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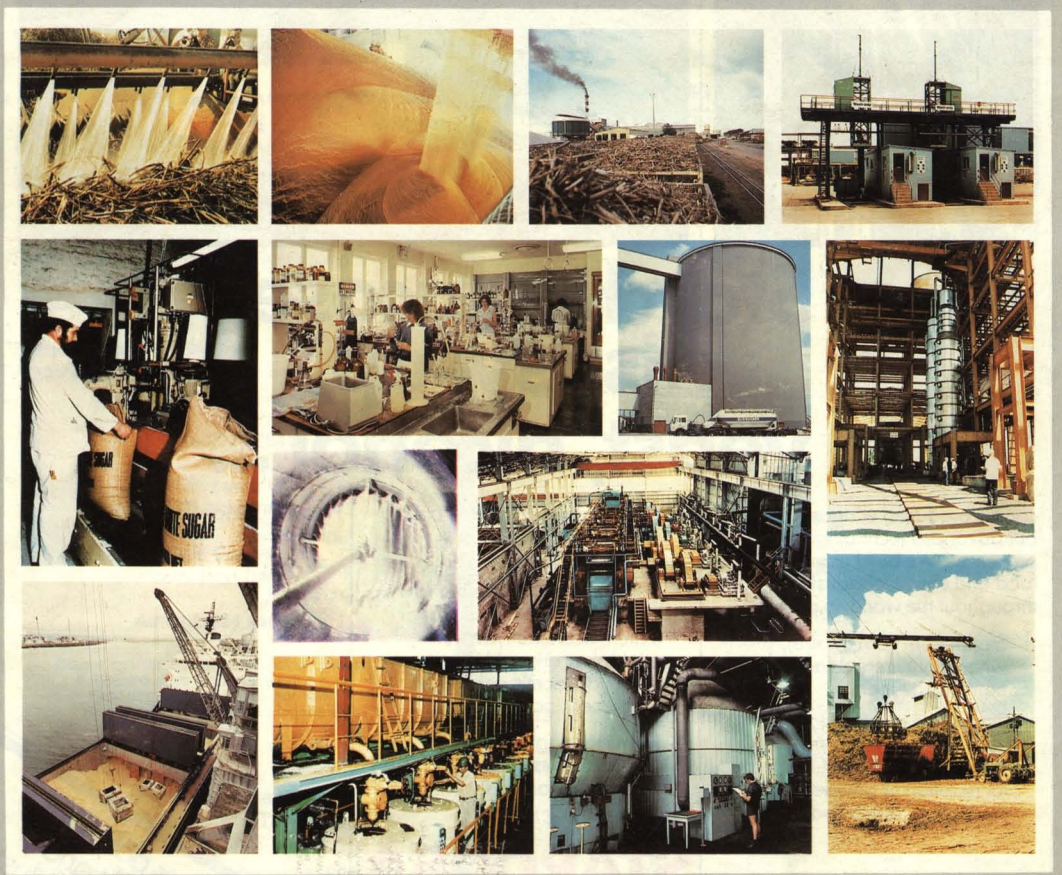

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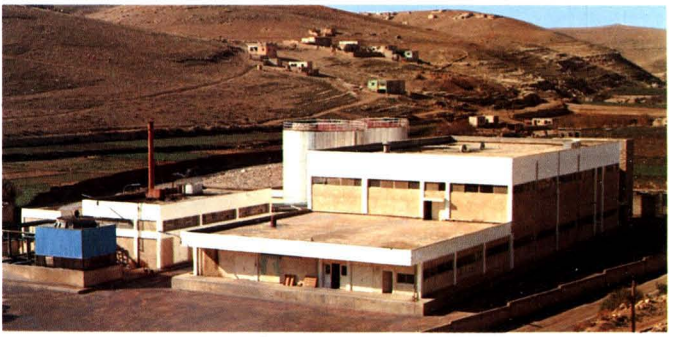

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News and views

Brazil sugar situation uncertainty[1]

A considerable degree of uncertainty continues to surround the Brazilian supply situation. The original production target for the current season was 8.56 million tonnes, tel quel (about 9.1 million tonnes, raw value) out of which exports were scheduled to reach 2.7 million tonnes. Subsequently the IAA announced that, owing to rising domestic requirements, the export allocation would be reduced to 2.0/2.2 million tonnes. Aside from the increase in domestic demand, it was also suggested that exports would be reduced from the original target as the production goal of 8.56 million tonnes might not be reached because of the effects of the drought which affected the southern states earlier this year.

While there remains uncertainty about Brazilian production and export availability from the 1986/87 crop, it is known that in recent weeks considerable rescheduling of the shipment program has taken place. In essence, it would appear that adjustments have involved both the deferral of sugar from the first half of 1987 to the second half of 1987 and 1988, and the advancement of sugar from the first half of next year to the second half of this year. It is believed that in the case of the advancements some of the sugar brought forward has been converted from raws to whites. The short-term implications of these adjustments have been to focus attention on the potentially large quantity of Brazilian sugar available for shipment in October/December. Although the IAA has avoided making any announcements as to the quantity now scheduled for shipment in the last quarter of the year, some estimates have ranged as high as 750,000 tonnes.

The overall Brazillian picture has been further clouded by a recent statement by the IAA that, depending on the performance of the crop in the north/north-east regions and also on whether world market prices improve, Brazil may return to the market in November with a further 400,000 tonnes which would be available for shipment in the new year.

The Brazilian government's Cruzado Plan has so far been highly successful in halting the runaway inflation that had become a by-word for the Brazilian economy. The purchasing power of people on low wages has increased substantially over the past few months and there has been a dramatic increase in the demand for a wide spread of commodities ranging from sugar and meat to cars. Recent statistics have indicated short term increases in the demand for sugar which, if extended, would point to a year-on-year rate of 30% – but this certainly includes an element of hoarding. After the initial burst it cannot be expected that offtake will be maintained at this level, but it is thought that there has been a real increase of at least 10%.

The IAA has made it clear that it intends to ensure as a first priority that domestic demand is met. Strategy for 1987 will only be decided after the current São Paulo crop closes; meantime, sales from the 1987/88 crop, which currently amount to 1.6 million tonnes, will not be added to for the time being.

If consumption does rise, as indicated, by 10%, this will reflect an additional domestic need of some 650,000 tonnes, making a total usage of the order of 6.95 million tonnes, raw value. Currently, it is planned that 2.2 million tonnes should be exported and all of this has been sold.

It is often suggested that, as Brazil has two end-products – sugar and alcohol from its cane, it would be an easy matter – to switch from one to the other. In fact, the quota arrangements set by the government control quite closely the amount of cane which can actually be utilized in each sector while, quite apart from that, there is a rapidly growing demand for alcohol fuel and demand is soaring. As an example, consumption in July 1986 has been put at about one million litres, up 40% on the figure for the corresponding month one year earlier.

As a consequence of a number of factors, including adverse weather conditions, the current São Paulo cane crop has been reduced by about 15%. To ensure an adequate supply of sugar the losses have to be borne by the alcohol sector and output has been reduced by about 1.5 million litres. As a result of this and the booming demand, the carryover stocks have been used up and, to ease the domestic market situation, exports will be reduced to 200 million litres from the 300 million litres originally planned.

World sugar prices

There were very few reasons for an increase in sugar prices which occurred on October 10 after a period in which there had been little change in the LDP and LDP(W) which had started the month at $122.50 and $175, respectively. The rise, to $136 and $184, respectively, was attributed to a "technical rally" as commission houses and commodity funds launched buying. In spite of the bearish influence of Licht's first estimate of world sugar production, doubts about the availability of sugar from Brazil, purchases by Algeria and talk of strong demand from India, Iran and Iraq led to further strengthening of the market and another rise on October 20 took the LDP to $145 although the LDP(W) was little affected. Subsequently the market slid and the LDP and LDP(W) ended the month at $141 and $181, respectively.

World sugar production, 1986/87

F. O. Licht GmbH recently published[2] their first estimate of world sugar production in the crops current in September 1986 or starting in the period to August 1987. World beet sugar production is set slightly lower than for 1985/86 at 36,343,000 tonnes against 36,975,000 tonnes, with increases in Holland, Italy, Spain, Turkey and the US offset by major reductions in France, West Germany, Austria, Yugoslavia, Czechoslovakia, East Germany, Poland, and the USSR.

1 *Carnikow Sugar Review*, 1986, (1753), 134; (1754), 148 - 149.
2 *Int. Sugar Rpt.*, 1986, **118**, 529 - 537.

