but on an area basis the loss in sugar receipts is more than compensated by the additional receipts for alcohol and electricity produced and sold.

Optimization of the cane juice settling process. L. G. Rodriguez, A. V. Gukalov, P. M. Fabregat and A. P. Nikolaev. *Izv. Vuzov, Pishch. Tekh.,* 1982, (6), 122-123 *(Russian).* — Mathematical modelling of cane juice clarification and filtration was carried out with the intention of determining the possibility of reducing daily costs of juice treatment in Cuban sugar factories by means of more economical systems and judicious selection of equipment. The model included material balances of the juice components and equations obtained by the authors for calculation of settling velocity and mud density as functions of juice calcium, phosphates and temperature and the amount of flocculant used. Results showed that the overall costs were mainly governed by those of filtration, in turn dependent on the quantity and density of the mud; after these came costs associated with equipment amortization and sugar losses caused by degradation during clarification — these costs were proportional to the residence time in the clarifier. With increase in the untreated juice insolubles content from 0.5 to 2.0%, the process costs rose, in a number of cases, by 350%. Increase in the juice Ca content above an optimum of 300 $mg.litre^{-1}$ caused a fall in settling rate; increase in the phosphate content above 200 $mg.litre^{-1}$ had the same effect, but did also cause increase in mud density, so that the optimum lies in the range 200-350 $mg.litre^{-1}$. Addition of 4 mg 10% Magnafloc solution per litre of juice was optimum in reducing costs, as was a clarification temperature of 80°C. A clarifier giving greater mud density was preferable to one in which juice residence time was shorter. Therefore, for a factory producing 50,000 tonnes of sugar annually, it is calculated that application of the various steps mentioned will permit an annual saving of 37,500 pesos.

[1] Meade-Chen: " Cane sugar handbook" (Wiley, New York) 1977, p. 65.

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An interlocking control panel for advanced operation of a sugar factory. D. Moc, F. Pulkrabek and J. Radek. *Listy Cukr.*, 1982, **98**, 255-257 *(Czech)*. — Details are given of the central control at Predmerice sugar factory, which is backed up by closed-circuit television; for access to central laboratory data, a television camera is located above the central register, while sampling is also centrally controlled.

Mechanical trash separator before the beet slicers. I. Stuchl and J. Rais. *Listy Cukr.*, 1982, **98**, 257-261 *(Czech)*. — A trash separator mounted before the beet slicer comprises two rollers contra-rotating at 32 rpm towards or away from each other. Each roller carries, at diametrically opposed points on the circumference, two stripper blades which remove trash as the beets pass over the rollers on an inclined path. The trash then falls between the rollers. When the rollers rotated away from each other during trials, the amount of trash removed was far greater (0.35% on beet) than when they rotated towards each other (0.23% on beet), while losses of beet were about the same with both directions.

Improving the operation of a trough-type diffuser by means of drive control. A. Furmanek and T. Kalitynski. *Gaz. Cukr.*, 1982, **90**, 179-180 *(Polish)*. — Details are given of a system for automatic control of scroll speed in a DDS-type diffuser based on regulation of the voltage and current input to the Ward-Leonard drives. Results obtained at Lublin factory are reported.

Application of a heat pump system in the evaporation station of Platy sugar factory. P. Christodoulou. *Hellenic Sugar Ind. Quarterly Bull.*, 1982, (48/49), 3-33 *(Greek)*. Full details are given of a steam jet ejector system used for vapour compression in which maximum efficiency is achieved by using four different sizes of jet nozzle; this permits 16 different compression ratios to be obtained. The driving steam of 25 bar pressure raises the pressure of 2nd effect vapour from 2 bar to 3.5 bar, and the mixture is then fed to the 1st effect of the quintuple-effect evaporator. The result is an increase in the capacity of the evaporator to meet the requirements of an increased daily beet slice of 8500 tonnes (compared with 7000 tonnes previously). Fuel oil consumption has been reduced by 0.125% on beet, while thermal pollution of the atmosphere has been decreased. The economics of the system are calculated.

Effluent treatment by auto-purification in a series of tanks at Xanthi sugar factory. C. Andronikides. *Hellenic Sugar Ind. Quarterly Bull.*, 1982, (48/49), 34-49 *(Greek)*. Details are given of the lagooning system used at Xanthi sugar factory for effluent treatment. Tabulated data demonstrate the gradual fall in BOD_5 over a 6 months' period; in 1981, it was reduced from an initial 830 mg.litre^{-1} to 20 mg. litre^{-1}. The total area is 7 ha and the water depth 2.5 m; the two factors favouring the system are climatic conditions (with continuous winds) and large amount of land available (because its poor quality precludes its use for any other purpose). Addition of N and P to the effluent is not necessary because of a sufficiency of these elements emanating from the beets and mud. Anaerobic treatment takes place in the winter months, while the aerobic phase occurs in the following spring.

The conditioning of heat circuits in sugar factories. M. Bartoletti. *Ind. Sacc. Ital.*, 1982, **75**, 137-143 *(Italian)*. The problems of water carryover in steam, scale formation, corrosion and caustic embrittlement and their effects on boiler performance are discussed, and treatment of condensate with various types of chemical for prevention of the above-mentioned phenomena is described.

Gypsum and other pulp pressing aids. M. Shore, J. A. Adams, N. W. Broughton, N. Bumstead and G. C. Jones. *Zuckerind.*, 1982, **107**, 1011-1024 *(German)*. — See *I.S.J.*, 1983, **85**, 6-10, 43-48, 76-81.

The rheology of the sugar-calcium carbonate complex. J. Grabka. *Zuckerind.*, 1982, **107**, 1024-1027 *(German)*. Rheological investigations conducted on the complex formed between calcium saccharate and calcium carbonate under controlled laboratory conditions are reported. The complex, K11G, was found to have a gel-like consistency and dissolved only slowly in raw juice, thus creating ideal conditions for colloid precipitation in preliming. Shear gradient and end-alkalinity affected changes in the structure of the complex.

Possibilities of reducing the energy consumption in the sugar industry. E. Manzke. *Lebensmittelind.*, 1982, **29**, 489-492 *(German)*. — The East German sugar industry consumes about 3,600,000 tonnes of raw lignite units annually; since lignite is at present the only real energy reserve in the country, it is important to use it as sparingly and effectively as possible. However, despite improvements already achieved, heat energy consumption in the sugar factories is still well above the levels attained in other countries. In an investigation of the situation in selected white sugar factories, waste heat and heat losses were found to constitute 49% of the heat input, the major loss (36.8%) being in condensate. Utilization of the condensate from pan vapours is made difficult by its low temperature (40-50°C) and the large amount of energy available in this form. Only by reducing the quantity of vapour to be condensed is a substantial reduction in this waste heat possible; potential means include full use of the vapour from the final evaporator effect for heating purposes, and increase in massecuite Brix (hence reduced evaporation requirement). At two factories a thick juice Brix of $> 70°$ was achieved by using 3rd effect vapour to heat the pans. Also recommended is the use of pan vapours for raw juice heating and cossettes prescalding. Possible methods of utilizing hot condensate are examined, and mention is made of the advantages of the heat pump as well as the generation of electricity within the factory. Means of generating maximum power and optimizing its consumption are described.

Higher sugar yield by means of improved low-grade massecuite treatment. K. P. Müller. *Lebensmittelind.*, 1982, **29**, 493-496 *(German)*. — With a fall in beet quality over a period of many years, as expressed by reduction in the sucrose content and increase in the non-sucrose constituents, there has been a rise in molasses

sugar and a concomitant fall in white sugar yield in East German factories. Means of increasing exhaustion are examined, covering various facets of boiling and massecuite cooling. Two-stage crystallization, wherein 20-30% of the massecuite is removed at the start of cooling, sent to the centrifugals and the run-off returned to the crystallizer, has a number of benefits, particularly for raw sugar manufacture, as shown by a Brix diagram of boiling house operations using both conventional cooling and the two-stage scheme. Application of the system at Haldensleben resulted in an average reduction in molasses purity of 3.3 units in 1980/81 by comparison with the results for 1975-80. The possible use of ion exchange or a saccharate process for sugar recovery from molasses is also discussed in brief.

Results of investigations on filter cloth application in the sugar industry. W. Schult. *Lebensmittelind.*, 1982, **29**, 496-498 *(German).* — Tests carried out over five years on a number of synthetic fibre cloths of East German manufacture are reported. Low-pressure filtration of 1st carbonatation juice in a unit containing 24 elements, totalling 52.8 m^2 filter area, gave a filtration coefficient in the range 0.8-3.5 at an hourly throughput of 30-35 m^2 and a temperature of 80-90°C, corresponding to a thickening ratio between 1:6 and 1:8. Thin juice filtration gave a turbidity level in the filtrate that was similar to that attainable with a membrane filter. In both cases, Dederon-Köper 510 cloths were used. However, problems in filtration of thick juice and standard liquor were attributed to inadequate sweetening-off with thin juice or condensate after each cycle and to the use of steam instead of air to clean the filter cloths (air being preferable because of the need for adequate turbulence).

Determination of the elasticity modulus of a juice-cossettes mixture. N. N. Pushanko and A. A. Seregin. *Pishch. Prom.*, 1982, (28), 21-25 *(Russian).* — The theory of cossette deformation by the scroll elements in a diffuser is explained and a method described for determination of the modulus of elasticity which is applicable to varying conditions and beet quality, permitting the field of distribution of applied pressure and deformation to be established.

Transporting of cossettes in tower diffusers. N. N. Pushanko and A. A. Seregin. *Pishch. Prom.*, 1982, (28), 26-29 *(Russian).* — Studies have shown that the radial velocity of movement of the juice-cossettes mixture in a tower diffuser is of an order lower than the vertical and tangential velocities and so was omitted from investigations of cossettes movement. Results of the studies showed that at the same angle of the scroll elements to the vertical, the cossettes underwent changes in their physical properties as they passed up the diffuser, leading to changes in the direction of movement in the different sections of the tower and causing non-uniformity in the space occupied and hence excessive recirculation. The method described is considered an aid to improvements in the design of transport systems.

The kinetics of mass transfer in rotary diffusers. N. V. Pogorelova and V. M. Lysyanskii. *Pishch. Prom.*, 1982, (28), 29-33 *(Russian).* — Investigations showed that, under normal operating conditions, mass transfer from cossettes of acceptable quality is at a high rate throughout a rotary diffuser; if there is any fall in the rate, it is due to inadequate temperature — this in turn lowers cell wall permeability.

Lifting of beets in sugar factories by centrifugal pumps with air injection in the delivery line. I. G. Zelenyuk and I. K. Motuz. *Pishch. Prom.*, 1982, (28), 33-36 *(Russian).* When beets are lifted e.g. to a height exceeding 16 m, increase in the speed of rotation of the centrifugal pump impeller will increase damage to the beets, while maintenance of too low a speed will be inadequate for the task. Hence, it is advisable to use air injection in the delivery line as a supplement to the pump capacity at which beet damage is minimal. Guidance is offered on calculation of the requisite parameters.

Storage of beet thick juice for subsequent processing to sugar. I. B. Petrichenko *et al. Pishch. Prom.*, 1982, (28), 36-41 *(Russian).* — Details are given of a scheme set up at Yagotinskii experimental sugar factory for production of thick juice and its subsequent processing after 59 days' storage. The scheme was successfully used during 1970-77.

Calculation of the final size distribution of sugar crystals with fluctuating reduction in massecuite temperature. I. G. Bazhal, L. I. Trebin, M. V. Popova and V. A. Mikhailik. *Pishch. Prom.*, 1982, (28), 41-44 *(Russian).* A method is described for calculation of massecuite target granulometry as a means of planning for a given sugar quality when the boiling scheme involves periodical imposed changes in the massecuite temperature (through changes in the pressure of the reheat steam). An equation is presented for calculation of the required sugar fractional composition, given the amplitude and frequency of temperature changes.

Rational operating conditions of centrifugal pumps at sugar factories. I. G. Zelenyuk and G. E. Rudenko-Gritsyuk. *Pishch. Prom.*, 1982, (28), 44-46 *(Russian).* The effect of viscosity on centrifugal pump performance is briefly discussed, and the need to convert known performance data for a liquid of lower viscosity to those corresponding to the higher viscosities of beet sugar factory intermediate products is stressed. Also important is knowledge of the hydraulic characteristics of associated pipelines.

The 24-frame A2-PRB-24 centrifugal beet slicer. A. M. Shcherbakov, V. G. Shelemekha, V. P. Kovalenko and V. A. Prigornitskii. *Sakhar. Prom.*, 1982, (11), 26-28 *(Russian).* — Details are given of the title beet slicer of Soviet manufacture which has been tested during two campaigns, providing a high degree of cossette uniformity at a fines content of about 3%. Rated throughput is 3100 tonnes of beet per day at a speed of 6 $m.sec^{-1}$, a knife pitch of 8.25 mm and a cossette length of 8-9 m/100 g; electricity consumption is 54-58 kWh.

Technological efficiency of cavitation-aeration treatment of juice in main liming. R. G. Zhizhina *et al. Sakhar. Prom.*, 1982, (11), 30-33 *(Russian).* — By bubbling air into the juice feed line to the main liming tank at the rate of 0.1-3.0 nm^3 per m^3 of juice (optimum 1-1.15 nm^3/m^3) after introduction of milk-of-lime, liming time was cut by about 30% and purification efficiency increased by 4.6%. Colour, lime salts and reducing sugar contents were decreased.

Hydromonitor unit for feeding beets to process. A. S. Zaets and N. B. Mistetskii. *Sakhar. Prom.*, 1982, (11), 39-42 *(Russian).* — Details are given of a rail-mounted, electrically driven platform provided with spray guns which is used to force the beets from storage piles into the flume.

Choice of materials for the heat exchange tubes in sectioned raw juice heaters. V. A. Yavor, M. M. Gitel'man, N. M. Piskunova and M. V. Dvornichenko. *Sakhar. Prom.*, 1982, (11), 43-44 *(Russian)*. — Tests conducted on tubular samples of two stainless steels confirmed their greater wear resistance by comparison with brass and particularly carbon steel when mounted in raw juice heaters in which juice flow was 2.9 $m.sec^{-1}$.

Application of the vertical concept to crystallizers. I. Problems of crystallizer development, and transition to vertical equipment. S. Kucera. *Listy Cukr.*, 1982, **98**, 272-276 *(Czech)*. — In a discussion of the limitations of horizontal crystallizer design and operation it is pointed out that, apart from problems associated with the mixer and discs used as cooling elements, such crystallizers are economically viable only for massecuite capacities up to 80 tonnes. Advantages of vertical crystallizers are then briefly examined.

Speed-controlled alternating current drive for a batch sugar centrifugal. K. A. Schultes and J. Merkl. *Zuckerind.*, 1982, **107**, 1124-1128 *(German)*. — While one of the main reasons for continued use of D.C. motors as batch centrifugal drives has been the availability of simple, economical means of speed control, advances in the production of inexpensive frequency changers has made the A.C. motor a serious competitor as a variable-speed drive. Details are given of an A.C. drive and associated controls installed on a batch centrifugal at Hohenau sugar factory for the 1981/82 campaign. Advantages of the change-pol, squirrel-cage motor are listed, and charts are reproduced that demonstrate its high performance. As a result of the results obtained, a drive of the same type was installed on another centrifugal. No modifications had to be made to the centrifugal for installation of the new motor.

Synthetic organic polyelectrolytes and their application in outdoor operations at sugar factories. R. Simon. *Zuckerind.*, 1982, **107**, 1128-1131 *(German)*. — After an introduction to the synthesis of organic polyelectrolytes such as acrylamide and its derivatives, the action of these flocculants in a dispersed system is briefly described, and their application to treatment of waste water and mud dewatering discussed. The use of laboratory tests to evaluate performance as a guide to selection and as a means of monitoring plant efficiency is described.

The fuel and energy economies in Wielkopolski sugar factories. E. Krupka. *Gaz. Cukr.*, 1982, **90**, 205-208 *(Polish)*. — The situation regarding fuel consumption and steam generation and use in sugar factories of a major western region of Polish is examined, with some information on equipment and its age, the efficiencies of specific factories, and advice on vapour use for juice heating.

Trials of a vapour thermocompression unit at Chelmza sugar factory. W. Ciechonski, G. Bator, K. Urbaniec and M. Wierusz. *Gaz. Cukr.*, 1982, **90**, 208-210 *(Polish)*. Details are given of a vapour thermocompressor installed at Chelmza and of its performance in trials in which pan vapour of 0.022 MPa pressure was compressed to 0.123-0.133 MPa at an hourly rate of 4.3 tonnes.

A modernized A1-PD2-S20 diffuser. N. N. Krutikov, D. I. Smetana and V. I. Andreev. *Sakhar. Prom.*, 1982, (12), 12-14 *(Russian)*. — Details are given of modifications made to a Soviet-built inclined-trough diffuser after trials had revealed a number of defects in both design and operation. The modified diffuser operated 131 days in trials without any breakdown, at a daily throughput of some 2000 tonnes of beet and mean losses to pulp of 0.37% on beet; juice draft was 112%.

A dosing device for injecting anti-foam agent into a diffuser. B. N. Valovoi, V. G. Yarmilko, N. V. Kulinich and L. M. Osadchii. *Sakhar. Prom.*, 1982, (12), 18-20 *(Russian)*. — While the three forms of dosing device widely used outside the Soviet Union (piston pump with stepless dosage control, magnetic valve and flowmeter of the Rotameter type) are sufficiently efficient for injection of anti-foam agent, they are considered somewhat expensive, so that it was decided to develop a model in the USSR based on a plunger pump driven by an asynchronous motor through a reduction gear. However, a number of problems were encountered in tests on the model, and an alternative design was used in which a diaphragm deflected by injected air is forced against a spring-mounted slide mechanism, the head of which carries ball valves through which the anti-foam agent is injected into the beet diffuser. The pulse generator operates at a constant 0.05 Hz, and the relative dosing error is no more than ± 7%.

An efficient scheme for condensate withdrawal to tanks. V. K. Chernetskii *et al. Sakhar. Prom.*, 1982, (12), 32-34 *(Russian)*. — A scheme is described for withdrawing evaporator condensate and collecting it in five constant-level tanks from which it is recirculated after cooling to a required temperature. From the first tank, the condensate at 130°C is pumped via a juice heater to the boiler house; some of the condensate from the 2nd tank is also pumped, at 124°C, to the boiler house, while the rest is transferred to the 3rd tank where it is boiled and the flash vapour fed to the evaporator. The same procedure is used in tanks 4 and 5 as in tank 3. Thus, the condensate in the 5th tank constitutes about 90% on beet and has a temperature corresponding to that of reheat steam in the 4th evaporator effect. It is further cooled in a raw juice heat exchanger.

Trends in the development of sugar manufacture technology. A. Vigh. *Cukoripar*, 1982, **35**, 143-148 *(Hungarian)*. — It is stated tht the technology of sugar manufacture develops along three main lines aimed at reducing energy consumption, safeguarding the environment and improving productivity. The major reduction in energy consumption can be brought about in the boiling house, although an important contribution is made by reducing the pulp drying requirements through more effective pressing (or drying may be completely eliminated). As regards environmental protection, the aim is to utilize as much waste material as possible, e.g. by processing beet pieces, raising the dry solids of filter cake for use as fertilizer, recycling water, etc., while productivity can be raised by using equipment of greater capacity and increasing the daily beet slice.

Trials on flume water settling. L. Haraszti. *Cukoripar*, 1982, **35**, 148-153 *(Hungarian)*. — Trials are reported in which various flocculants were used in the settling of flume water. Tabulated data demonstrate the effectiveness of the various chemicals in terms of reduction of COD and suspended matter after given times by comparison with the untreated water. In different sets of experiments, Drewfloc 275 (manufactured by Drew Chemical Corp.) was approximately as effective as

Struktol I 658 (manufactured by Schill & Seilacher) at the same concentration, while both were better than Struktol Superflok S in terms of suspended matter but about the same as regards COD reduction. Sedakril (of Yugoslavian origin) was superior to Struktol I 658 in another test, while Cyanamid A 130 was about the same in efficiency as Struktol I 658 in another separate trial.

Construction of the beet yard at Petohaza sugar factory. J. Szakovits and M. Tomordi. *Cukoripar,* 1982, **35,** 153-157 *(Hungarian).* — An illustrated description is given of the new beet yard under construction at Petohaza, with diagrams showing the layout. Work started in 1981 and is planned to finish in 1984. Details are given of the equipment, which includes Elfa plant.

Disintegration of a centrifugal basket during the 1981/82 campaign. New safety regulations for the manufacture and testing of batch sugar centrifugal baskets. G. Schneider. *Zuckerind.,* 1983, **108,** 19-21 *(German).* Details are given of specific tests conducted on a centrifugal basket after it had disintegrated during spinning of white sugar, destroying the entire centrifugal and injuring two factory employees. The casing had split along the longitudinal weld, and inspection of welds on 454 centrifugal baskets showed that in 67 cases the welds were sufficiently poor as to make future use of the baskets inadvisable. As a result of the investigations, safety standards for centrifugal baskets have had to be raised.

Manufacture and initial testing of batch sugar centrifugal baskets. H. K. Maushagen. *Zuckerind.,* 1983, **108,** 22-23 *(German).* — Following a number of failures of batch centrifugal baskets during operation, the professional association of the West German sugar industry conducted investigations that resulted in a complete re-appraisal of the test procedures and safety standards for such baskets. The underlying principles of the new testing and manufacturing procedures recommended are described, and the extension to commissioning trials is discussed.

Investigations of disinfectants in regard to their use in diffusers. A. Nickisch-Hartfiel and W. Mauch. *Zuckerind.,* 1983, **108,** 24-35 *(German).* — Comparison was made between 15 commercial disinfectants in regard to their suitability for use in beet diffusers. A purified gram-positive strain of *Bacillus* sp. isolated from a beet extract was used in the studies; the agar slide diffusion method gave a qualitative indication as well as a quantitative one (within a given concentration range) of the toxicity of readily soluble disinfectants. Details are given of the methods used to determine the minimum inhibiting concentration of disinfectant, the killing power, the degree of disinfection in terms of change in oxygen consumption, redox potential and ATP concentration, and microbial resistance to the disinfectants. Results, given in graph and tabular form, showed that the pH during diffusion affected the efficiency of the disinfectants; at pH 6, quaternary ammonium compounds were more effective than cationic disinfectants, thiocarbamates, formalin, hydrogen peroxide, cresol, an iodophore and an amphotenside. All the disinfectants tested were stable with temperature rise to 70°C. The effect of other chemicals added in the diffuser (anti-foam agents, acids for pH adjustment and $CaCl_2$ for improving pulp pressability) on the action of the disinfectants was found to be negligible at the concentrations studied, although a considerable adverse effect could occur at higher concentrations as illustrated by that of SO_2 on formalin at 10% acid (v/v). Since an increase in the resistance of microbes to disinfectants was observed after prolonged contact, continuous dosing is not recommended.

Mixing of sugar solutions. L. J. Kuijvenhoven and L. M. de Pree. *Zuckerind.,* 1983, **108,** 35-38. — Rapid and uniform distribution of syrup feed in the vacuum pan is of importance in regard to prevention of false grain formation with increase in Brix. Tests were conducted in a 25-litre vessel made of transparent material and housing a central cylinder (having a surface area half that of the total surface area of the vessel) in which a stirrer was inserted. Both stirrer rotary speed and the flow velocity of the continuously injected syrup were varied, and the mixing time in the vicinity of the stirrer and in the annular space between central cylinder and outer wall of the vessel determined. The mixing process was followed optically with the aid of ink, added to the feed in identical amounts for each test run. Results showed that mixing was fastest with sugar solutions of 1300-1350 $kg.m^{-3}$ density and a viscosity of 0.05-0.1 $Pa.sec^{-1}$ when they were fed directly below the stirrer, rather than at a point near the bottom of the outer wall of the vessel, and were immediately carried by the surface of the propeller. A long mixing time resulted when the syrup was injected at a point far from the stirrer. It appeared that mixing occurred primarily in the zones of high turbulence such as in the vicinity of the stirrer.

Determination of the explosive and flammable properties of dust and products of sugar manufacture. E. N. Popova, N. I. Pavlyuchenko, O. I. Tetekina and I. D. Stepchuk. *Sakhar. Prom.,* 1983, (1), 9-12 *(Russian).* — The explosive and flammable properties of granulated and icing sugar, and of dust from sugar, dried pulp, beet seed and sacking, were investigated and the threshold concentration of each type of substance at which flash ignition could take place was determined. The effect of dispersion and hence specific surface area on the threshold concentration is discussed.

Selection of operating conditions for cold-hot main liming. K. P. Zakharov, R. G. Zhizhina, V. Z. Semenenko and N. I. Zharinov. *Sakhar. Prom.,* 1983, (1), 20-23 *(Russian).* — The effect of time and temperature of the cold stage in cold-hot fractional liming on the filtration properties of 1st carbonatation juice and on the quality of 2nd carbonatation and thick juice was determined in experiments involving raw juice of varying quality. It was found that a temperature above 50°C in the cold liming stage adversely affected juice filtrability and caused increase in the colour of thick juice. A residence time of 20-30 minutes at 50°C resulted in a 30% lower juice colour content than hot liming at 85°C, as well as a lower concentration of nitrogenous and colloidal matter.

Adsorption of raw juice non-sugars in preliming. L. P. Reva, G. A. Simakhina and V. M. Logvin. *Sakhar. Prom.,* 1983, (1), 23-26 *(Russian).* — Investigations of albumin precipitation in preliming showed that some 20% was adsorbed on calcium oxalate, which is only slightly soluble and is formed by reaction of oxalic acid (constituting half of the total acids in raw juice) with Ca^{++} cations. The extent of adsorption fell with increase in temperature and was maximum at a pH near to neutral. Addition of extra oxalate to raw juice proved to be ineffective. The adsorption process was in conformity with the Langmuir equation.

Boiling 1st massecuite on a crystal footing of low-grade massecuite. A. R. Sapronov *et al. Sakhar. Prom.*, 1983, (1), 26-28 *(Russian).* — Tests showed that the quality of white sugar obtained by boiling 1st massecuite on a footing of affined low-grade sugar was almost the same as sugar obtained by the normal boiling process, including nucleation of fresh crystals, while the boiling cycle was cut by 25-30%. White sugar quality depended on efficient affination of the low-grade sugar with, preferably, dilute 1st massecuite wash syrup heated to 85°C, and on efficient washing of the white sugar, preferably with some of the wash water replaced with dilute 1st massecuite green syrup, also heated to 85°C.

Separation of sugar dust from aspiration wastes. A. F. Zaborsin, I. D. Stepchuk, P. A. Lyubarets, Yu. V. Tovstenko and V. D. Novoseletskii. *Sakhar. Prom.*, 1983, (1), 32-34 *(Russian).* — The amount of dust in air from a fluidized bed dryer/cooler is 100-150% greater than that of the air in a drum dryer section. The particle size distribution of sugar dust in samples of air taken from different sugar house process stations was determined, and that from a fluidized bed dryer/cooler found to contain the greatest proportion of larger particles (about 20% of fractions in the range 125-160 μm). The performances of various types of dust separator at sugar factories and refineries are discussed, and details given of a Sh1-PUV-50 patented wet dust separator which features a disc-type atomizer and has an efficiency of at least 99.8%.

The performance of purification plant at Chervonoznamensk sugar factory. I. V. Skirdov, I. M. Tavartkiladze, V. V. Sakhnenko and V. I. Tsaruk. *Sakhar. Prom.*, 1983, (1), 35-37 *(Russian).* — Details are given of the plant for treatment of sugar factory effluent and domestic sewage, which includes quiescent tanks, aeration-flotation tanks and biofilters. Some performance data are tabulated and discussed.

The electric drive of a modified A1-PD2-S20 diffuser and its features. N. N. Krutikov, V. V. Bogachev and V. I. Potekhin. *Sakhar. Prom.*, 1983, (1), 46-49 *(Russian).* Details are given of the thyristorized motor and control systems on modified A1-PD2-S20 twin-scroll trough diffusers; the automatic centralized lubrication system is also described.