On the other hand, the cane sugar production forecast is for an increase to 64,070,000 tonnes against 61,703,000 tonnes in 1985/86 and a higher figure than in any of the six past seasons. Half the increase is expected in Asia and almost all of this accounted by the 1,050,000 tonnes increase expected in India as a consequence of government action designed to cut sugar imports. Higher production levels are also expected in Indonesia and Pakistan, while reductions are forecast for China, Taiwan and Thailand. A small reduction in Australia is balanced by increases in Fiji and Papua New Guinea, while a reduction of 110,000 tonnes in South Africa is more than balanced by small increases in the rest of the continent so that the total for Africa is set at 7,323,000 tonnes in 1986/87 against 7,161,000 tonnes in the previous season.

Most of the increase for North and Central America – from 16,924,000 tonnes in 1985/86 to 17,687,000 tonnes – is accounted for by an increase of 650,000 tonnes in the Cuban figure. The US cane sugar output is expected to rise by 131,000 tonnes to 1,964,000 tonnes, with only small changes for other countries. Similarly, small changes are expected for most countries in South America, with increases of 232,000 tonnes in Brazil and 56,000 tonnes in Venezuela accounting for the overall rise in the production estimate from 12,863,000 tonnes in 1985/86 to 13,141,000 tonnes for 1986/87.

Licht concludes that hopes for a reduction of 4 million tonnes in stocks may not materialise and the current outlook is for a limited deficit at best, which is not sufficient to solve the current surplus problem. "The price rise earlier this year was not in the best interest of the sugar industry, as it prompted some exporters to pursue a more expansionist production policy, while at the same time there are no signs of a revival in import demand".

EEC-ACP agreement on 1986/87 sugar prices[3]

The European Community and the African, Caribbean and Pacific (ACP) countries have agreed to hold unchanged prices for imports of ACP white and raw sugar into the Community during the 1986/87 season. Up to 1.3 million tonnes of sugar will again be allowed into the EEC at prices of 44.92 e.c.u. per 100 kg of raw sugar and 55.38 e.c.u. for white sugar. An EEC spokesman noted that guaranteed prices for sugar grown in the Community were left unchanged at this year's price fixing for the season which began on July 1. The EEC/ACP accord will have to be officially endorsed by the Community's agriculture ministers; although normally a routine matter, last year lengthy talks preceded agreement on a compromise increase of 1.3% in prices.

British Sugar ownership

Agricola UK Ltd., the vehicle for the British interests of the Ferruzzi group, is reported to have confirmed its negotiations with S. & W. Berisford for the sale of 70% of British Sugar plc, the remaining 30% to be retained by Berisford. It is understood that the value of the transaction is about £400 million. Such a deal cannot go to fruition, however, while the bid by Ferruzi is the subject (like that of Tate & Lyle Ltd.) of an investigation by the UK Monopolies and Mergers Commission.

Clearance by the Commission is by no means a foregone conclusion since Tate & Lyle have the support of many who include most of the UK beet farmers and others who do not wish to see control of the UK industry pass into the hands of Italian group who already control a large part of the French sugar industry. By withholding Continental supplies, which are the principal source of what limited competition there is in Britain, Ferruzzi could exert a decisive upward pull on prices. Conversely, by swamping the market with French sugar, it could deliver a knockout blow to Tate & Lyle.

On the other hand, in spite of the competition of small-scale imports from the other EEC countries, the bid by Tate & Lyle would give one company 94% of the UK market, placing it in a very strong and almost monopoly position. For these reasons, it is the view of the *Financial Times*[4] that the Monopolies Commission ought to recommend a veto of both prospective owners of British Sugar. "There is an obvious need for rationalization in the European sugar industry as a whole, but that should not be engineered by increasing the dominance of the dominant player and eliminating the remnants of competition. Tate & Lyle, which in the UK is suffering the consequences of ill-thought-out political decisions, may need some relief, but that should be achieved by action to ensure that it obtains its cane supplies at reasonable prices, not by creating an even more unwieldy monopoly than already exists".

Indian sugar supplies in 1986/87

Sugar output in India is expected to rise to 8 million tonnes in 1986/87 from 7.6 million tonnes in 1985/86 which, with an opening stock of 2.16 million tonnes at the start of the new sugar season on October 1, brings total availability in 1986/87 to an estimated 10.6 million tonnes[5]. Sugar consumption is likely to be around 8.4 million tonnes (compared with 8.2 million tonnes in 1985/86), leaving a balance of 1.76 million tonnes.

According to a spokesman of the Indian Sugar Mills Association[6], output in the three seasons 1983/84 to 1985/86 was 5.91, 6.14 and 7.0 million tonnes, respectively, largely because of shrinking yields from drought-affected cane. As a consequence it was necessary to import white sugar in quantities of 500,000 tonnes in 1983/84, 1,100,000 tonnes in 1984/85 and a record 1,750,000 tonnes in 1985/86. Good monsoon rains are likely to help produce a good sugar cane crop in 1986/87; the target is 185 - 190 million tonnes. If this is achieved India should be self-sufficient, according to the ISMA, and will be unlikely to buy any foreign sugar during 1986/87.

3 *Public Ledger*, November 1, 1986.
4 November 7, 1986.
5 *Standard Chartered Review*, October 1986, 24.
6 *Reuter Sugar Newsletter*, September 15, 1986.

International Commission for Uniform Methods of Sugar Analysis (ICUMSA)

19th Session 1986

At its 19th Session, held in Cannes during May 25 - 30, 1986, the International Commission for Uniform Methods of Sugar Analysis (ICUMSA) elected Dr. Murray R. Player and Dr. Ted Whayman, of Australia, President and General Secretary for the next four years.

The immediate past-President, Professor E. Reinefeld, and his General Secretary, Dr. A. Emmerich, were honoured by being appointed Honorary President and Honorary General Secretary in recognition of the long service they have given the organization.

In one of his first actions, the new President, Dr. Player, announced that the invitation to hold the 20th Session in the United States, at a location still to be determined, had been accepted.

Other important decisions of the 19th Session involved the adoption of a new Sugar Scale. ICUMSA has determined that, as from July 1, 1988, the 100 Degree point of the International Sugar Scale will be defined as a rotational value of 40.777 degrees, measured under standard conditions at the Hg wavelength of 546 nm, compared with the value of 40.765 degrees on the scale currently in force. To avoid possible confusion between values on the old and new scales, sugar values on the new International Sugar Scale will be designed °Z rather than °S. To convert values in °S on the old scale to values in °Z on the new scale it is simply necessary to multiply the °S value by the factor 0.99971, i.e. to reduce the °S value by 0.029%.

For a quartz control plate calibrated in °S on the current scale under any of the accepted illumination conditions conversion to the °Z value on the new International Sugar Scale can be effected by multiplying the °S value by the factor 0.99971. There is no need to have quartz control plates recalibrated at the time of the change although this may be done if desired. Quartz control plates with °Z values can then be used to calibrate existing polarimeters and saccharimeters according to the definition of the new International Sugar Scale. The scales of the instruments manufactured after July 1, 1988 should, of course, conform to the new Sugar Scale. If users need further amplification of what this change involves, they should contact their national measurement laboratories.

Simultaneously with the adoption of the new Sugar Scale, ICUMSA has determined that, for determining the pol of raw sugar, the option of subtracting 0.1°S when reporting results according to an "equivalent dry lead method" would be withdrawn. After July 1, 1988, all raw sugar pol values will be reported on the same basis, thus removing the confusion that has prevailed since the 1930's, when wet and dry lead clarifying agents were both allowed.

At the final session there was considerable discussion about the future directions that the ICUMSA organization might take. It was agreed that close relations should be maintained with other international organizations such as ISO, the Codex Alimentarius Commission, OIML and AOAC. Dr. Player has formed a three-man special committee comprising Professor Giorgio Mantovani of Italy, Mr. Malcolm Faviell of Canada and himself to examine the issues involved with the view to putting a plan of action to the 20th Session in 1990.

Recommendations

The following Recommendations were adopted during the 19th Session of ICUMSA in Cannes. They will be reproduced, together with the Referees' Reports, Discussions, etc., in the bound volume of the 19th Session Proceedings which will be available early in 1987 from ICUMSA Publications Department, c/o British Sugar plc, Research Laboratories, Colney, Norwich, England, NR4 7UB.

Subject 1: Constitution and bye-laws
Referee: E. Reinefeld (Germany)

1. In Article IV of the Constitution a new item No. 4 should be inserted:

4. If a National Committee does not pay the contribution due according to No. 3 and does not react upon the reminders of the Treasurer during the time between two Sessions it will have no voting power during the Session. In cases of valid reasons put forward by the National Committee involved the Executive Committee decides whether this rule should be applied or not.

Item No. 4 then becomes item No. 5
Item No. 5 then becomes item No. 6

Subject 1A: Method and subject specifications
Referee: E. Reinefeld (Germany)

In this Subject no special Recommendations were adopted. During the Session it was proposed to form three Working Groups within Subject 1A as follows:–

1. Statistics and Collaborative Tests Working Group
2. Chromatography Working Group
3. Enzymatic Analysis Working Group

There was also a resolution to actively develop connexions with other international organizations such as OIML, ISO, AOAC, the Codex alimentarius Commission and IUPAC in particular. Mrs. M. A. Godshall was recommended to be the ICUMSA representative for AOAC and ISO (Starch hydrolysis products) and Dr. R. Strauss to be the ICUMSA representative in ISO (Microbiology tests).

Subject 2: Laboratory apparatus
Referee: P. Kadlec (Czechoslovakia)

1. Referees for other Subjects are requested to consider what instruments and apparatus used in sugar industry laboratories are suitable for international standardization and cooperate in this respect with the Referee for Subject 2.

2. In cooperation with the Referees for other Subjects the requirements for general analytical apparatus (range, precision, sensitivity, working conditions) are to be specified in accordance with OIML Recommendations and with respect to their use in sugar industry laboratories.

3. Inter-laboratory tests and verifications are to be made of any proposed or Recommended apparatus.

Subject 3: Sampling of sugar and related products
Referee: E. G. Muller (UK)

1. The principles to be applied in the continuous and automatic sampling of liquid sugar products and molasses, described in the Appendix to the present Report, may be regarded as guidelines.

2. The subject should be kept under review.

Subject 4: Specifications and tolerances for pure sucrose and reagents
Referee: W. Braunsteiner (Austria)

1. The Scholz Karl Fischer titration method for the determination of surface moisture and total water in pure sucrose is Tentatively adopted.
2. The enzymatic determination of glucose and fructose remains Tentative because of the lack of collaborative work.
3. Studies of the specification of clarification agents used in Official ICUMSA methods should be undertaken. The following basic lead acetate solutions are Officially adopted:–

(A) In the polarization of raw sugars, basic lead acetate solution shall contain total lead of 24.4 ± 1.0 g PbO/100 cm^3 which is equivalent to a density of 1.24 ± 0.01 g/cm^3 and basic lead of between 9.5 and 10.5 g PbO/100 cm^3. Details of the preparation and analysis of this reagent have been given in various Sessions: 1958, Subject 21; 1962, 1970 and 1982, Subject 11.

(B) The ICUMSA specification of basic lead acetate solutions for purposes other than raw sugar polarization was given in the 17th Session *Proceedings* [1978, 47 (Rec. 9)]. Because solutions are conveniently checked by density, the equivalence of 1.24 ± 0.01 g/m^3 and 244 ± 10 g PbO/dm^3 was established (See *Proc. 18th Session ICUMSA*, 1982, 190, Rec. 4). This total lead specification replaces the 250 ± 5 g PbO/dm^3 given previously. The basicity specification of 36 ± 0.5% remains.

Further tests of solutions conforming to specifications (A) and (B) are recommended.

4. The term "invert sugar" in the specifications for pure sucrose should be changed to "fructose and glucose" if determined by enzymatic methods and "reducing substances expressed as invert sugar", if determined by chemical methods.

Subject 5: Polarimetry
Referee: A. Emmerich (Germany)

1. The definition of the "International Sugar Scale", presented at the 16th Session of ICUMSA in 1974, is officially adopted. It will be set in force on July 1, 1988.

The full details of this definition are as follows (in brackets the values of the old scale are given for use up to the time of change in 1988):

1(a) The "normal sugar solution" is defined as 26.0160 g of pure sucrose weighed in vacuo and dissolved in pure water at 20.00°C to 100.00 cm^3. This corresponds to a concentration of 26.0000 g of sucrose weighed in air under normal conditions (1013 mbar pressure, 20°C, 50% relative humidity) in 100.000 cm^3 of solution at 20.00°C.

1(b) The basis of the 100°Z point of the "International Sugar Scale" is the optical rotation of the "normal sugar solution", as defined in Recommendation 1(a), at the wavelength of the green line of the mercury isotope ^{198}Hg (λ = 546.2271 nm in vacuo) at 20.00°C and using a 200.000 mm tube length.

1(c) The rotation value for the 100°Z point under standard conditions specified in Recommendations 1 (a) and 1 (b) is officially adopted as:

$$\alpha^{20.00°C}_{546.2271\ nm} = 40.777° \pm 0.001° \quad (40.765° \pm 0.001°)$$

1(d) For fixing the 100°Z point at wavelengths other than 546.2271 nm, the following equation remains Officially adopted (see *Proc. 14th Session ICUMSA*, 1966, 17):

$$\alpha_\lambda/\alpha_{0.5462271} = a + b/\lambda^2 + c/\lambda^4 + d/\lambda^8$$

Where λ = wavelength in vacuo in µm,
$a = -0.0017982$
$b = +0.2765318$
$c = +0.00655736$
$d = +0.0000103825$

Until further notice, the range of wavelengths is fixed for practical polarimetry from 540 nm to 633 nm.

1(e) The definition of the mean effective wavelength of spectrally filtered yellow sodium light remains Officially adopted as:

λ = 589.4400 nm
(See *Proc. 15th Session ICUMSA*, 1970, 42) At this wavelength, according to Recommendation 1 (c) and 1 (d) the 100°Z point is:

$$\alpha^{20.00°C}_{589.4400\ nm} = 34.626° \pm 0.001° \quad (34.616° \pm 0.001°)$$

At the wavelength of the He/Ne laser of 632.9914 nm the 100°Z point is:

$$\alpha^{20.00°C}_{632.9914\ nm} = 29.751° \pm 0.001° \quad (29.743° \pm 0.001°)$$

1(f) The sugar scale, corresponding to the redefinition in Recommendations 1 (c) 1 (e), is to be called "International Sugar Scale", and both saccharimeters and standards (quartz control plates) calibrated according to this should be characterized by °Z (from German Zucker, Italian zucchero, Spanish Azúcar).

1(g) The dependence of the optical value of pure sucrose solutions $\alpha(t,p,\lambda)$ on temperature (18 to 30°C), concentration (0 to 65 g/100 g), and wavelength (λ = 480 to 647 nm) is given by combining formulae (1) and (2) in the Referee's Report of 1974 (*Proc. 16th Session ICUMSA*, 1974, 56) with one correction: in formula (1) the coefficient a_5 must read $-1.3222229.10^{-9}$ instead of $-1.3233339.10^{-9}$).

1(h) Quartz control plates used to check saccharimeters should fulfil the conditions adopted under Subject 6.

1(i) Quartz control plates have the sugar value of 100.00°Z at a given wavelength if their rotation is equal to the values given in Recommendations 1 (c) and 1 (e) for that particular wavelength.

1(j) A plate which shows the same optical rotation as the normal sugar solution under the standard conditions defined in Recommendation 1 (b), viz. the value specified in Recommendation 1 (c), is to be called a "normal quartz control plate".

1(k) Quartz control plates of the sugar value 100.00°Z for saccharimeters equipped with quartz wedge compensation with an effective wavelength of 587.0000 nm, have the following rotation values.

$$\alpha^{20.00°C}_{546.2271nm} = 40.703° \pm 0.001° \quad (40.691° \pm 0.001°)$$

$$\alpha^{20.00°C}_{589.4400nm} = 34.629° \pm 0.001° \quad (34.619° \pm 0.001°)$$

$\alpha^{20.00°C}_{632.9914\ nm}$ = 29.792° ± 0.001° (29.783° ± 0.001°)

1(l) Saccharimeter scales and quartz control plates calibrated according to the ICUMSA definition existing up to the present time show sugar values which are too high to the extent of 0.029%.

1(m) Saccharimeter scales should be linearly divided.

1(n) The scales of saccharimeters with smaller angular rotation ranges than those fixed in Recommendations 1(b), 1(c) and 1(e) should be divided so that the normal sugar solution [according to Recommendation 1(a)], in tubes with a length of less than 200 mm belonging to these instruments, shows 100°Z.