A Sangerhausen (GDR) continuous centrifugal with thyristor electric drive. N. F. Sirotenskii and V. F. Pushanko. *Sakhar. Prom.*, 1983, (1), 49-51 *(Russian).* Details are given of the FKHo-1400-C continuous low-grade centrifugal of East German manufacture; it has an hourly throughput of 12 tonnes and gives a sugar of approx. 97 purity when dilution water is added to the massecuite (94 purity without water addition).

Application of the vertical concept to crystallizers. II. Development of a design solution for vertical crystallizers. S. Kucera. *Listy Cukr.*, 1983, **99**, 13-18 *(Czech).* After a discussion of vertical crystallizers manufactured outside Czechoslovakia, particularly the Salzgitter and BMA models (design parameters of which are tabulated), the question of designing a vertical crystallizer for use in Czechoslovakian sugar factories is examined. The type of cooling surface is considered, and preference shown for a horizontal disc arrangement with an opening in each disc to allow massecuite flow. Design parameters are given for a model (under construction) of throughput corresponding to a daily beet slice of 1500 and 3000-4000 tonnes. The rated cooling velocity is 1-1.5°C per hr and the massecuite flow rate at least 0.3 $m.hr^{-1}$; the massecuite temperature should not be allowed to fall below 40°C. As an indication of the type of series arrangement for a vertical crystallizer, the Salzgitter 4-crystallizer system is reproduced.

Forces imposed on a knife during slicing of sugar beets. S. M. Grebenyuk, V. G. Belik and A. M. Shcherbakov. *Izv. Vuzov, Pishch. Tekh.*, 1982, (5), 88-94 *(Russian).* For investigation of the force factors involved in beet slicing, the process was divided into the rupture of the beet by the cutting edge of the knife and rubbing of the layers of beet over the body of the knife by analogy with the flow of a liquid or air over a solid. The force imposed by the beet on the knife are defined by empirical equations characterizing the energy balance of the slicing process. The optimum slicing velocity is governed by beet quality, geometry of the knife cutting edge and cossette dimensions; under normal conditions, it will be in the range 3-7 $m.sec^{-1}$. The mean square difference between experimental and theoretical data did not exceed ± 7%.

A rheological equation of the state of dried beet pulp. V. P. Borodyanskii and V. L. Kegeles. *Izv. Vuzov, Pishch. Tekh.*, 1982, (5), 94-97 *(Russian).* — The forces exerted in pulp pressing and the resultant deformation were measured by tensometer, and a mathematical model of the kinetics of deformation and contributory factors developed. The validity of an equation for calculation of % deformation was tested, and a maximum difference between the experimental and theoretical data of ± 1.2% established.

Biogas — fundamentals of the mechanisms. J. D. Finck and G. Goma. *Biomasse Actualités*, 1983, (Suppt. 2), 5-11 *(French).* — The fundamentals of methane fermentation of waste water are explained, and some examples of application indicated in a table, including continuous treatment of sugar factory effluent by the IRIS process. At a daily COD charge of 5 $kg.m^{-3}$, treatment reduced the COD by 85% to yield 0.24 m^3 of biogas per kg COD (0.28 m^3 per kg COD removed). Average retention time was 1.7 days, and treatment was carried out at 30°C.

A lime kiln mass balance. I. Havranek and V. Bulena. *Listy Cukr.*, 1983, **99**, 37-40 *(Czech).* — A mass balance has been drawn up for a lime kiln of 80 m^3 volumetric capacity operating at a Czechoslovakian sugar factory; from the results it is considered that a kiln of 100 m^3 capacity would meet the lime and CO_2 requirements of a factory slicing 2000 tonnes of beet per day.

Increasing the performance of existing (sugar) milling plant. J. Gebler. *Listy Cukr.*, 1983, **99**, 40-41 *(Czech).* While the annual production of powdered sugar in Czechoslovakia is about 45,000 tonnes, there is marked fluctuation in delivery and hence consumption during the year, and this is ascribed to inadequate milling plant capacity. The author examines ways of remedying the situation, dividing the solution into two parts: improvement in the sugar so as to provide optimum material for milling, and improvement in the mechanical aspects of the equipment.

Decalcification of second carbonatation juice using the Gryllus process. J. Ponant. *Sucr. Belge*, 1982, **101**, 369-380. — See *I.S.J.*, 1983, **85**, 179.

SUGAR REFINING

On the automatic control of pan boiling by micro-computer. K. Fukushima, K. Kurokawa and F. Kawata. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **31**, 29-35 *(Japanese)*. — An automatic control system based on a micro-computer has been developed for granulated and crop sugar pans. The computer was introduced as master controller and sequencer in an analogue system based on a rheometric sensor which had operated successfully. Advantages of the system are given as: easy selection of the required boiling pattern, since one micro-computer can store six patterns; easy modification of the patterns; the possibility of altering set points and control patterns even during the actual boiling; and good reproducibility of performance. As a consequence of these improvements, the amount of balancing water was noticeably reduced, so that energy consumption fell. The results are tabulated.

Air bubble-type Brix meter for melt liquor. T. Teshima and Y. Kondo. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1982, **31**, 47-54 *(Japanese)*. — An air bubble meter based on the differential pressure method was used instead of a refractometer to measure and control the Brix of melt liquor. It covers a Brix range of 40-80° and is accurate to within ±0.5°Bx.

Experimental study on the effect of some mixing parameters on the quality of pressed sugar tablets. P. Betak and O. Mikus. *Ind. Alim. Agric.*, 1982, **99**, 517-522 *(French)*. — Laboratory investigations are reported, in which it was found that the resistance of moist sugar to cutting into tablets diminished with increase in the porosity of the pressed sugar, as did the time taken for the tablet to dissolve. The tendency to crumble during transportation and packaging was reduced by decreasing porosity and the proportion of the fine particles in the sugar mixture and increasing the moisture content. For bridge cubes, a porosity in the range 23-33% is recommended, while the press should be designed to apply a pressure of 15 MPa.

Reserves for increasing the sugar yield from cane raw sugar. E. Ya. Goisman. *Sakhar. Prom.*, 1982, (9), 30-31 *(Russian)*. — The white sugar yield from cane raw sugar could be increased in the USSR by various modifications to processing, and balances are calculated which show by how much the theoretical exceeds the true yield in specific factories (the difference between factory molasses and standard molasses sugar contents). Calculation of the amount of lime required for liquor treatment is also demonstrated; better control of the lime dosage would also contribute to increased sugar yield.

Calculation of the products in processing of raw sugar at a beet sugar factory. R. Ts. Mishchuk and L. G. Belostotskii. *Sakhar. Prom.*, 1982, (9), 42-45 *(Russian)*. A method of calculating the balances involved in raw sugar processing during the post-campaign period is set out; it is based on a 3-boiling scheme with recycling of some of the 1st massecuite green syrup to carbonatation.

Regeneration of powdered activated carbon. I. Thermal decomposition kinetics. K. Chihara, J. M. Smith and M. Suzuki. *A.I.Ch.E.J.* (Amer. Inst. Chem. Engineers), 1981, **27**, (2), 213-220. **II. Steam-carbon reaction kinetics.** K. Chihara, I. Matsui and J. M. Smith. *ibid.*, 220-225; through *S.I.A.*, 1982, **44**, Abs. 82-1298, 82-1299.

I. Powdered carbon was shaken with sucrose solutions of various concentrations and dried, producing carbon containing 4-25% by weight of adsorbed sucrose. The kinetics of its thermal regeneration (with inert gas) were studied at temperatures from 298 to 1033°K. The regeneration process was interpreted in terms of a two-step process: (a) low-temperature decomposition of sucrose to an adsorbed intermediate and gaseous products, and (b) a higher-temperature decomposition of the intermediate into adsorbed residual carbon and gaseous products. Surface area measurements indicated that most, but not all, of the original carbon surface could be restored by thermal regeneration. The % restored was greater at 773°K than at 523°K, but did not increase further with increasing temperature.

II. Thermally regenerated spent activated carbon was reacted with a steam-helium or steam-helium-hydrogen mixture at 1003-1123°K and 1 atm pressure. The kinetics of the reaction were measured. The data fitted a Langmuir-Hinshelwood equation, with activation energy 2.3×10^5 J/mol. Oxidation rates for virgin activated carbon were essentially the same as for the spent carbon. Surface area and pore volume measurements indicated that the adsorption capacity of the original carbon could be completely restored by thermal regeneration followed by reaction with steam. However, some carbon was lost, implying that there would be an optimum degree of steam gasification in a cyclical adsorption-regeneration process.

Science and the art of low-purity cane sugar crystallization. E. J. Culp. *Sugar J.*, 1982, **45**, (4), 7-12. — See *I.S.J.*, 1983, **85**, 55.

Raising the efficiency of cane raw sugar processing. T. A. Baimbekov, V. P. Usikova and N. V. Kostenko. *Sakhar. Prom.*, 1982, (10), 38-40 *(Russian)*. — Some information is given on the refining operations at Kainda sugar factory in Kirgiziya, and the annual performance of the factory compared with the average for the state and the Soviet Union. Particular mention is made of ferrous material removal by magnetic separators in the sugar drying plant.

Experience in preparation of clearing liquor for refinery massecuite washing at Krasnopresnensk and Cherkassy refineries. S. A. Brenman, F. P. Alekseenko, L. V. Ogorodniichuck, E. M. Lyublina and E. A. Skorobogatov. *Sakhar. Prom.*, 1983, (1), 28-31 *(Russian)*. — Details are given of the procedures and automatic controls used in the preparation of claring liquor at the title refineries, starting from unloading of raw sugar. Instead of ultramarine (which is in short supply) as bluing agent added to the liquor, indigo carmine was tested and found to be a suitable alternative.

Filter cake sweetening-off in raw sugar processing. A. B. Lander. *Sakhar. Prom.*, 1983, (1), 41-42 *(Russian)*. Sweetening-off procedures used in both beet sugar manufacture and refining are discussed and the quantities involved calculated.

LABORATORY STUDIES

Chemical analysis of seven nutrient elements in some sugar cane products and by-products. C. Y. Ivan, P. L. Bodoe and R. Mohammed. *Trop. Agric.* (Trinidad), 1983, **60**, 41-43. — Samples of clarified juice, clarified syrup, *A*-, *B*- and *C*-molasses, *C*-massecuite, filter cake, vinasse from a rum distillery as well as Comfith and Comrind (the milled central core and rind, respectively, of the cane stalk used as animal fodder) were analysed for Ca, Mg, P, K, Na, Fe and Cu. Results showed that the concentrations of the seven components, with the exception of Cu, increased from clarified juice to *C*-molasses, with a dip in the low-grade massecuite as a result of the diluting effect of sugar crystals as reflected in the higher Brix but lower ash content than for *B*- and *C*-molasses and indicating that most of the minerals remain in solution. The levels of the minerals in Comfith and Comrind were similar, except for Ca, which was of a far higher concentration in the Comrind. Filter cake was rich in Ca, P and Fe but relatively poor in the other elements. Vinasse contained high levels of Ca, P, K, Na and Cu but little Mg and Fe.

Standard molasses of 87% dry solids and extension of the validity of the saturation coefficient equation to cover cane sugar manufacture. E. Svoboda and J. Klepal. *Listy Cukr.*, 1982, **98**, 277-281 *(Czech)*. — Use was made of a programmable calculator to make a statistical analysis of standard molasses composition data obtained at 40°C and 87% refractometric dry solids (at which sucrose crystallization rate was found to be optimum). From the results, equations have been derived for calculation of the constants *m*, *b* and *c* in the saturation function $C = mA + b\ (1 - b)e^{-cA}$, where C = saturation (solubility) coefficient, A = non-sugars:water ratio, and e is the base of natural logarithms. The equations take the form: $m = -1.481 + 13.289\ x^{-1} - 38.195\ x^{-2} + 43.417\ x^{-3}$; $b = 3.736 - 31.895\ x^{-1} + 108.159\ x^{-2} - 121.010\ x^{-3}$; $c = 6.372 - 1.356\ x$, where x = standard molasses non-sugars concentration (kg/kg). The equations are valid for C in the range 2.2-4.3 and are equally applicable to beet and cane sugar manufacture.

Effect of chemical ripeners and insoluble solids on molasses exhaustibility and viscosity. T. Moritsugu and G. E. Sloane. *Rpts. 40th Ann. Conf. Hawaiian Sugar Tech.*, 1981, 37-38. — An investigation was conducted on molasses (and composites) obtained from cane treated with chemical ripener to see what effect ripener application had on the accuracy of exhaustibility prediction (purity calculated in terms of carbonate and conductimetric ash). Results showed that the difference between calculated and experimental results was similar for ripener-treated and untreated cane and that the difference between the average difference values for both types of cane were well within random error. The difference between experimental and calculated values rose with increase in the insoluble solids levels in molasses from both treated and untreated cane. Comparison of the relationship between viscosity (measured at 50°C) and refractometric dry solids for molasses from treated and untreated cane showed no significant differences. The study illustrated the differing relationships between viscosity and the several concentration factors that may be calculated from the measured insoluble solids; RDS as a percentage of the soluble fraction was found to be more closely related to viscosity than when expressed as a percentage of the total sample, while there was good correlation between viscosity and total solids, RDS and insoluble solids treated as individual independent variables in a multiple correlation.

HPLC analysis of sucrose and reducing sugars. N. Nomura. *Proc. 40th Ann. Conf. Hawaiian Sugar Tech.*, 1981, 43. Advantages of high-performance liquid chromatography for carbohydrate analysis are briefly stated to be its specificity, which allows sucrose, glucose and fructose to be determined quantitatively in a single analysis, the simplicity of sample preparation and a "reasonable" analysis time.

Determination of organic acids in pressed pulp silage. N. Kubadinow. *Zuckerind.*, 1982 **107**, 1107-1110 *(German)*. — Details are given of HPLC application to quantitative and qualitative determination of organic acids formed as a result of fermentation processes during beet pulp ensilage. The use of 0.013N sulphuric acid as eluent is of benefit in preventing fouling of the strongly acid cation exchange resin with cations adsorbed from the sample (thus extending the column life to that required for treatment of 700-800 samples), while the concentration of sulphuric acid is sufficiently small to prevent any effect of the acid on the system. Comparison with enzymatic determination of lactic acid and with GLC determination of acetic, propionic and butyric acids showed very good agreement between individual values, while the mean values were identical for both methods in each case.