1(o) Saccharimeters with an angle of rotation which, at the 100°Z point, is not smaller than 2° related to a a wavelength of 546 nm, are to be checked with quartz control plates which correspond to Recommendations 1(h), 1(i), 1(k) and 1(n) above.

2. The new scale shall be set in force on July 1, 1988. Up to that date the old scale as given in Recommendation 1 above in brackets remains valid.

3. As saccharimeters have to be calibrated with quartz plates, instruments with the old scale need no change of their scale since readings may easily be corrected. The corrections for the new scale are of the order of magnitude of normal scale correlations (see Recommendation 4 below).

4. The sugar values of quartz control plates certified according to the old scale valid up to 1988 are from July 1, 1988, to be lowered by 0.029%.

5. ICUMSA should not give Recommendations with Official character about "Tropical Scales". Data for "Tropical Saccharimeters" are given in Appendix 2 to this Report. They should be regarded as guidelines for manufacturers and users.

6. The application of wavelengths in the near infra-red for saccharimetry should be studied.

7. The rotatory dispersion of sugar solutions after acid inversion or enzyme treatment should be studied.

8. The use of invariable standards other than quartz should be studied.

Subject 6: Quartz control plates
Referee: K. Zander (Germany)

1. The conversion between the rotation values at the basic wavelength of 546.2271 nm, the reference wavelengths 589.4400 nm and 632.9914 nm and the effective wavelength 587.0000 nm of the quartz wedge saccharimeter shall be made by the formula for the specific rotation of quartz given by Bunnagel (*Proc. 14th Session ICUMSA*, 1966, 32). By this Recommendation, Rec. 2 in the Subject 6 report of 1982 (*Proc. 18th Session ICUMSA*, 1982, 67) is cancelled.

2. In order to calibrate saccharimeters, which work with LED's as light sources, the rotatory dispersion of quartz in the region of 650 - 900 nm shall be determined.

Subject 7: Density
Referee: H. Wagenbreth (Germany)

1. During the forthcoming four-year working period of ICUMSA the Plato density table of sucrose solutions should be further used.

2. If there is any need to publish a new edition of the Plato density table during that period,

- the density ρ, (and not a relative density, for instance $d^{20°C}_{4°C}$ or $d^{20°C}_{20°C}$) should be used, and expressed in kg/m^3
- the mass fraction should be designated by w (according to ISO 31/8) and expressed as a percentage.
- the mass concentration should be designated by c (and not by ρ, as recommended by ISO 31/8) and expressed in g/dl according to the International System of Units. ICUMSA should ask ISO TC 12 to change ISO 31/8 in that respect.
- The formula given in Appendix 1 may be used to calculate new editions of the Plato density table.
- the old expressions "degree Balling" and "degree Brix" should not further be used, because they do not fit into the International System of Units and the density tables of Balling and Brix have not been in Official use since 1909 (*Proc. 6th Session ICUMSA*, 1909, Subj. 2).

3. Further studies aimed at the establishment of improved density data for aqueous sucrose solutions should be given priority during the forthcoming four-year working period of ICUMSA in order to present a final report on that item to the 20th Session of ICUMSA.

Subject 8: Sucrose in factory and refinery products excluding beet, cane and crystalline sugars
Referee: K. J. Schäffler (South Africa)

1. Work on Isotope Dilution methods is to be discontinued.

2. For GLC determination of sucrose the (Schäffler) method referred to in Appendix 2 is Officially adopted.

3. The Reverse Phase HPLC method (of Palla, Ivin, Rajakyla *et al.*) referred to in Appendix 4 is Tentatively adopted.

4. The Cation Exchange HPLC method (of Charles, Abeydeera & Ivin) referred to in Appendix 5 is Tentatively adopted.

5. Further testing of the GLC method (of Schäffler & Morel du Boil) for fructose, glucose and sucrose as described in Appendix 8, in collaboration with the Referee for Subject 14, is recommended.

6. An HPLC method for the simultaneous determination of fructose, glucose, sucrose and trisaccharides should be drawn up for further testing in collaboration with the Referees for Subject 14 and 15.

7. Further testing of enzymatic techniques for the determination of sucrose and total fermentable sugars is recommended. The methods of Devillers *et al.* and of Boehringer Mannheim GmbH are particularly recommended.

Subject 9: Sucrose in sugar beet
Referee: W. Mauch (Germany)

1. In view of the importance of samples being both representative and homogeneous, proposals should be evolved for standardizing the preparation of brei and its characteristics; consideration should also be given to the treatment of beet cossettes.

2. In view of the widespread use of mixing/filtration tracks, proposals for the standardization of relevant instrumental and analytical parameters should be evolved in conjunction with Subject 2.

3. Polarimetric determination methods which use aluminium sulphate [$Al_2(SO_4)_3,18H_2O$; 3 g/dm^3 water] as clarifying agent, are Tentatively adopted.

4. Development and examination of alternative methods for the determination of sucrose (chromatographic, enzymatic) should be continued. In this connexion, the partial steps of the analysis must also be checked as to the cause of the systematic errors.

Subject 10: Sucrose in sugar cane
Referee: M. A. Brokensha (South Africa)

1. Investigation into core sampling should continue, with emphasis on the sampling of cane with relatively high levels of extraneous matter.

2. Assessment of the full width hatch method of sampling should be continued with the view to it being given Tentative status at the 20th Session.

3. The hydraulic press method of cane analysis should be further studied.

4. The wet disintegrator-cum-indirect fibre method as described in Appendix 1 is Tentatively adopted.

5. HPLC methods for determining sucrose in cane juice should be further studied.

6. The GLC method given in Subject 8, Appendix 2 (with modifications as given in Appendix 2 of this Report) is Tentatively adopted for the determination of sucrose in cane juice.

7. The investigation into freeze-drying of cane juice samples as a means of preservation and thus facilitation of collaborative studies should be vigorously pursued.

8. Methods using non-toxic reagents instead of lead salts for clarification in analysis should be further studied.

Subject 11: Polarization of raw sugars
Referee: M. R. Player (Australia)

1. As a consequence of the adoption of the President's resolution regarding changing the 100°S point and deleting the optional 0.10°S deduction from pol results, the wording of the method is to be altered as follows:

(a) The second paragraph of "5.6 Expression of results" (*Proc. 18th Session ICUMSA*, 1982, 180) commencing "If the above-described procedure, involving the use of wet lead, is modified so that dry lead is used for clarification....." is deleted without replacement.

(b) The title of the method should read "Polarization of raw sugar".

The above changes will be effective on July 1, 1988.

2. The Referee is urgently requested to initiate studies of the influence of different clarification methods on the results of raw sugar polarization. The aim should be to develop a scientifically founded basis which is independent of changes in the procedure.

3. In section "3.3 Filtration equipment", the example of "Carlson-Ford BIC Quality 4912 100/S" is to be replaced with "Whatman No. 91 in 15 cm circles".

4. In section "5.2 Preparation and defecation of the sample solution", the first sentence of the second paragraph is to be deleted and replaced by "Distilled water is added, if necessary, to bring the volume to 60 to 70 cm^3. Basic lead acetate solution is then added according to the expected polarization of the raw sugar: below 99.3°S use (1.00 ± 0.05 cm^3) and above 99.3°S use (0.50 ± 0.05 cm^3)".

5. The title of section 5.7 should be amended to read: "Repeatability and reproducibility of method". The following sentence should follow that on repeatability: "The reproducibility of the method (95% confidence limits) is 0.25°S".

Subject 12: Refractive index
Referee: K. J. Rosenbruch (Germany)

1. For mixtures of aqueous solutions of sucrose and invert sugar at concentrations from 0 to 85%, wavelength λ = 589.3 nm and a temperature of 20°C, the values according to Equation (3) of the Referees's Report should be Tentatively adopted. The application in practice should be studied.

2. For measurement temperatures other than 20°C, temperature corrections, which can be determined from the mean values, taking into account the mixing ratio, should be corrected by the values given in Table 5 of the Referee's Report.

3. The coefficients given in the Referee's Report as Table 1 for the refractive index, in standard air, of aqueous solutions of D-glucose, D-fructose and invert sugar, at concentrations from 0 to 85%, temperatures from 15 to 30°C and wavelengths of λ = 589.3 nm and 546.1 nm, retain their Tentative status.