Contribution to knowledge of the behaviour of amino-acids during sugar extraction. II. Investigations on the effect of juice purification process parameters. E. Reinefeld, K. M. Bliesener and J. Schulze. *Zuckerind.*, 1982, **107**, 1111-1119 *(German)*. — The effects of juice purification parameters on the amino-acid composition of beet juice were studied. All 17 amino-acids present in raw juice underwent a fall in content with each stage of purification, the total thin juice content being some two-thirds of that in untreated raw juice. Only two were formed during processing and were not present in the original raw juice, viz. glycine and γ-aminobutyric acid, the former from threonine and serine, and the latter from glutamine via pyrrolidone carboxylic acid and its decarboxylation product, 2-pyrrolidone. The greatest reduction occurred in glutamine + glutamic acid and asparagine + aspartic acid; ornithine and lysine, which participate preferentially in the Maillard reaction, also suffered considerable falls. Increase in liming time and temperature caused increase in glutamine cyclization, in the browning reaction and in glycine formation, while the fall in asparagine + aspartic acid was greater with increase in the quantity of lime added, indicating the particular role played by $CaCO_3$ as adsorbent. With the exception of the special case of glutamine, mud samples contained about half of the total quantity of amino-acids eliminated in juice purification. The liming parameters and invert content of raw juice had a much greater effect on the amino-acid balance than the method of juice purification. Further falls in amino-acid contents during evaporation and crystallization are attributed to contin-

uing glutamine cyclization and particularly to the Maillard reaction.

Reason for increase of the different faces of the sucrose crystal in the presence of technical dextran. L. Carrazana R. and E. A. Abreu. *Centro Azúcar,* 1981, **8,** (3), 83-91 *(Spanish).* — A total of 113 well-formed monocrystals of sucrose were obtained and, held in thread supports, were grown in circulated solutions of supersaturation 1.02 within an apparatus held at 70°C. The control solutions were of sucrose alone; other solutions contained 0.1%, 0.5% and 1.0% of a technical dextran. Five dimensions of each crystal were measured with a stereoscopic microscope and the measurements and the a:b (length:width) ratio subjected to statistical analysis. It is concluded from the results that the dextran affected the crystal habit with a different effect for each face. The growth was equal or less in the presence of dextran than in pure sucrose solution.

Determination of inorganic substances in colloidal or microdispersed state in cane sugar factory products. G. Fernández M., M. Darias P., J. Orestes G. and D. Moreira. *Centro Azúcar,* 1981, **8,** (3), 93-100 *(Spanish).* Samples of clear juice, dissolved raw sugar and molasses were screened and fractions treated to remove dispersed Ca and Mg compounds by dilution to 12°Bx followed by filtration and centrifugation, and a further fraction treated to remove colloidal Ca and Mg compounds by gel filtration through Sephadex G-50. The Ca, Mg and phosphate contents of the treated solutions were then analysed by a number of methods including photocolorimetry, complexiметry and atomic absorption. The first and last were suitable for measuring colloidal Ca and Mg, while the second was suitable for phosphate determination. The methods used for phosphate analysis gave the same result for *B*- and *C*-molasses, and the analyses showed that there was a reduction in the colloidal phosphate content during clarification which coincided with a reduction in colloidal Ca and Mg and may be attributed to an interaction between them.

Study of the effect of pH, of Ca^{++} concentration and of initial amino-acids concentration on colour formation in 5% fructose solutions. C. Díaz R. *Centro Azúcar,* 1981, **8,** (3), 109-122 *(Spanish).* — Colour formation in 5% fructose solutions held at 80°C was measured 15 and 30 minutes after mixing with the required amount of aspartic acid to give 0.062 and 0.082 g.litre^{-1}, with $CaCl_2$ solution to give a Ca^{++} ion content of 1, 5.5 and 10 mM, and/or buffer solution to provide a pH of 8.5, 9.0 or 9.5. The measurements of colour were subjected to statistical examination and are presented in a series of six graphs. The curves are converted to linear polynomial equations and the significance of the coefficients examined. Colour formation increased significantly with pH, with initial amino-acid concentration, with Ca^{++} concentration and with time. The Ca effect was greater than that of pH but there was an interaction such that the effect of Ca increased as pH rose. It is recommended that the Ca content in clear juice be reduced as much as possible to limit colour formation as well as to reduce scale formation.

Quantitative thin-layer chromatographic analysis of sugars, sugar acids and polyalcohols. R. Kalus and J. Ripphahn. *J. Chromatography,* 1982, **244,** (1), 99-124; through *S.I.A.,* 1982, **44,** Abs. 82-1624. — The possibilities of quantitative *in situ* fluorimetric analysis of sugars and diols are described with several examples. Separations are carried out on high-performance thin-layer chromatographic (HPTLC) plates, or (better still) HPTLC aluminium foils precoated with silica gel 60. Detection is by an *in situ* reaction which gives similar fluorescence spectra with all sugars, sugar alcohols and sugar acids. The reagent is a mixture of 5 ml saturated solution of lead tetra-acetate in glacial acetic acid, and 5 ml 1% 2,7-dichlorofluorescein, made up to 200 ml with toluene. This method of detection is very sensitive. However, qualitative tests on unknown mixtures, e.g. aldoses + ketoses or pentoses + hexoses, should be carried out by conventional staining methods. Separations described include those of (a) a mixture of several oligosaccharides, and (b) glucose, fructose, sucrose and glycerol in beverages.

Determination of copper in raw sugar: an application of kinetic methods. T. Gaytan P., N. Benitez H., Yu. A. Zhukov and B. E. Kalinina. *Centro, Ser. Química y Tecnología Química,* 1978, **6,** (1-2), 65-80; through *S.I.A.,* 1982, **44,** Abs. 82-1631. — A method is given for determination of Cu^{++} via its catalytic effect on the reduction of Fe^{+++} by thiosulphate in weakly acidic media. Before applying this method, Cu^{++} is separated from interfering species by extraction into dithizone in chloroform, acidification with HNO_3 and back-extraction into water. Solutions containing known amounts of $FeCl_3$, KSCN and $Na_2S_2O_3$ are mixed, giving an intensive red colour due to $Fe(SCN)_3$; to one of two samples is added the solution under test; the pair are kept 5 min at 32°C before measurement of optical density at 533 nm. The Cu^{++} concentration is deduced from a calibration curve according to the logarithmic relative decrease in optical density. Results for (sucrose + Cu^{++}) and for sugar agreed with those obtained via diethyldithiocarbamate colorimetry, to within 3%. Effects of 34 possibly interfering species were tested, starting with 2 mg Cu^{++} or (2 g X + 2 mg Cu^{++}); relative optical densities are indicated.

Calculation of particle size distribution in the industrial crystallization of sucrose. K. E. Austmeyer. *Chem. Ing. Technik,* 1981, **53,** (9), 716-719; through *S.I.A.,* 1982, **44,** Abs. 82-1731. — The theory of crystal size distribution (CSD) is discussed, with reference to residence time distribution and the laws of crystal growth, and using the Rosin-Rammler-Sperling-Bennett distribution as a basis for calculations. For a typical sugar boiling process in a batch pan with seed of known CSD, the theoretical curve for the CSD of the product can be calculated; the actual CSD is always wider, owing to non-uniform conditions within the pan. Similar calculations for a 7-compartment continuous pan show closer agreement between theoretical and actual curves. Calculated values of CSD obtainable in continuous pans with 1, 3, 5, 7, 10 and 15 compartments are shown in a graph.

Some aspects of the adsorption of sugar colorants by calcium salts. S. C. Sharma and P. C. Johary. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, Mg.1-Mg.17. In connexion with colour removal during clarification, studies were conducted on adsorption by three calcium salts of specially prepared caramel, alkaline degradation product of dextrose and melanoidin. Results showed that the percentage of melanoidin removed (of the order of 30%) was only slightly higher than that of caramel, while the removal of dextrose degradation product was poor (generally about 5-7%). The degree of adsorption by the three salts was in the following decreasing order: calcium phosphate > calcium sulphite > calcium carbon-

ate; increase in the quantity of carbonate and in its time of contact improved its decolorizing efficiency, which was nevertheless still the lowest of the three in terms of overall raw juice colour.

Identification of humic acid: a new colorant in clarified cane juice and its effect on the sulphitation reaction. M. Prasad and V. Dubey. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, C.1-C.14. — A colorant, isolated from clarified cane juice by absorption on active carbon and elution with an aqueous pyridine solution, was found, from infra-red spectra, to be humic acid; its absorption maximum occurred at 256 nm, compared with 280 nm for caramel. Further studies showed that it appeared to affect the ionization constant of H_2SO_3 formed in sulphitation and hence the rate of mud precipitation.

Solubility of sucrose in the presence of some salts. N. A. Ramaiah and K. Murari. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, G.1-G.12. — Sucrose solubility was determined in the presence of sodium, potassium and magnesium sulphates at 35, 40, 45, 50 and 55°C and different salt concentrations. All three compounds reduced solubility in water. The test data are tabulated.

The acid properties of sucrose in solutions. V. S. Shterman, I. Shakhovtseva and A. R. Sapronov. *Sakhar. Prom.,* 1983, (1), 38-40 *(Russian).* — Wide divergencies between values of dissociation constants K_1 and K_2 found for sucrose as a dibasic acid by different authors are discussed. The authors of the present article determined titration curves for sucrose of 0.05, 0.1, 0.5, 1.0 and 2.0 moles.litre^{-1} concentration in NaOH solutions of pH in the range 9.0-12.5 at 25°C. For calculation of the dissociation constants, sucrose was assumed to be a tetrabasic acid, and a series of equations are presented for constants K_1, K_2, K_3 and K_4. However, determination of the effect of the dissociation constants on the titration curves, using the experimental data as computer input, showed that K_3 and K_4 over a wide range of values had no effect on the form of the curves and so could be ignored. Hence, it is valid to regard sucrose in aqueous solutions as a dibasic acid, although its acid properties in concentrated and dilute solutions are noticeably different.

The density of technical sugar solutions. Z. Bubnik and P. Kadlec. *Listy Cukr.,* 1983, **99,** 18-23 *(Czech).* — The densities of raw sugar solution, molasses, syrups and thick juice from the 1974 and 1978-80 campaigns were measured at concentrations in the range 65-82°Bx, purities in the range 60-92 and at temperatures in the range 40-90°C. Regression equations were derived for calculation of the constants *a, b, c* and *d* (functions of sugar content) in the equation $\rho = at^3 + bt^2 + ct + d$, where t = temperature, for 16 different products represented by 110 samples. The density values were then used for compilation of a sub-program for application in calculation of the density of pure and technical solutions as well as massecuite. The calculated values are tabulated for Brix in 2-unit intervals, temperature in 5-unit intervals and purity in 10-unit intervals.

Determination of pol in bagasse by wet disintegration. H. G. Ayala. *La Ind. Azuc.,* 1982, **87,** 123 *(Spanish).* Currently, in Argentina, bagasse pol is measured by the hot digestion method of Norris which takes 2-3 hr. At Famaillá Experiment Station the use of wet digestion has been examined, since this takes only 15 minutes, and a description is given of the technique recommended. 200 g of bagasse is weighed, 2000 g of water added and the mixture disintegrated during 20 minutes. The liquid is recovered, compressing the fibre to the maximum. A portion of the extract is clarified with lead subacetate and filtered; the first 20 ml is discarded, and the pol reading then measured in a 400-mm tube. Pol % bagasse is given by $13L\ (P - F)/100\ M$, where L is the pol reading, P the weight of liquid + bagasse + fibre, F = fibre % bagasse, and M = weight of bagasse.

Contribution to the knowledge of colour formation in sugar beet juices. E. Reinefeld, K. M. Bliesener, E. Brandes and V. Borrass. *Sucr. Belge,* 1982, **101,** 333-345. — See *I.S.J.,* 1983, **85,** 183.

Immobilization of glucose isomerase. I. Covalent bonding of the enzyme to modified cellulose matrices. D. Petrovic, B. Barl and A. Gelineo. *Glas. Khem. Drush.,* 1982, **47,** 557-562. — A commercially available soluble glucose isomerase, Maxazyme GI (obtained from *Actinoplanes missouriensis)* was insolubilized by covalent bonding to two derivatives of micro-crystalline cellulose, octamethylene diamino carboxymethyl cellulose (DCM) and succinyl-DCM (SDCM), with the aid of water-soluble N,N'-dicyclohexyl carbodiimide. The mean activity of the immobilized enzyme preparations obtained by bonding of the enzyme carboxyl groups to DCM was 5.80 IU per ml, while that of preparations obtained by bonding of the amino groups to the corresponding SDCM matrix was 4.68 IU per ml. The effects of the method on the thermal stability of the preparations and on their optimum pH for glucose conversion are discussed.

Kinetics of thermal degradation of fructose, glucose and invert sugar in weakly alkaline medium. V. A. Kolesnikov and G. I. Gorokhov. *Izv. Vuzov, Pishch. Tekh.,* 1982, (5), 65-70 *(Russian).* — The degradation kinetics of glucose, fructose and their mixture in water were determined under conditions typical of 2nd carbonatation juice concentration in an evaporator (temperature of 100-140°C, pH 7.1-9.2 and a reducing sugars content of 0.1-0.2%). Aqueous phosphate buffer solutions prepared from citric acid and sodium phosphate were used as solvents, having pH values of 7.25, 8.38 and 9.30 at 20°C. Empirical equations were derived from the results and permitted calculation of the rate constants of the monosaccharides as a function of the energy of activation under the effect of pH. Under the test conditions, glucose decomposed at a slower rate than fructose.

Calcium hydroxide dissociation in aqueous solutions. V. S. Shterman, I. Shakhovtseva, I. F. Bugaenko and A. R. Sapronov. *Izv. Vuzov, Pishch. Tekh.,* 1982, (6), 55-58 *(Russian).* — The dissociation constant of $Ca(OH)_2$ was calculated from known values of pH at varying concentrations in the temperature range 20-60°C. A mean value of 1.65×10^{-1} was established, which was practically independent of temperature. Using this value, theoretical values of pH were calculated for a range of concentrations and found to be in very good agreement with experimental values obtained by the authors and by Bates *et al.*[1] The degree of dissociation, OH^- ionic activity and ionic strength of the solution were established for molar concentrations in the range from 1.10×10^{-4} to 2.12×10^{-2}. Tabulated data show that the degree of dissociation, even in solutions that were

[1] *J. Res.* (Nat. Bureau Standards), 1956, (6), 305-312.

almost saturated, was still only approx. 90% and fell with temperature.

Comparative study of the usual methods and of a new method for determining filter cake pol. N. M. Wa Bangi. *Sukari* (Zaire), 1982, **2**, (5), 22-26 *(French).* – The official methods of the ISSCT and the Société de Technologie Agricole et Sucrière de Maurice for determining filter cake losses are described, and details given of a method developed in Taiwan[1]. Analyses were carried out during one month; results showed that the values given by the three methods were comparable, despite occasional differences that were attributed to possible errors in weighing, errors associated with the use of dry lead acetate in the Mauritius and the Taiwan methods, and other factors. The Taiwan method is applicable, provided the amount of lead acetate is reduced, but it takes too long for it to be of value as a rapid control method; the other two methods are shorter and easier to carry out. On the other hand, the Taiwan method may be of use in a research laboratory for purposes of comparing other methods.

The effect of a low-voltage electric field on the electrical resistance of beet tissue during extraction. L. A. Fedorenchenko *et al. Sakhar. Prom.*, 1983, (2), 23-24 *(Russian).* Laboratory experiments showed that application of a current of 10 $V.cm^{-1}$ in diffusion cells, representing the cells of a Robert battery diffuser, substantially reduced the electrical resistance of the 500-g cossette placed in each and thereby noticeably increased juice purity by comparison with convential diffusion. Maximum effect was achieved at a temperature of 40-50°C in contrast to 60 or 70°C.

A rapid method of calculating the coefficient of sugar diffusion in beet tissue. N. S. Karpovich, O. N. Missin and M. A. Totkailo. *Sakhar. Prom.*, 1983, (2), 24-26 *(Russian).* – A method is described for calculation of the diffusion coefficient of sugar in beet tissue based on the Biot and Fourier diffusion numbers and the concentration simplex over a given time interval. The variables incorporated in the equations for a cossette taking the form of an infinite cylinder are established by means of a special piece of equipment which is described. A sample calculation is given.

Determination of alpha-amino-nitrogen in sugar beet. M. Medved. *Listy Cukr.*, 1983, **99**, 30-32 *(Czech).* The modification of the Stanek & Pavlas method proposed by Kubadinow & Wieninger for α-amino-N determination[2] was tested on samples of L-asparagine of known amino-N content. Spectrophotometry was carried out at 600 nm, and the results analysed statistically by the Student *t*-test to show that any difference between theoretical and experimental values was the result of random error.

Topography of the chemical composition of the sugar beet root. VIII. Spatial distribution of free amino-acids in the beet root – Dobrovicka A variety. J. Zahradnicek, V. Svachula and P. Vratny. *Listy Cukr.*, 1983, **99**, 32-36 *(Czech).* – Samples of ripened beet similar in shape and weight were divided into 16 morphologically and anatomically different sections and these analysed for 19 free amino-acids, using an automatic chromatographic analyser for detection. The maximum amino-acid content was found in the middle of the epicotyl and the hypocotyl, and the minimum in the tip of the root. Glutamine was dominant in all 16 zones, followed by γ-aminobutyric acid, aspartic acid, asparagine and glutamic acid. With use of scientifically controlled irrigation, the total amino-acid content clearly fell and distribution of the individual acids changed.

The deterioration of sugar cane. J. Michl. *Agric. Tropica et Subtropica* (Czechoslovakia), 1979, (12), 87-97; through *S.I.A.*, 1983, **45**, Abs. 83-10. – Cane of variety Co 290 was stored at a relative humidity of 60-80% and an average daily temperature of 26-27°C, and analysed 0, 1, 3, 6, 8 and 10 days after harvesting. Changes in sucrose, glucose and fructose contents are tabulated. On average, the sucrose content decreased by 2.70% absolute (14.45% relative). Reducing sugars increased from 0.51% to 14.95% of total sugars; of this, fructose was 6.61% and glucose 8.34%. The weight of the cane decreased by 16.3%.

Measurement of sugar content in fodder and sugar beets. B. F. Quin, C. E. Wright and P. H. Woods. *Proc. Agron. Soc. N.Z.*, 1980, **10**, 81-84; through *FSTA*, 1982, **14**, (17), 7L505. – An autoanalyser method for determination of total sugars, sucrose and reducing sugars in roots and tops of fodder beet and sugar beet is described. Sugars are extracted from grated roots or chopped leaves, with addition of lead acetate as clarifying agent. Total sugars are determined after hydrolysis of sucrose to glucose + fructose by heating the extract with N HCl at 68°C, the resulting monosaccharides being determined by alkaline reduction of ferricyanide to ferrocyanide with colorimetric determination at 420 nm. Reducing sugars are determined similarly, with omission of the sucrose hydrolysis step; sucrose is calculated by difference. Sucrose contents found by this method agreed well with polarimetric values, provided that reducing sugar concentrations were low. Sucrose contents agreed surprisingly well with refractometric values; however, the difference increased with increasing sucrose concentration. Data are given for sucrose and reducing sugars contents in fresh and frozen-stored sugar beet and fodder beet.

Chemical and physical properties of sugar cane bagasse irradiated with γ rays. Y. W. Han, E. A. Cayalano and A. Ciegler. *J. Agric. Food Chem.*, 1983, **31**, 34-38. Bagasse was irradiated with gamma-rays of ^{60}Co in a dosage range 0-300 Mrd, and the changes in chemical and physical properties examined. Irradiation with more than 10 Mrd caused a loss in fibre strength, and the bagasse became pulpy. The hemicellulose component decomposed more readily than the cellulose and lignin fractions. Irradiation increased acid and enzyme digestibility. The amount of reducing sugars produced by enzymatic hydrolysis of samples of bagasse irradiated with 100 Mrd was about three times greater than that from untreated bagasse. At or above 50 Mrd, cellulose crystallinity decreased and *in vitro* rumen digestibility increased. As a pretreatment method, irradiation is equivalent to NaOH treatment in terms of increased digestibility. As a hydrolysis method, irradiation has some advantages over conventional acid and enzymatic hydrolysis, including simplicity of the process and effectiveness of chain cleavage, but also suffers from the disadvantage of glucose loss as a result of indiscriminatory destruction. Direct comparison of the effect of irradiation with that of other methods is difficult, however, because of the difference in nature of the causative agents and the different result produced by irradiation.

[1] Yu: *I.S.J.*, 1956, **58**, 286.
[2] *ibid.*, 1972, **74**, 120.

BY-PRODUCTS

Alcohol-based chemical industry. V. V. Eswaran. *Chem. and Ind.,* 1982, (24), 967-968. — While India has for some time had a chemical industry based on alcohol as feedstock, the five-year plan for 1980-85 has given high priority to accelerated development of the chemical industry, particularly in the organics field, but based on petroleum and natural gas resources discovered on the western coast. It is stressed that the question is not one of failing to expand the alcohol-based industries but of examining alternative choices in relation to the availability of raw materials and production costs. While currently there are 127 distilleries having a total installed capacity of 732 million litres of alcohol per year, the prospects of generating a large production potential for alcohol in the near future are limited because of the close links with sugar industry expansion, while the demand for organic chemicals is growing at a rate that is several times faster than the increase in alcohol availability. On the other hand, there are a number of organic chemicals required in relatively small volumes that can be economically produced from alcohol, and there would be scope for expansion of their production. While alcohol production from materials other than molasses would be much more costly, the relatively low price of molasses in India (which is due to a deliberate goverment policy on molasses pricing) has led to its inefficient collection and utilization, so that supplies of alcohol are proving to be below demand. In addition, the level of efficiency in Indian distilleries is currently far below international standards; there has been little technological improvement and the yield of alcohol per unit molasses sugar is very low. However, a low alcohol price is no incentive for distillery modernization. One answer to the problem suggested is international trading in alcohol, so that a shortfall in domestic production could be balanced by imports, while alcohol would have to be exported during years of large surpluses. However, this would introduce an element of uncertainty for an alcohol-based chemical industry.

Economic and social feasibility of the Brazilian alcohol program — Proalcool. J. Borges. *Rpts. 40th Ann. Conf. Hawaiian Sugar Tech.,* 1981, 15-16. — Economic, social and technological aspects of the Brazilian program for fuel alcohol production from cane are discussed by the Chief Adviser to the Board of Directors of Copersucar.

Cost of production of anhydrous alcohol under the conditions of the Tucumán agro-industry. Preliminary study. G. J. Cárdenas and O. Ruiz. *Bol. Estac. Exp. Agro-Ind. Obispo Colombres,* 1982, (138), 17 pp *(Spanish).* — Using as a basis the prices fixed by law for cane, transport, etc., and historical quantities for average molasses production, alcohol yield, etc., the total and marginal costs of manufacture, storage, taxes, etc., are calculated. Two variants are provided: distillation using gas and oil, respectively, as fuel; the former is cheaper in all cases.

A technological scheme for recovering non-sugars from electrodialysis concentrate after treatment of intermediate products in beet sugar manufacture. L. D. Bobrovnik and G. P. Voloshanenko. *Pishch. Prom.,* 1982, (28), 46-49 *(Russian).* — A scheme is described for recovery of glutamic acid, lactic acid, amino-acids (particularly leucine) and monosodium glutamate.

Mechanical aeration *versus* hydrogen peroxide in stabilization pond treatment. K. O. Iwugo. *Effluent and Water Treatment J.,* 1981, **21,** (1), 8-10, 12-16, 18; through *S.I.A.,* 1982, **44,** Abs. 82-1674. — Waste water from a molasses-based yeast plant was neutralized, diluted and fed to a 100-litre oxygenated tank; it then passed to a 100-litre facultative tank. Oxygenation was carried out either by addition of 150 ml 50% H_2O_2/day, or by mechanical aeration. Changes in quality parameters of the waste are tabulated and discussed. H_2O_2 was as effective as air in supplying oxygen to the system. The H_2O_2 decomposed only slowly; its efficiency of conversion to metabolically useful oxygen appeared to be over 50%. It could be used in waste water treatment systems in developing countries, where mechanical aerators may be unreliable.

Ethanol production from pentoses and sugar cane bagasse hemicellulose hydrolysate by *Mucor* and *Fusarium* species. P. P. Ueng and C. S. Gong. *Enzyme and Microbial Technol.,* 1982, **4,** (3), 169-171; through *S.I.A.,* 1982, **44,** Abs. 82-1694. — Bagasse was hydrolysed by spraying with 5.4% H_2SO_4 (w/w) followed by steaming at 100°C. The hemicellulose hydrolysate was recovered by leaching and neutralized. It contained the following sugars (%, w/v): xylose 4.3, glucose 1.4, arabinose 0.9. *Mucor* 105 was able to ferment the hydrolysate to ethanol, but *Fusarium* F5 was not. Xylitol was produced from the xylose, together with the ethanol.

Production of calcium citrate using inferior quality sugars and molasses from the north Santa Fe area (Argentina). I. Adjustment and formulation of culture media for surface and submerged fermentation on a laboratory scale. Surface fermentation of sugars on a pilot scale. J. C. Basilico, F. T. Pomar and C. A. Meinardi. *Rev. Facult. Ingenieria Quim.* (Univ. Nacional del Litoral, Santa Fe), 1978-79, **43,** 25-33; through *S.I.A.,* 1982, **44,** Abs. 82-1701. — Laboratory and pilot tests on optimizing citric fermentation by *Aspergillus niger* and *A. phoenicis* are reported, using (a) low-grade sugar in static surface culture, and (b) molasses in submerged culture agitated by a rotary table. In surface culture, best results were obtained by incubating at 40°C for 36-48 hr, then allowing to cool to 28-30°C for the rest of the 6 days; the optimum aeration was 0.4-0.6 vol/min. Molasses had to be pretreated with steam and milk-of-lime; a particular effect was the removal of most of the silicate, which appeared to be the main inhibitor of citric fermentation. Addition of ferrocyanide was inadvisable, since the presence of iron improved the conversion of sugar to citrate.

Biosynthesis of glutamic acid by *Corynebacterium glutamicum* 3144 on media with molasses and its isolation from the culture fluid. R. M. Balitskaya, N. N. Kuznetsova, N. G. Demina and A. F. Sholin. *Priklad. Biokhim. i Mikrobiologiya,* 1981, **17,** (1), 85-95; through *S.I.A.,* 1982, **44,** Abs. 82-1702. — Glutamic acid was produced by the above strain of micro-organism in media containing 20% beet molasses (in some tests 10 or 15%). The effects of other components of the medium were tested; urea was the best N source. Changes in the

concentrations of KH_2PO_4 and $MgSO_4$, and use of different batches of molasses had little effect on glutamic acid yield. Up to 54.7 g glutamic acid/litre was obtained.

Enzymatic hydrolysis of cellulosic materials by *Sclerotium rolfsii* culture filtrate for sugar production. J. G. Shewale and J. C. Sadana. *Can. J. Microbiol.*, 1979, **25**, (6), 773-783; through *S.I.A.*, 1982, **44**, Abs. 82-1706. — The hydrolysis (saccharification) of various purified celluloses and cellulosic wastes, including bagasse, by the above filtrate was studied. Effects of pH, temperature, enzyme concentration, substrate concentration and other factors were tested. Saccharification of alkali-treated bagasse was up to 48.6% in 48 hr; additional pre-treatment with peracetic acid increased this to 54%. Reducing sugars concentrations up to 80 $mg.ml^{-1}$ were obtained.

Pressed pulp — a complete fodder from the sugar factory. R. Vanstallen and J. P. Vandergeten. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1982, **50**, 155-172 *(French, Dutch)*. — Experiments on beet pulp ensilage and on fattening of bulls with a feed ration made up of pulp silage and straw are reported. Optimum ensilage conditions are given. While two silage compositions gave almost the same results (a daily weight gain of the order of 1.2-1.3 kg), where vitamins were added to the pulp (together with molasses, urea and minerals) before ensilage they were degraded during storage, and noticeable vitamin deficiencies (particularly in vitamin A) were found in the cattle three months from the start of the trials. With the other ration, the vitamins had not been incorporated in the pulp, but were given separately.