Subject 13: Dry substance in sugar products other than sugars
Referee: G. Mantovani (Italy)

1. The Karl Fischer titration method, as set out in Appendix 2 to the 1982 Report, is to be Officially adopted, subject to examination by the Statistics Working Group.

2. The method using vacuum drying on sand, as set out in Appendix 2 to the 1978 Report, is to be Officially adopted, subject to examination by the Statistics Working Group.

3. Procedures for the measurement of refractive index should be submitted to further studies, in particular as far as the corrections required to convert refractometer solids to true solids are concerned.

4. Methods for the determination of water by means of near infra-red spectroscopy (NIRS) should be further studied on the basis of the details given in Appendix 1 to this Report.

The method for the detemination of moisture in raw sugars as specified in Appendix 2 to this Report is Tentatively adopted.

This subject is to be renamed "Dry substance of sugar products other than white sugars".

Subject 14: Reducing sugars
Referee: J. Laursen (Denmark)

1. The Luff-Schoorl method, as described in Appendix 3 to the Referee's Report "Proposal for ISO Standard", supplemented by a standardization factor (described in Appendix 4 to the Referee's Report), should be further studied in comparison with the Lane & Eynon method.

2. The sucrose correction factor for the Constant Volume Modification of the Lane & Eynon method, adopted at the 17th Session of ICUMSA in 1978, should be revised according to the method described in Appendix 6 to the Referee's Report.

3. Methods for the determination of fructose and glucose by HPLC and GLC should be further studied with special regard to post-column derivatization.

4. The enzyme-photometric method for the determination of glucose and fructose given in the 18th Session *Proceedings* of 1982 (Subj. 14 Appendices 1 & 3) continues to enjoy Tentative status. Further studies of methods involving the use of immobilized enzymes should be carried out.

Subject 15: Oligosaccharides and glycosides
Referee: H. Schiweck (Germany)

1. The Official status of the method of Schiweck & Büsching involving the splitting of raffinose by α-galactosidase, followed by the determination of the galactose produced by means of galactose dehydrogenase, for the determination of raffinose in white sugar is confirmed.

2. For raw juice, thin juice, thick juice, other syrups and molasses, after dilution and filtration through membrane filters, but without lead clarification, the method of Schiweck & Büsching gives the sum of raffinose, galactinol, polygalactans and free galactose, expressed as raffinose, but does not give absolute values. The Tentative status of the method is retained.

3. The Tentative status of the HPLC method for the determination of raffinose, galactinol, 1-kestose, 6-kestose and neo-kestose, as outlined in the Referee's Report to the 18th Session in 1982, is continued.

Subject 15A: Pectin and polysaccharides
Referee: B. C. Goodacre (UK)

1. The Roberts test for dextran in cane sugar and syrups should be further studied. Specificity should be evaluated more thoroughly and the reproducibility improved.

2. The immunological method for dextran in cane sugar and syrup should be studied further, in particular in respect of the effect of the method of anti-serum preparation. Collaborative tests should be undertaken and comparative measurements made with the "haze" and Roberts methods.

3. The British Sugar method is retained on a Tentative basis for the determination of dextran in beet juice at concentrations in excess of 100 mg/dm^3.

4. The Tentative status of the CSR "haze" method should be discontinued and the method subjected to further study.

5. The methods of Carruthers & Oldfield and of Reinefeld, Thielecke & Lücker are retained on a Tentative basis for the determination of pectic acid in raw and diffusion juices at concentrations in excess of 50 mg/dm^3.

6. Naphthoresorcinol should be evaluated as an alternative reagent to *m*-hydroxydiphenyl for the determination of pectic acid in beet juice.

7. Enzymatic cleavage followed by HPLC analysis of the monomers should be evaluated as a method of determining pectic substances in beet juice.

8. The Tentative status of the method of Schneider, Emmerich & Laudien for pectin analysis in beet juice is withdrawn.

9. The British Sugar methods for the determination of levan and araban are retained on a Tentative basis for concentrations in excess of 100 mg/dm^3 and 50 mg/dm^3, respectively.

Subject 16: Ash
Referee: P. L. Devillers (France)

1. The gravimetric method for determination of sulphated ash with two incinerations at 550° and 650°C is maintained on an Official basis.

2. The conductivity method for determination of ash at a concentration lower than 50 mg/cm^3 without addition of sugar is adopted on an Official basis.

The following formula gives the coefficient to be applied:

$$K = (16.2 + 0.036\ D) \times 10^{-4}$$

Where D = concentration (mg dry matter/cm^3) of the measured solution.

Subject 17: Inorganic non-sugars
Referee: J. P. Ducatillon (France)

1. A preliminary exercise should be carried out in order to choose a standard sugar sample preparation method for trace metal determination by atomic absorption and emission spectrophotometry. Once chosen, this method should be submitted to a full collaborative study.

2. The (Pérez & Kara-Murza) method given in Appendix 3 for for phosphate determination in cane sugars is Tentatively adopted.

3. Methods of SO_2 determination in sugars other than white sugar should continue to be studied.

4. Methods using high performance ion chromatography for the determination of inorganic anions and cations should be studied.

Subject 18: Organic non-sugars
Referee: N. Kubadinow (Austria)

1. On the basis of the application for many years of the reineckate method (of Pärnoja, including ion-exchange separation) (Appendix) for betaine determination in samples from beet processing, this method is Tentatively adopted.

2. Other methods for the determination of betaine should be studied, aiming at a greater sensitivity compared with the existing methods.

3. Methods for the determination of α-amino acid nitrogen should be further studied, for instance the fluorimetric determination method (of Burba & Georgi).

4. The application of clarifying substances in analyses of organic non-sugars should be investigated within the scope of the relevant method of analysis and if necessary in collaboration with other Subjects involved.

5. In the determination of nitrogen according to Kjeldahl, the use of catalysts which are not harmful to the environment should be further studied. At the same time the effect of H_2O_2 should also be examined.

6. Research work should be carried out in order to find appropriate methods for determining formaldehyde in white sugar.

Subject 19: Characteristics of white sugars
Referee: D. Hibbert† (UK)

1. The Official method for dermination of loss on drying is to be modified in such a way as to require the dishes, after drying, to be cooled to a temperature of (ambient plus maximum of 2)°C instead of (ambient plus 5)°C.

2. The method of Schneider, Emmerich & Ticmanis for the determination of surface and total water, using the Karl Fischer reagent, is Tentatively adopted.

3. The method of Rens for the evaluation of screening test results is Tentatively adopted; the Tentative status of the Powers method is retained. The RRSB method should be taken into Consideration and receive Tentative status.

4. The British Sugar method for the determination of calcium phosphate in powdered sugars is Tentatively adopted.

5. Taking into account the requirements of Codex Alimentarius, a method should be developed for the determination of anticaking agents as listed in Codex specifications for powdered sugars.

† Deceased in 1986

Subject 20: Deterioration of sugars
Referee: D. S. Martin (UK)

1. Instruments depending upon measurement of the resistance of an electrolyte solution should continue to be favoured for the ready measurement of the ERH of sugars, and field trials should be continued to test the effectiveness of such instruments.

2. Studies should be made of means to accelerate the arrival of a sample of freshly-made sugar at the ERH that would result after conditioning.

3. Studies of the relationship between Dilution Indicator and ERH of sugars should continue and be intensified for more reliable statistics in different parts of the world.

4. Data about any aspects of sugar deterioration should be monitored and reported.

Subject 21: Microbiological tests
Referee: R. Strauss (Germany)

1. Nutrient media A 1 (1) and A 2 (5) (see Appendix) for the detection of mesophilic bacteria with the membrane filter method are Officially adopted. For the detection of slime-forming bacteria it is recommended that comparative analyses using the media B 1 (14), B 2 (15a) B 3 (see Appendix) be carried out.

2. Nutrient medium 1 (7) (see Appendix) for the determination of yeasts and moulds is Tentatively adopted. Additionally the nutrient media C 2 (9) and C 3 should be tested for selectivity. Nutrient medium D 1 (8) (see Appendix) for osmotolerant yeasts is Tentatively adopted.

3. Comparative analyses for thermophilic spore-forming bacteria should be carried out on nutrient media E 1 (10) and E 2 (10a) (see Appendix) with and without acid indicator. Furthermore, it is recommended to identify the acid-forming bacteria through post-growth staining.

4. The elimination of vegetative bacteria by heating to 100°C for 5 minutes in identical vessels and volumina, as described in this Report, is adopted as an Official method for the determination of thermophilic spores.