Feed value of pressed pulp compared with other cattle fodders. J. Haaksma. *Publ. Trimest. Inst. Belge Amél. Betterave*, 1982, **50**, 173-184 *(French, Dutch)*. — Beet pulp composition is given as typically 82.5% carbohydrate; fresh pulp contains 5-10% sugar on dry solids, while the protein content is only 10%. Typical values are given for the four energy factors: crude, digestible, metabolizable and net energy. Calculation of crude energy is demonstrated, and a formula also given for the relationship between available energy and digestibility of the different feed constituents. Feeding trials were conducted with fattening bulls and dairy cattle, in which the values of pressed pulp, concentrates and maize were compared. Results are reported.

Pressed pulp silage as an alternative to pulp drying. C. Heller. *Sucr. Belge*, 1982, **101**, 285-297. — See *I.S.J.*, 1983, **85**, 186.

Profiting from distillery bottoms. J. A. de Araujo, H. A. M. de Souza, M. J. G. Pontes and H. A. Germek. *Brasil Açuc.*, 1982, **100**, 155-157 *(Portuguese)*. — During fermentation, yeast cells are kept in suspension by the gas evolved but, towards the end, the gas is insufficient to support the cells and they sink in the vessel to form a mud known as the "bottoms". This contains additional waste material and is disposed of as a polluting effluent; if any remains in the fermented mash, it can form deposits on the heat exchanger surfaces and also in the distillation columns. It has been found, however, that the proportion of impurities is low, so that as a yeast suspension it is worth recovering. At Usina Caeté in Alagoas, the bottoms are separated from the fermentation vats and sent to three treatment vessels. The mash is passed through a centrifuge and the remaining yeast cells separated and added to these vessels. The cells are concentrated and collected for sale, while a proportion is returned to fresh fermentation. The yeast-free mash using this system has a 6.8% higher alcohol content and fermentation yield is increased by 2.9%.

Citric acid production by the fermentation of molasses. H. Kampf. *Sugar y Azúcar*, 1982, **77**, (12), 28-29. — Descriptions are given of citric acid manufacture from molasses by surface or submerged fermentation, with *Aspergillus niger* as yeast culture. World production and use of citric acid are also briefly mentioned.

Use of sugar beet by-products in a fodder base. J. Benda. *Listy Cukr.*, 1983, **99**, 8-10 *(Czech)*. — The value as animal fodder of a silage produced from beet pieces and straw and of molasses and pulp is discussed, and mention made of feeding trials with a special "fodder syrup" (of unstated composition) prepared at Kolinske sugar factory; in some cases the syrup proved superior to molasses.

Sucrose: alternative raw material for the chemical industry. A. M. S. Antunes and G. M. C. Bouch. *Brasil Açuc.*, 1982, **100**, 110-120 *(Portuguese)*. — A brief survey is presented of the reactions which sucrose can undergo to produce other chemicals and of the sources of sucrose available for this purpose in Brazil. A bibliography of 16 references is included.

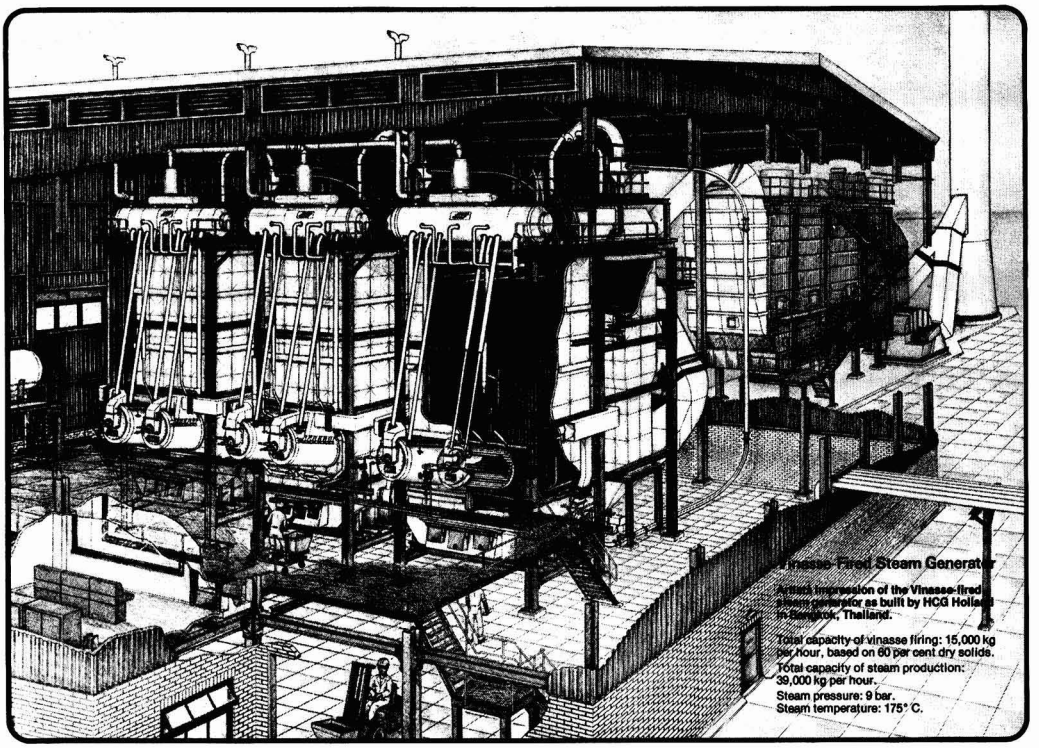
Developments in pulp drying control. J. S. Hogg, J. D. F. Wilkie, R. D. Morgan and S. C. H. McCarey. *Sucr. Belge*, 1982, **101**, 315-331. — See *I.S.J.*, 1983, **85**, 186.

Effect of the nature of the yeast inoculum on alcoholic fermentation. D. Saigal and L. Viswanathan. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India*, 1982, G.33-G.40. Investigations of alcohol fermentation of cane molasses using *Saccharomyces cerevisiae* showed that growth of yeast cells increased with the age of the inoculum up to a maximum at an age of 18 hours, while alcohol yield was unaffected. A 10-fold increase in the number of cells caused a 10% increase in growth and a 5% increase in alcohol yield, which was higher with aerobically- than with anaerobically-grown inoculum.

Studies on fermentation of sugar cane juice for the production of ethanol. B. S. Yadav, D. S. Dahiya and P. Tauro. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India*, 1982, G.41-G.52. — In experimental alcohol fermentation of cane juice with *Saccharomyces cerevisiae*, yield rose sharply with time in the case of hand mill-extracted primary juice containing 18.7% sugars and was far greater at 8.3% v/v after 36 hours (the maximum time) than in the case of factory mixed juice (5.1%) and primary juice diluted to almost the same sugars content as the factory juice (4.9%). Up to 6 hours, results for all three juices were about the same. Addition of 200 ppm urea increased alcohol yield, while 400-1000 ppm increased yield and reduced fermentation time. The optimum fermentation temperature was 35°C.

Mould protein from molasses distillery spent wash. B. D. Kapoor, O. P. Bhatia and A. K. Misra. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India*, 1982, G.63-G.70. *Rhizopus nigricans* was grown on vinasse which had been centrifuged to remove suspended yeast cells, etc. and diluted with tap water to a specific gravity of 1.025 $g.cm^{-3}$. Incubation was continued for 6 days at 30°C, giving a mycelium yield of 18.53 g dry weight % COD removed. This was considerably increased by addition of urea and less so when phosphate was added, while

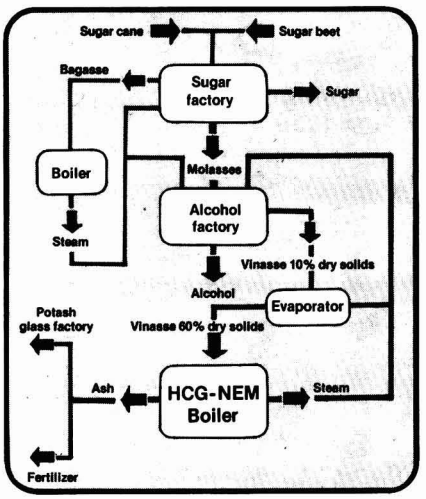
EFFLUENT TREATMENT and ENERGY SAVING through NEM VINASSE BOILER



Vinasse Fired Steam Generator

Artist's impression of the Vinasse-fired steam generator as built by HCG Holland in Bangkok, Thailand.

Total capacity of vinasse firing: 15,000 kg per hour, based on 60 per cent dry solids.
Total capacity of steam production: 39,000 kg per hour.
Steam pressure: 9 bar.
Steam temperature: 175° C.



- During the production of power alcohol as well as industrial alcohol, vinasse is obtained as by-product. By evaporation to 60% solids concentration this vinasse becomes suitable as fuel for the HCG combustion boiler for generating process steam.
- By using vinasse as fuel, the alcohol factory can achieve savings of approximately 50% in fuel consumption.
- HCG has been involved in the development of vinasse-fired boilers for many years. Nine boilers have been built.

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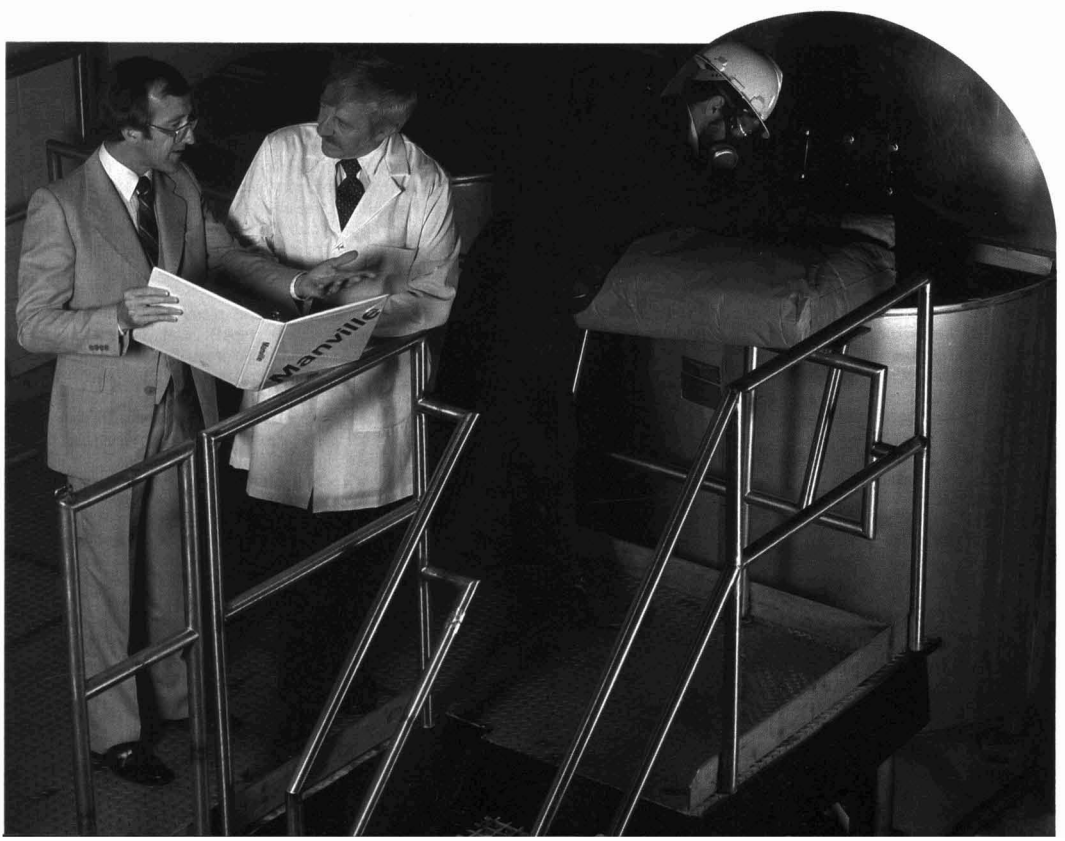
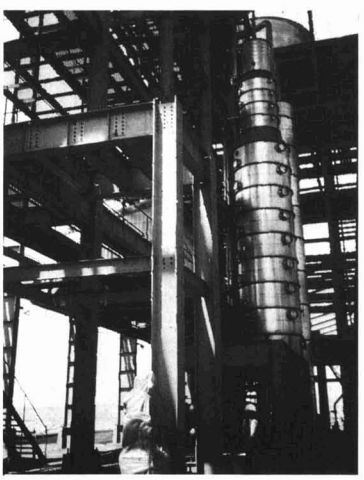


ENERGY CONSERVATION...

New ideas in sugar technology

One example : the new plant at TIRLEMONT. High performance plant due to :

- its original new crystallization scheme,
- large reductions in power consumption,
- controlled completely by computer.



Integration of distilleries into sugar factories

- improved viability,
- optimum power efficiency,
- minimum investment and operating costs.

Our latest references

- Study on reorganization and power conservation for two factories in the RAFFINERIE TIRLEMONTOISE Group (Belgium).
- Study for the reorganization of two factories in the C.I.A. Group (Spain).
- Study on the integration of a distillery into the BRUCK sugar factory (Austria).

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zinc had no effect. COD reduction was 29.8% after 6 days. The crude protein content of the mycelium rose from 39.8% to 41.6% with increase in urea dosage from 0.01 to 0.03% w/v. The dried and heat-treated mycelium is of value as a cattle feed.

Isolation of bacterial cultures for the treatment of distillery effluent. S. Kumar and L. Viswanathan. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, G.71-G.83. Details are given of investigations on isolation from sewage of bacterial cultures that could be used for treatment of vinasse. The performance of the cultures at different stages during isolation are reported. Isolation on a specific medium followed by gradual acclimatization to vinasse was found to be essential for recovery of cultures that would reduce the pollution load in a short period of time without aeration. Several transfers were required at the intermediate stages, whereas direct transfer from the standard medium to the vinasse inhibited acclimatization. The cultures active in vinasse treatment were mixtures of gram-positive rods and gram-negative cocci. Work is being carried out to characterize and identify the cultures and determine the microbial interactions.

Further studies on recycling of spent wash in cane molasses distilleries. M. Koshy and D. S. Dahiya. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, G.85-G.91. Studies have shown that dilution of molasses with 25% vinasse has little effect on alcohol fermentation of molasses, while use of the cell mass recycling technique plus dilution actually improved fermentation efficiency. Thus, not only would the level of distillery waste be reduced, but the recycled vinasse would be enriched and could possibly be used for gas production and drying purposes. One apparent problem needing investigation is possible scaling of the distillation column as a consequence of recycling.

Oxalic acid from sugar cane molasses: process development and waste utilization. N. P. Shukla, A. K. Ray and P. Sanyal. *Proc. 46th Ann. Conv. Sugar Tech. Assoc. India,* 1982, G.93-G.101. — Experiments on oxalic acid recovery from molasses are reported, in which oxidation with nitric acid was catalysed by vanadium pentoxide. A maximum yield of 48.5% of 99.5% purity oxalic acid crystals was obtained. Treatment of the mother liquor with soda ash yielded Glauber's salt, while passage of the reaction vapour products through soda ash in a gas absorber permitted 30% by weight recovery of nitrates in salt form.

Accumulation of yeast biomass during fermentation of molasses wort. P. P. Reger, V. V. Yarovenko and B. A. Ustinnikov. *Izv. Vuzov, Pishch. Tekh.,* 1982, (5), 147-149 *(Russian).* — Investigations of yeast manufacture from molasses using a mixture of two strains and two hybrids showed that restricting the residence time in the fermenters to 14-17 hr at a dilution rate $D = 0.15$-$0.20\ hr^{-1}$ prevented ageing of the yeast, increased its specific growth rate and hence its concentration in the ripened product.

Dehydrated sugar cane final molasses for feeding broilers reared on wood shavings deep litter. M. Valdivié, L. Fraga, P. Pérez and E. Brito. *Cuban J. Agric. Sci.,* 1982, **16,** 173-179. — In trials in which 1-day-old broilers were fed on diets containing 0, 5, 10, 15 and 20% dehydrated final molasses over a 4-week period, liveweight of the birds and feed conversion efficiency fell with increase in molasses content, while mortality rose (reaching a maximum of about 40% with 15% molasses inclusion) as a result of the adverse effect of excessive faecal moisture on the deep litters, which were found to be contaminated with Coccidia, *Escherichia coli* and *Rhizopus nigricans.* A molasses content of 5% in unpelleted diets containing 20% torula yeast is considered the maximum advisable when broilers are reared in deep litter.

Metabolizable energy and apparent dry matter retention in diets with filter cake-mud oil and rice polishings for broilers. P. Pérez, I. Tzvetanov and E. Lamazare. *Cuban J. Agric. Sci.,* 1982, **16,** 181-185. — Trials are reported in which 8-weeks-old chickens were fed on diets containing 1:1 mixtures of filter cake oil (obtained in wax extraction) and rice polishings in total concentrations of 14, 28, 42 and 56%. Results were also obtained for a diet containing no filter cake oil but 7% rice polishings. It was found practical to replace some of the maize in the rations with 14% filter cake oil:rice polishings mixture without affecting the metabolizable energy level or the apparent dry matter retention of the feeds.

Effect of dehydrated final molasses feeding (DFM) on mineral excretion in broilers. L. Savón and R. A. Alvarez. *Cuban J. Agric. Sci.,* 1982, **16,** 201-210. — In 56-day chicken feeding trials, diet consumption and liveweight fell with increase in the proportion of DFM, as did the dry matter content of the faeces and the Ca and Mg contents in the blood; Ca, Mg, Na and K in the faeces increased with DFM inclusion, while P was not significantly affected. The ash content in the tibia was not significantly affected, while the Ca content increased and the P content decreased significantly with increase in DFM. On the basis of the results, high levels of DFM are not recommended in broiler diets because of the adverse effect on mineral metabolism.

Sucrose and molasses as feedstocks for fermentation processes. O. Brown. *Chem. and Ind.,* 1983, (3), 95-97. The economic aspects of using sugar and molasses (both beet and cane) as sources of chemical feedstock, particularly in the EEC and USA, are discussed.

Pressed pulp silage is an excellent fodder for fattening bulls. G. Burgstaller. *Die Zuckerrübe,* 1983, **32,** (1), 44-46 *(German).* — In a discussion of the benefits of beet pulp silage as animal fodder, it is pointed out that it has relatively low keeping properties, so that it is important to take care in ensilage and to remove sufficient daily quantities, particularly during warm weather. On the other hand, it is very much better as an energy ration than other fattening fodders, contains sufficient Ca and Na but very little P. It is readily consumed by fattening bulls and has no adverse effect on carcass properties.

Some thoughts on the use of low-temperature drying of (beet) pulp. D. Schröder. *Zuckerind.,* 1983, **108,** 126-135 *(German).* — Calculation is made of the variables and possible savings in energy when waste heat from various low-temperature sources in a sugar factory of 8000 tonnes daily beet slice is used for drying or predrying of beet pulp at 55-60°C. Since the possible savings in energy will depend primarily on the available waste heat, they will vary from one case to another. Moreover, although the process reduces the primary energy consumption of the pulp drying section, it does increase the overall electricity consumption of the factory by some 3 kWh per tonne of beet, since in most cases conventional high-temperature drying will also be

used to complement the low-temperature process. Power consumption is divided into that used by the ventilators drawing air through the heat exchangers before use in low-temperature drying, and that used by the various drives (for conveyors, pumps, screws, etc.).

A pilot project for ethanol and biogas manufacture in association with Ochsenfurt sugar factory. Anon. *Zuckerind.,* 1983, **108,** 144-147 *(German).* — Details are given of a pilot project financially supported by the West German government for manufacture of ethanol and methane from sugar beet, molasses and starch-containing materials such as grain and potatoes. Designed for a daily fermentation rate of 25 tonnes of sugar, the plant will use a continuous process with yeast recycling; the energy consumption required for pure anhydrous alcohol distillation, using a multi-stage column, is calculated to be half that of previous conventional processes. Anaerobic treatment of all material that cannot be fermented to produce alcohol, including the vinasse, will yield a quantity of methane (15,000 m^3 biogas per day) equivalent to 10 tonnes of fuel oil and sufficient to raise 125 tonnes of steam, of which only half is required for ethanol manufacture. The COD reduction will be sufficiently high (85% of the maximum of 43 tonnes per day emanating from the sugar factory, or 70% of that from the distillery) to reduce that power that would otherwise be needed for oxygenation of the effluent.

Identification and digital control of a rotary dryer for sugar beet pulp. W. Mann. *Regelungstechnik,* 1981, **29,** (8), 263-269; (9), 305-311; through *S.I.A.,* 1983, **45,** Abs. 83-151. — Manual control of the dry solids content of beet pulp from rotary dryers, as used in the past, was not satisfactory. A digital control system was devised with the aim of improving the performance. First, a linear multi-variable model of the drying process was constructed by parameter estimation. Then a digital multi-cascaded control and a digital optimal state feedback control was designed by a computer-aided method, and compared by a simulation procedure. For practical reasons, it was decided to implement the cascaded control on a process computer (Siemens 310 K). Experience during three campaigns showed that control was much better than with the manual system. In particular, there was much less variation in the dry solids content of the dried pulp; provided that there were no extreme changes in conditions, it could be kept within the required tolerance of ± 1%. This permitted fuel savings of 2-2.5%. Labour requirements were decreased, as the operator did not have to be present all the time.

Influence of filter cake and mineral fertilization on sugar cane juice quality. I. Influence on cane juice composition. II. Influence on cane juice clarification. R. Gomez. *Cultivos Trop.,* 1981, **3,** (1), 81-92, 93-107; through *FSTA,* 1982, **14,** (7), 7L477, 7L478. Phosphate contents of cane juice were increased by application of increasing levels of filter cake as fertilizer, and the N:P ratio was decreased. N and K levels were increased by combined applications of filter cake and mineral fertilizer. The treatments had no adverse effect on juice purity and pol. Application of filter cake at 140 or 210 tonnes.ha^{-1} resulted in good-quality clarified juice and good N and P_2O_5 elimination, and had no adverse effect on pol. Owing to the improved yield of cane per ha, tonnes of pol per ha increased. The rate of filtration was not reduced.

Pressed pulp silage. H. Prigge and A. Meyercordt. *Die Zuckerrübe,* 1983, **32,** 86 *(German).* — Comparison is made between the compositions of dried beet pulp and ensilaged wet and pressed pulp (of 90%, 11% and 18.5% dry solids content, respectively). Apart from the difference in dry solids content, the only other major differences between the wet and pressed pulp silage lay in the raw ash content (10.8% on dry solids in the wet pulp and 5.6% in the pressed pulp) and N-free extract (54.7% on dry solids in the wet pulp and 62% in the pressed pulp). The compostion of the dried pulp was almost the same as that of the pressed pulp silage. The value of pressed pulp silage as an energy-rich fodder is indicated.

Production of ethyl alcohol from cellulose hydrolysate by whole cell immobilization. T. K. Ghose and R. D. Tyagi. *J. Molecular Catalysis,* 1982, **16,** (1), 11-18; through *S.I.A.,* 1983, **45,** Abs. 83-173. — Bagasse hydrolysate was obtained as described previously[1]. It was continuously fermented to ethanol by means of *Saccharomyces cerevisiae* NRRL Y-132 immobilized on an inert carrier. Tests were carried out with a feed glucose concentration of 100, 150 or 200 g.$litre^{-1}$ at various flow rates. Maximum productivity attained was 23.2 g.$litre^{-1}$.hr^{-1} with a feed glucose concentration of 150 g.$litre^{-1}$ and a residence time of 2.6 hr. Conversion efficiency of glucose to ethanol was 97%.

Stillage recycling. A. da S. Teixeira. *Anales Asoc. Brasil Quím.,* 1979, **30,** (3-4), 95-102; through *S.I.A.,* 1983, **45,** Abs. 83-174. — Experiments on vinasse recycling to ethanol fermentation are reported. The vinasse may be mixed with raw or diluted cane molasses, or with cane sugar factory effluent to which molasses is added to give the desired Brix. Recycling increases the ethanol yield from a given quantity of molasses. The vinasse, which is finally discarded after several recycles, has a higher Brix and can economically be concentrated further.

Batch fermentation by bacteria of pith from bagasse pretreated with mixtures of sulphuric and nitric acids to obtain protein for animal consumption. R. Lopez P., G. Iglesias and L. M. Hernandez. *Cellulose Chem. Technol.,* 1981, **15,** (1), 17-25; through *S.I.A.,* 1983, **45,** Abs. 83-188. — Bagasse pith was treated with 0.25N or 0.5N HNO_3 or (H_2SO_4 + HNO_3) at 100°C for 120 or 240 min. The hydrolysate was fermented by *Cellulomonas* sp. in an air-lift fermenter. The best specific growth rate combined with a high percentage of fermentable polysaccharides was obtained by pretreatment with 0.5N HNO_3 for 120 min. Biomass yields of 26-29% on pith could be obtained.

Bioconversion of sugar cane bagasse for cellulase enzyme and microbial protein production. S. K. Garg and S. Neelakantan. *J. Food Technol.,* 1982, **17,** (2), 271-279; through *S.I.A.,* 1983, **45,** Abs. 83-189. — A cellulolytic mould, *Aspergillus terreus* GN_1, was cultured in a 10-litre fermenter in a medium containing 1% alkali-treated bagasse. In 96 hr, biomass containing 29.8% crude protein was obtained from bagasse containing only 3% crude protein. In the first 24 hr, water-soluble carbohydrates were utilized, and not cellulose. The carboxymethyl cellulase activity was almost zero for 24 hr, and subsequently increased slowly, then rapidly. After 96 hr, 72.5% of the cellulose had been utilized.

[1] *I.S.J.,* 1981, **83,** 286.

Colombia sugar exports, 1982[1]

	1982	1981	1980
	tonnes, raw value		
Canada	39,000	0	0
Chile	0	0	107,309
China	49,800	0	0
Cuba	12,000	0	0
Finland	24,015	0	0
Portugal	0	13,130	12,096
USA	57,913	151,987	161,049
USSR	36,120	12,096	0
Venezuela	74,471	0	0
	293,319	177,213	280,454

EEC production levy on B-quota sugar[2]. — The European commission proposes to set the production levy on B-quota sugar at the maximum amount of 37.5% of the intervention price. This move is necessary to help recoup a 738 million e.c.u. shortfall in the European Community sugar régime over the past two years. The régime aims to finance export refunds from a 2% levy on production of A- and B-sugar and a sliding levy on B-quota sugar up to the maximum of 37.5%. Hence the total production levy for B-quota sugar will be 39.5%.

India sugar stocks[3]. — Stocks at sugar factories have mounted to an all-time high of 6.5 million tonnes, valued in excess of 25,000 million rupees and thus imposing a heavy financial burden on the Indian sugar industry. The stock position has come about primarily because of the huge carryover of 3.3 million tonnes at the beginning of the current sugar season (October 1982 — September 1983). Sugar production during the first six months of this season increased to 6.2 million tonnes from 5.96 million tonnes for the same period in the 1981/82 season. Production for the whole of the current season is, however, expected to be lower, at 8 million tonnes against the 8.4 million tonnes of the previous season. Although demand for sugar during the current year is placed higher at 6.5 million tonnes compared with last year's consumption of 5.7 million tonnes, carryover stocks within the industry are expected to touch another record of 4.5 million tonnes by end-September 1983.

Alcohol production in Brazil[4]. — Under revised plans, alcohol production in 1982/83 has increased from 5200 to 5830 million litres, of which 3600 million litres will be anhydrous alcohol to be mixed with petrol and the remainder hydrous alcohol to be used alone as motor fuel. Sales of alcohol-powered cars have increased sharply recently owing to a lower price, lower taxation, lower fuel price, easier finance, and the possibility of obtaining alcohol fuel on Saturdays whereas petrol stations are closed during the weekends. Alcohol production in 1983/84 is expected to increase by 20% to 7000 million litres, the increase coming from a larger cane area, expected to produce a cane crop of 210 million tonnes for sugar and alcohol, against 172 million tonnes in 1982/83.

Philippines drought. — The prolonged drought in the Philippines[5], recently broken after eight months[6], is likely to affect the 1983/84 cane crop rather than the current season, according to sugar industry sources. Early-planted cane has suffered badly, forcing farmers to replant. The Sugar Commission will be carrying out a survey to see how the drought has affected cane planted for the 1983/84 crop, but it is estimated that between 10 and 15% will be lost.