5. The suitability of the quick test for bacterial counts comparing the counting of microcolonies on a microscope after staining with fluorescent dye (*Proc. 18th Session ICUMSA*, 1982, 356 - 363) should be tested by comparing with the conventional incubation method for different incubation periods.

6. Nutrient pads can be Officially recommended as far as they correspond to the nutrient media recommended by ICUMSA.

Subject 22: Colour and turbidity
Referee: M. A. Clarke (USA)

1. The use of TEA buffer, as described in Appendix 1, for pH adjustment in the measurement of white sugars should be subjected to collaborative testing.

2. In the measurement of colour of sugars other than white sugars by the ICUMSA method, a dry substance content should be specified.

3. The use of buffers for pH adjustment in the measurement of colour in sugars other than white sugars should be studied further.

4. The use of a pH other than 7 for colour measurement should be analysed by further study.

5. The determination of turbidity in sugar solutions should be submitted to further study.

6. The use of the probe-type colorimeter for sugar colour measurement should be studied in comparison with standard spectrophotometers.

Subject 22A: Reflectance and visual appearance of white sugars
Referee: S. Akoglu (Turkey)

1. The title of Subject 22A is to be changed to "Reflectance and visual appearance of sugars"

2. The chromaticity co-ordinate z (E) is adopted as a Tentative standard in white sugar colour-type measurement by the reflectance method and in the calibration of Braunschweig colour-type series.

3. The use of the reflection ratio of R(495)/R(620) instead of the ratio R(426)/R(620) in the evaluation of reflectance factors is Tentatively adopted.

4. Investigation of the reflectance measurements for the evaluation of the colour of white sugars should be continued giving special consideration to the CIE (L*a*b*) system.

5. Studies on the influence of size, gloss and surface structure on visual grading and on reflectance measurements should be continued.

6. The application of visual and reflectance techniques to the evaluation of brown sugars should be continued.

7. The Imperial Sugar Method for reflectance measurement of brown sugars as described in Appendix 4 should be further studied internationally.

8. Methods involving the measurement of transluminescence in relation to white sugar should be studied in close co-operation with Subject 22.

Subject 23: Rheological properties
Referee: T. Moritsugu (USA)

1. Investigations of factors influencing the rheological properties of molasses and massecuites should be continued.

2. The pipeflow and falling-ball methods are adopted as alternatives to the rotating-cylinder method for determining the viscosity of molasses.

3. Investigations of the elastic-flow properties (tack), interfacial tension, and surface tension of molasses and massecuites should be initiated.

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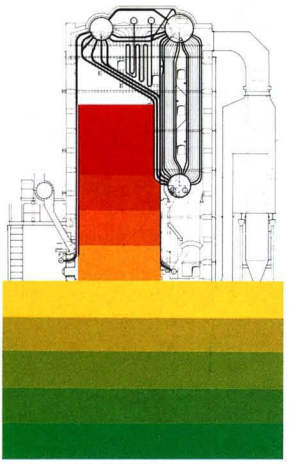

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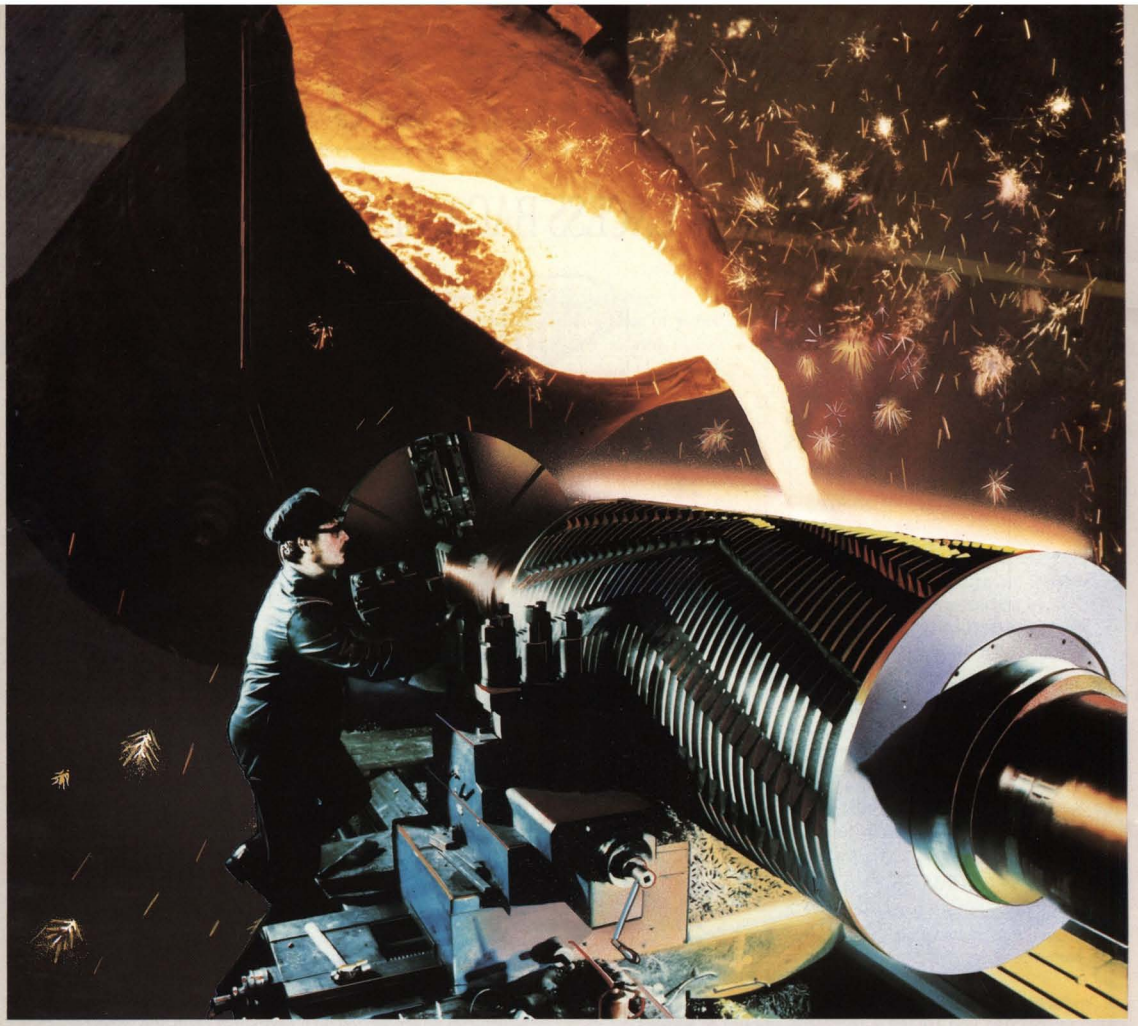

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ISJ Abstracts

Cane sugar manufacture

Automatic pan boiling

D. N. Maid. *Maharashtra Sugar*, 1985, **10,** (10), 41 - 42, 45 - 46, 48 - 50.

Descriptions are given of the sequences in *A*- and *C*-massecuite boiling at the author's sugar factory for which automatic programmed controls supplied by Poland were installed. The *A*-massecuite system is based on consistency control, while low-grade boiling is based on conductivity. Results of one month's operation of the *A*-massecuite system and of 15 days' operation of the *C*-massecuite scheme show a reduction in boiling time and in the amount of sugar dust, higher massecuite purities and lower molasses purities, decrease in molasses recirculation, maintenance of maximum crystal growth and a cut in steam consumption.

Automation in the boiling house

B. A. Bhagwat. *Maharashtra Sugar*, 1985, **10,** (10), 53 - 54.

The main purpose of automation and the effects on processing of cane pol, fibre, non-sugars and water contents are stated. Automatic control of clarification, particularly juice pH, is briefly discussed, and the importance of Brix for boiling house performance stressed; brief mention is made of a digital Brix indicator and control unit developed by the author's company.

A microprocessor-based pan monitoring system

P. Kapur, V. L. Patil, G. K. Gautam and G. N. Acharya. *Maharashtra Sugar*, 1985, **10,** (10), 61 (*Abstract only*).

While direct measurement of masscuite Brix, purity and supersaturation is difficult, each variable may be estimated indirectly on the basis of certain specific parameters. On-line calculations require the use of a computer, and the paper highlights a pan monitoring system for low-grade massecuite and graining strikes which is based on resistivity, viscosity, temperature and level; Brix, purity and supersaturation are computed and displayed as well as the measured variables. Advantages of the system are noted.

The use of aluminium tubes in the sugar industry - a low-cost scheme

V. K. Goyal and K. N. Agarwal. *Indian Sugar*, 1985, **35,** 81 - 83.

While aluminium tubes are lighter and much less expensive than brass or steel tubes, they have not been widely used in the sugar industry because of leakages caused by the differences in coefficient of expansion between the aluminium tubes and e.g. steel shells and tube plates of juice heaters, evaporators and vacuum pans, and because of the corrosion of aluminium tubes caused by caustic soda used for evaporator cleaning. Grooves in the holes of juice heater tube plates and the use of expansion joints are two means tried at Dhampur to overcome the problems; the same methods have been applied to climbing-film semi-Kestner evaporators used as vapour cell, 1st and 2nd effects so as to reduce scaling and thereby eliminate the need for cleaning with NaOH. The results obtained are discussed.

Influence of bleeding on the overall heat transfer coefficient in multiple-effect evaporators

D. U. Leal, P. Friedman and A. Valdés. *CubaAzúcar*, 1984, (Jan/March), 3 - 10 (*Spanish*).

The inapplicability of design criteria from multiple-effect evaporators without vapour bleeding to evaporators with provision for bleeding is discussed; heat transfer coefficients tend to be higher in the latter case owing to the fact that the coefficient, as well as overall heat transfer, tends to increase with the higher temperature in the bodies. A number of equations from the literature for calculation of the heat transfer coefficient have been compared and it is concluded that a Swedish equation is better for the later vessels in a multiple-effect and the Danish equation is better for the earlier vessels; both are quoted from a book by Jenkins[1].

Economic analysis of industrial downtime in an agro-industrial sugar complex

M. Pérez V. and A. Morales P. *CubaAzúcar*, 1984, (Jan/March), 11- 16 (*Spanish*).

A mathematical and statistical approach is used to calculate the benefit to result from reduced downtime (i) where, over a fixed crushing season, average daily throughput is increased, and (ii) where, with a fixed daily throughput, the length of the crushing season is reduced.

The double seeding technology to improve recovery in standard raw sugar factories with mechanized harvesting

E. Díaz G., J. Pérez E. and P. Pérez T. *CubaAzúcar*, 1984, (April/June), 12 - 18 (*Spanish*).

The double seeding method of boiling dates from 1959/61 and has been used for the manufacture of high quality sugar for direct consumption and inadequate refining capacity. The latest version involves completely counter-current boiling through three strikes, the whole of the *C*-sugar being used as grain for the *B*-sugar and all the latter being used as seed for the *A*-sugar. The *A*-molasses is all used for boiling the *B*-massecuite and the separated *B*-molasses from this used to boil the *C*-massecuite. The equipment required is described and the advantages of the system discussed and quantified; these include better final molasses exhaustion, 20% reduction in the volume of low-grade massecuites, and an increase in sugar recovery.

Selection of metallic materials for the handling of sulphited cane juices

C. A. Echevarría L., G. Govantes P., A. López R. and L. A. López C. *CubaAzúcar*, 1984, (April/June), 32 - 37

1 "Introduction to cane sugar technology" (Elsevier, Amsterdam), 1966, 236.

(*Spanish*).

Laboratory tests have been made at the Matanzas University Centre to evaluate a range of materials for sugar plant, including some in current use, others recommended in the literature and yet other materials. The tests included metallography, determining polarization curves and also weight loss due to corrosion and erosion. From the results, the authors consider that CT-3 steel and grey cast iron should not be put in contact with sulphited juices, and they recommend X18H-10T steel for the construction of tanks, pipes, pump casings and impellers, etc.

Different models of biodigesters and possibilities for their use in the sugar industry

M. S. Leal S., S. Orúe and A. G. Núñez. *CubaAzúcar*, 1984, (April/June), 44 - 52 (*Spanish*).

A review is made of the main anaerobic processes used for the treatment of effluents from a number of industries, and a combination of techniques proposed for use in the sugar industry.

Why dry bagasse?

P. Friedman and A. Arrascaeta. *CubaAzúcar*, 1984, (July/Sept.), 27 - 37 (*Spanish*).

A review of bagasse dryer installations since 1910 is presented and the reasons for increased use of bagasse dryers explained. Various types of dryer are described with illustrations, together with some integrated systems of drying and combustion.

Evaluation of the cane diffuser by use of mass transfer theoretical equations

L. Hernández C. and A. Valdés. *CubaAzúcar*, 1984, (July/Sept.), 37 - 43 (*Spanish*).

Theoretical equations are developed for mass transfer in a cane diffuser and data collected from a sugar factory used to determine the number of theoretical equilibrium stages, and to calculate the efficiency of the diffuser and the distribution of pol in juice and bagasse; these calculated values agree reasonably well with measured values.

Chemical method for retarding deterioration of sugar industry products. Part III. Formation of carbonyl substances during the alkaline treatment of syrups

J. A. Urrutia F., E. L. Ramos S. and R. A. Linares C. *CubaAzúcar*, 1984, (Oct./Dec.), 7-14 (*Spanish*).

In the method described, part of the syrup from a raw cane sugar factory is treated in the laboratory with NaOH whereby carbonyl compounds are formed. This portion of the syrup is mixed with the remainder, whereupon half the amino-acids in the latter are removed by reaction with the carbonyl compounds. Such elimination makes the raw sugar produced from the syrup less liable to deterioration in storage.

Mathematical modelling of final massecuite

R. Consuegra, M. Alfonso, J. Riesgo and O. Mayo. *CubaAzúcar*, 1984, (Oct./Dec.), 15 - 21 (*Spanish*).

A mathematical model has been worked out for the boiling of low-grade massecuites and description is given of the method used for determination of input data to achieve material balance. Values of the coefficients are discussed.

Studies on colour development in stored plantation white sugars

H. T. Cheng, W. F. Lin and C. R. Wang. *Proc. Maillard React. Foods Nutrit. Symp.* (183rd Meeting Amer. Chem. Soc.), 1983, 91 - 102; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (5), Abs. 5 R559.

Causes of increased colour in cane white sugar during its storage are examined. A comparison of change in the colour of white sugar obtained by carbonatation and by sulphitation showed that the colour increase was greater in the former case. It was found that the quality of sugar manufactured at the start (November - December) and end (April - May) of the season deteriorated more rapidly than for mid-season (January - March) sugar. The increase in colour intensified with rise in temperature, and the colour increased even where the sugar was stored in the dark and had no contact with air. The high alkalinity of juices in 1st carbonatation was found to promote degradation of reducing sugars with formation of colouring matter. Recommendations are given on increasing sugar quality by replacing 2nd carbonatation with sulphitation or phosphatation and improving 1st carbonatation so as to reduce the degradation of reducing sugars.

The characterization of the polysaccharides in sugar factory products in Indonesia

M. Mochtar. *Gula Indonesia*, 1985, **11**, 1140 - 1145.

The procedures used in sampling raw and thick juice, molasses, low-grade and white sugar for polysaccharide determination and in pretreatment of the samples and analysis of the fractions obtained are described, and the adverse effects of polysaccharides on processing indicated. The monetary value of losses caused by polysaccharides are calculated.

Classification of colorants responsible for degradation of sugar quality and their fate in the sugar manufacturing process

V. Dubey. *Indian Sugar*, 1985, **35**, 297 - 301.

Colorants occurring during sugar manufacture are classified under those present in the cane, colourless materials in the cane which react to form coloured compounds during processing, those formed by degradation of sugar and reducing sugars, and enzymatically formed colorants. Advice is offered on prevention or removal of colouring matter.

Improved sugar factory efficiency – suggestions

H. J. Delavier. *Gula Indonesia* , 1985 (Special Edition), 22 - 28.

Among measures to improve factory performance are those pertaining to cane agriculture, reduction in extraneous matter, the use of diffusion in place of milling (but recognising that higher sucrose extraction is accompanied by higher non-sucrose extraction with its attendant bacterial problems), installation of vertical crystallizers and improved bacteriological control.