US price support measures[7]. — The US Department of Agriculture is continuing to maintain the current fiscal year import quota from the base figure of 2,800,000 tons, raw value. The effect of this restriction on the supply pattern to the US domestic market has been heightened by the indifferent-to-poor start to the growing season for the domestic beet crop. Consequently prices continue to run at some 2 cents per lb in excess of the minimum support price.

Bagasse treatment for animal fodder[8]. — A graduate of Louisiana State University, Professor W. C. Neely of Auburn University has developed a process for treatment of bagasse with ozone gas after which it may be used immediately as fodder. As boiler fuel bagasse is valued at $4 per short ton while the ozone, costing $21 per ton of feed, and the processing costs, estimated at $10 per tonne, raise the value of the bagasse to $50 per tonne as fodder. The process is to be tested at L.S.U., especially for the new high-fibre varieties bred there recently. The ozone attacks the lignin around the cellulose and provides opportunity for the animal's enzymes to penetrate this and digest the cellulose.

West Germany sugar exports, 1982[9]

	1982	1981
	tonnes, white value	
Algeria	11,000	0
Belgium-Luxembourg	34,092	25,969
Bangladesh	0	6,215
Burundi	480	1,000
Chile	10,173	1,044
China	293	11,707
Cyprus	12,606	10,674
Czechoslovakia	48,226	15,145
Djibouti	14,800	15,220
Egypt	24,476	48,935
France	6,247	5,780
French Polynesia	1,513	979
Gambia	10,825	8,168
Greece	0	55,819
Holland	4,330	4,273
Hong Kong	1,620	648
Iceland	1,855	1,825
India	0	3,127
Iran	14,950	34,304
Iraq	0	5,226
Israel	44,966	45,046
Italy	115,388	50,641
Jordan	2,049	0
Kenya	2,670	3,100
Kuwait	15,329	12,876
Lebanon	14,247	20,753
Liberia	458	1,156
Maldive Is.	2,200	1,300
Mali	1,212	250
Malta	2,003	975
Mauritania	4,406	608
Mexico	13,000	0
Morocco	7,187	24,348
New Caledonia	1,242	356
Nigeria	121,711	122,470
Norway	18,967	33,062
Oman	1,600	6,000
Pakistan	1,756	1,456
Papua	6,485	5,691
Poland	1,531	9,050
Portugal	4,794	8,290
Rumania	4,152	45,451
Rwanda	607	3,750
Saudi Arabia	5,591	56,665
Sierra Leone	1,557	2,537
Somalia	5,330	887
Sri Lanka	18,056	57,021
Sudan	13,450	4,000
Surinam	0	4,650
Sweden	4,787	0
Switzerland	110,508	82,377
Syria	13,840	1,475
Tanzania	850	4,610
Tunisia	13,513	17,999
Turkey	116	10,150
UK	1,929	3,759
United Arab Emirates	37,728	41,025
USSR	375,290	202,697
Yemen, North	10,982	3,500
Yugoslavia	3	16,501
Other countries	6,159	4,932
Total	1,205,135	1,167,472
Total, raw value	1,309,929	1,268,991

Réunion sugar crop, 1982/83[10]. — The sugar factories in Réunion began their season in June 1982 and were expected to produce a record outturn; they crushed 2,492,000 tonnes of cane, against an expected crop of 2,500,000 tonnes, but the sugar content was very low at 13.48% and recovery only 10.37%, the lowest level since 1953 and contrasting with the usual recovery of about 12%. Production was thus only 258,279 tonnes.

1 *I.S.O. Stat. Bull.*, 1983, **42**, (3), 9.
2 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 315.
3 *Standard Chartered Review*, June 1983, 25.
4 *World Sugar J.*, 1983, **5**, (12), 34.
5 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 319.
6 *ibid.*, 334.
7 C. Czarnikow Ltd., *Sugar Review*, 1983, (1652), 106.
8 *Sugar Bull.*, 1983, **61**, (19), 8, 10.
9 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, S129.
10 *Zuckerind.*, 1983, **108**, 598.

South Korea sugar imports and exports, 1982[1]

	1982	1981	1980
	tonnes, raw value		
Imports			
Australia	247,290	274,500	315,393
Philippines	100,082	148,517	226,106
South Africa	145,250	63,888	0
Taiwan	124,100	175,815	190,244
Thailand	92,450	96,661	67,289
	709,172	759,381	799,032
Exports			
Bangladesh	0	5,271	4,130
Canada	95	0	0
Hong Kong	83,124	76,590	50,641
India	0	24,944	0
Indonesia	96,682	217,418	147,120
Iran	0	0	13,696
Japan	1,086	1,631	0
Jordan	8,695	0	34,946
Kuwait	14,946	13,695	11,957
Mexico	24,782	0	27,989
Nepal	0	7,227	0
Saudi Arabia	12,391	0	0
Singapore	1,108	303	109
Sri Lanka	0	57,280	12,554
Sudan	0	0	12,554
Thailand	0	0	22,609
US	326	978	978
Other Oceania	37	0	0
	243,272	405,337	339,283

Indonesian sugar import requirements fall[2]. — Indonesia has asked Tate & Lyle to defer shipment of a contracted 300,000 tonnes of sugar until later in the year, apparently owing to the existence of abundant sugar supplies. Indonesian sugar imports in 1982 amounted to 682,000 tonnes, raw value. Sugar production has increased, however, and estimated domestic requirements of 2 million tonnes leave 230,000 tonnes to be covered by imports. For 1983 production is again expected to be around 1.8 million tonnes, raw value, and, even if sugar consumption should continue to rise, import requirements would be substantially lower this year than in the years before 1982.

South African sugar production, 1982/83[3]. — During the 1982/83 season in South Africa, a record sugar production of 2,125,993 tonnes of sugar was made from 19,339,492 tonnes of cane at a cane:sugar ratio of 9.10. Comparative figures from the preceding season were 2,055,665 tonnes of sugar, 19,532,120 tonnes of cane and a cane:sugar ratio of 9.50. As these figures indicate, cane quality was better than in 1981/82 although lower than the long-term average. Recoverable sugar in cane expressed as ERC (10.94%) was 0.41% better than for the previous season. Average crushing rate was very nearly the same as in 1981/82 at 232.96 *vs.* 233.87 t.c.h. and extraction, at 97.02% was exactly the same as the record level of the previous crop. Unfortunately, boiling house recovery at 87.64% followed the downward trend which started in 1978/79 and was 0.11% lower than for 1981/82 in spite of the better cane quality. Undetermined losses dropped to 1.91% but losses in final molasses rose by 0.27% to 9.74% as a result of the higher amount of final molasses on cane and slightly higher molasses purity.

Alcohol from sugar beet in Australia. — Australia's first plant for ethanol from beet has been established at Smithton in the north-west of Tasmania. Kingston Research Pty. Ltd., a subsidiary of the engineering firm Kingston Brothers Engineering, began developing the pilot plant in 1978 and it could result in beet becoming a new cash crop for the state. Located on the Kingston family farm outside Smithton, the ethanol venture was the brainchild of Mr. Neil Kingston and his father, Gordon. It is claimed that a commercial plant could produce alcohol for about 40 Australian cents per litre ($A 1.80 a gallon), the price depending on the cost of harvesting.

Sugar beet irrigation in the UK. — A survey was carried out by the UK Ministry of Agriculture in February 1983 in order to determine the amount of irrigation applied to crops in England and Wales. The crops include sugar beet and has been reported that the survey shows 15,770 hectares receiving irrigation in 1982 making it the third largest irrigated crop, using 8,260,000 cubic metres of water. The irrigated area is some 8% of the total beet area in the UK.

Thailand sugar exports, 1982[4]

	1982	1981	1980
	tonnes, raw value		
Algeria	10,276	22,640	0
China	549,244	112,956	56,153
Hong Kong	2,171	0	0
Indonesia	68,959	20,283	0
Japan	369,999	107,326	112,919
Korea, South	96,675	116,970	15,417
Laos	3,355	805	0
Malaysia	102,972	45,249	18,261
Morocco	70,603	136,516	49,596
New Zealand	15,547	0	0
Saudi Arabia	38,696	0	0
Singapore	0	16,524	28,274
Sri Lanka	7,356	0	0
Tunisia	0	11,013	0
USA	285,493	281,624	81,637
USSR	423,468	282,952	97,443
	2,044,814	1,154,858	459,700

ISA quota increases[5]. — The ISO Executive Committee has granted hardship relief allocations of 35,000 tonnes of Nicaragua and 20,000 tonnes to the Ivory Coast. Nicaragua may now export 141,500 tonnes this year and Ivory Coast 90,000 tonnes. Nicaragua exported some 50,000 tonnes during the first quarter of 1983 while exports in the whole of 1982 were 79,000 tonnes. Sugar production in the Ivory Coast has risen steadily during recent years from 47,000 tonnes in 1978/79 (when imports were needed to cover domestic requirements) to an estimated 192,000 tonnes in 1982/83. Norway has received permission to import an additional 25,000 tonnes of white sugar from non-member countries, raising the entitlement to 104,000 tonnes, raw value. Norway has traditionally covered its sugar requirements by imports from the EEC countries, mainly Denmark, the UK and West Germany. Jamaica also has been allowed to raise its imports of non-member sugar from 1000 to 5000 tonnes, white value.

Madagascar sugar project[6]. — The second phase of the Analaina sugar project comprises 4310 hectares of cane land and establishment of a mill with a crushing capacity of 1000-1200 t.c.d. Finance for the project has been arranged with the African Development Bank, the Caisse Centrale de Coopération Economique of France, the Madagascar government and the National Rural Development Bank.

Cane smut in Barbados[7]. — The Ministry of Agriculture has recently announced that the fungal disease cane smut has returned to Barbados and is affecting sugar cane. The Ministry said reports of the disease had come from farmers throughout the island. An official of the Sugar Producers Association said that some small farmers may lose their entire 1984 crop as a result of having to destroy badly affected cane.

CSR Limited annual report, 1983. — Although raw sugar production at CSR's seven factories increased from 812,000 tonnes in 1981 to 915,000 tonnes last year, and refined sugar sales were only slightly down at 685,000 tonnes against 697,000 tonnes, the sugar division made a profit of only $A 11.5 million against $A 22.1 million. The fall was largely due to reduced returns because of low world raw sugar prices, but the effect was modified by the more stable refining business and the existence of long-term contracts for Australian sugar which gave a better return. Owing to drought, the amount of cane to be crushed in the 1983 season is likely to be down on the record figure of 1982.

China sugar production, 1982/83[8]. — Revised figures of sugar production in China in 1982/83 and 1981/82 show that output was slightly lower than had originally been indicated. For 1982/83 the figure was 3,384,000 tonnes, white value, while the previous season it was 3,166,000 tonnes, according to an official announcement. The split between cane and beet sugar was not specified.

[1] *I.S.O. Stat. Bull.*, 1983, **42**, (3), 24.
[2] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 319.
[3] *S. African Sugar J.*, 1983, **67**, 168.
[4] *I.S.O. Stat. Bull.*, 1983, **42**, (2), 41.
[5] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 396.
[6] *World Sugar J.*, 1983, **5**, (12), 37.
[7] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 332.
[8] C. Czarnikow Ltd., *Sugar Review*, 1983, (1660), 140.

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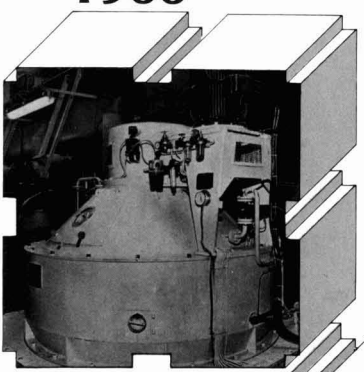

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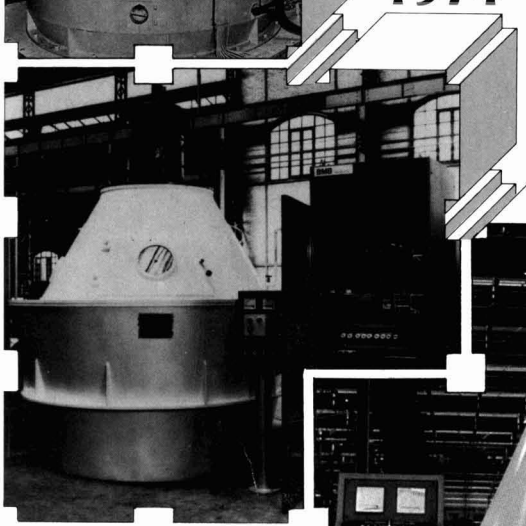
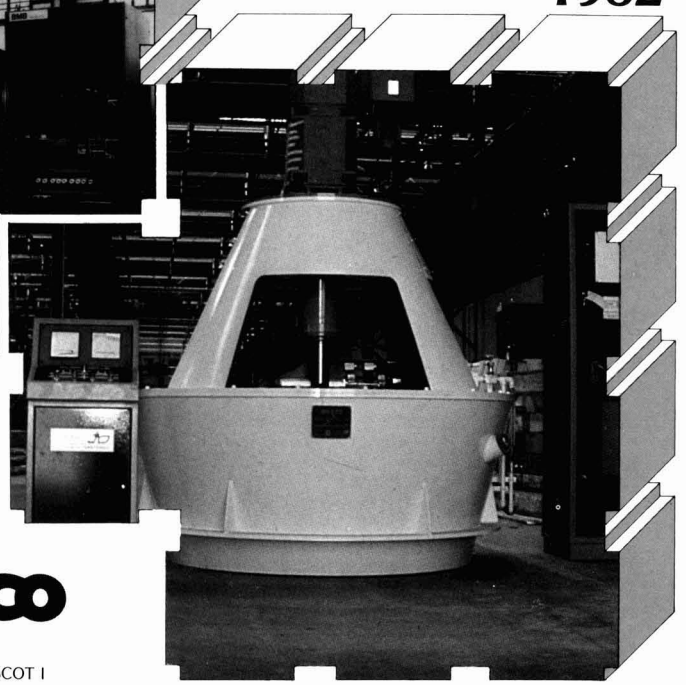


1982



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