Methods for the improvement of white sugar quality

J. T. Rundell and V. P. Verney. *Gula Indonesia*, 1985, (Special Edition), 39 - 43.

The processes employed in the manufacture of Blanco Directo sugar are outlined. The sugar has a colour in the range 100 - 200 International Colour Units by comparison with 300 - 400 ICU for plantation white sugars; while sugar produced by double carbonatation-double sulphitation (DCDS) sometimes has a colour of only 50 - 100 ICU, considerable quantities of lime are consumed and high mud volumes result. Blanco Directo sugar has much better keeping qualities than DCDS and double sulphitation sugar. The sugar is produced by raw juice sulphitation, clarification and evaporation, the syrup from which is clarified by the Talodura system of phosphatation-flotation. The syrup passes to crystallization while the mud is subjected to Talofiltrate clarification (another phosphatation-flotation process) together with dirty filtrate from clarification mud filtration which also handles the scum from the Talofiltrate treatment. The overflow from Talofiltrate clarification is sent to the evaporator. A 3-massecuite boiling scheme is used, yielding an *A*-sugar of 99.8 purity which has a number of good characteristics besides its low colour and turbidity.

Reheating systems for low-grade massecuite

S. J. Clarke and L. Serebrinsky. *Sugar Bull.*, 1986, **64,** (8), 8, 11.

Information is given on various systems which are suitable for rapid, controlled reheating of low-grade massecuite which the authors feel should be considered as alternatives to current practices in Louisiana. They include the Green-Smith model designed especially for low-grade massecuites and widely used in both cane and beet sugar factories in many countries, and various designs of electrical resistance heater. Experimental work in the USSR on microwave heating is also mentioned.

Introducing membrane technology

P. S. Tjokroadikoesoemo. *Gula Indonesia*, 1985, **11,** (3), 13 - 20.

Three methods of sugar recovery from molasses are briefly described, viz. the Applexion multiple flocculation method, the Goodworth desalting process and the Finnsugar chromatographic separation technique. Details are then given of reverse osmosis, electrodialysis and ultrafiltration with mention of their applicability to molasses desugaring and of their possible eventual introduction in the Indonesian sugar industry.

Microprocessor-based electronic instrumentation and control systems for modernization of the Indian sugar industry

G. N. Acharya. *Maharashtra Sugar*, 1985, **11,** (1), 9 - 11, 13 - 14, 16, 19 - 22, 24 - 26, 29 - 36, 39 - 42, 45, 48, 53, 55, 57 - 58, 60 - 62, 64, 66 - 68, 77, 79, 81 - 84.

The Director of the Central Electronics Engineering Research Insitute surveys processes and process stages which would benefit from the use of electronic controls and indicates in each case the direct and indirect improvements that would result. The role of microprocessors and microcomputers is discussed, and possible applications of microprocessors and distributed systems are described; these include: monitoring and control of the functions involved in cane harvesting, transportation and delivery so as to reduce the delay between cutting and processing; cane and juice weighing; wet bagasse weighing and moisture estimation; cane milling; juice liming and pH control in clarification; sulphitation; temperature measurement and data acquisition; automatic pan boiling; centrifugal operation; and energy management, particularly furnace and boiler control. Descriptions are given of various CEERI systems designed to fulfil the various tasks. The advantages and disadvantages of various types of electric drive for centrifugals are also examined.

Instrumentation and process control systems in the sugar industry

S. C. Sharma. *Maharashtra Sugar*, 1985, **11,** (1), 85 - 87.

The author deplores the poor level of instrumentation in Indian sugar factories and welcomes a growing awareness of its importance and that of automation. Areas where instrumentation and automatic control may be desirable are indicated and the possible benefits described. The complexity of electronic instruments and hence the need for adequate training of personnel involved are discussed, and the role of the microprocessor is mentioned.

Some current and future trends in pan boiling automation

G. N. Acharya. *Maharashtra Sugar*, 1985, **11,** (1), 89 - 92.

See I.S.J., 1986, **88,** (*Maharashtra Sugar*, 1985, **10,** (10), 35-36, 39-40.

Study of A.C. resistivity and viscosity and their role in regulating low-grade strikes

G. N. Acharya, P. Kapur and V. L. Patil. *Maharashtra Sugar*, 1985, **11,** (1), 97 - 109.

See *I.S.J*, 1982, **84,** 294 - 299; 1984, **86,** 131 - 135.

Auto-Teimac system for the sugar and allied industries

H. Singh, S. M. Sharma and S. S. Ahluwalia. *Maharashtra Sugar*, 1985, **11**, (1), 111 - 112, 114 - 121, 123 - 125, 127.

Details are given of an automatic temperature indicating, monitoring and control system which was successfully tested over three seasons on maintenance of sulphitation juice at 102 ± 2°C by means of the control of steam flow through the juice heater and on maintenance of SO_2 gas generation by temperature control of the combustion chamber in the sulphur burner.

Automatic pH control systems for the juice clarification process in the sugar industry

L. Narayan, K. S. N. Rao and G. N. Acharya. *Maharashtra Sugar*, 1985, **11**, (1), 129 - 133, 135 - 136, 141 - 146.

A microprocessor-based automatic pH control system is described which was designed for use with lime dosing. Automatic control of SO_2 feed is incorporated; an earlier digital system had erroneously assumed a constant SO_2 supply. In trials at one factory during two seasons, the system maintained the pH to within ± 0.1 unit and allowed for fluctuations in the crushing rate and juice flow rate.

Suggestions for minimizing losses during the manufacture of plantation white sugar. I

S. C. Roy. *Indian Sugar*, 1985, **35**, 429 - 442.

Measures described for minimizing losses start with cane varietal selection and maturity scheduling and include the need to reduce the time lag between harvesting and processing. Extraneous matter should be as low as possible, and cane preparation optimized. Besides raising process efficiency, the author stresses the need for adequate microbiological control, and then examines the importance of clarification, including the quality of lime and sulphur. Aspects of filtration and evaporation are also discussed.

Activities in a sugar mill between harvests

M. Biddlestone and D. G. Foster. *Barbados Sugar Rev.*, 1985, (53), 11 - 13.

Maintenance, repair and installation work carried out in Barbados sugar factories outside the cane processing season (which usually lasts an average of only 15 weeks in the year) are discussed. Installation of a dryer for cassava at Carrington factory for operation on waste heat during the "non-sugar" period is mentioned.

Improving low-grade sugar crystallization

R. S. Patterson. *Sugar y Azúcar*, 1986, **81**, (2), 23, 26 - 27.

See *I..S.J.*, 1985, **87**, 123A.

Energy management in a sugar factory

M. Singh. *Maharashtra Sugar*, 1985, **11**, (2), 53 - 55, 57 - 58, 60 - 61, 63, 65, 67 - 68.

Optimization of steam and power consumption is discussed in the light of what the author considers to be an excessive fuel consumption of 0.6 - 0.7 tonnes of oil per tonne of sugar produced by Indian sugar factories. Measures included are: the use of waste heat recovered from boiler flue gases, increased combustion efficiency, generation of high-pressure steam, improvement in the power factor, installation of a common header in the delivery line of the injection water pumps for the vacuum system of the pan station, interlocking of standby pumps to prevent them being operated in parallel with a poorly performing pump over long periods, reduction of the load on the cane carrier drive, and installation of continuous centrifugals.

Control of the undetermined loss of sugar due to inversion in plantation white sugar manufacture

D. S. Lande and A. R. Patil. *Maharashtra Sugar*, 1985, **11**, (2), 77 - 78, 80 - 82, 84 - 87.

Undetermined losses are analysed and sources of inversion losses indicated. Means of reducing inversion include improved cane mill sanitation, automatic control of clarification and of juice flow to avoid over-liming and over-gassing with SO_2, evaporating to a syrup Brix no lower than 60° (so as to avoid the need for excessive reboiling), raising the temperature of injection water to an optimum so as to improve the vacuum and hence evaporator and vacuum pan operation, molasses conditioning, and avoidance of clarifier and evaporator capacities that are too high relative to the crushing capacity of the factory.

Membrane permeability of ultrafiltered cane juice

M. Tako, M. Takara and S. Nakamura. *J. Agr. Chem. Soc. Japan*, 1985, **59**, (8), 779 - 786; through *S.I.A.*, 1986, **48**, Abs. 86-309.

Raw cane juice was ultrafiltered through membranes of four types: PM-30, PM-10, YM-5 and YM-2. With the first three, juice flux was high (about 0.8 ml/cm²/min) and was further improved by previous liming at 85°C. The initial flux was highest with PM-30 and PM-10, but decreased more rapidly than with YM-5. Data are given on protein and reducing sugars contents in permeate and retentate; contents in permeate were lowest after liming to pH 8.1 at 10°C or pH 7.0 at 85°C. Rejection of sucrose was lowest (2.9%) when juice limed to pH 7.0 at 85°C was ultrafiltered through a YM-5 membrane. This membrane is considered the most suitable for use in the process.

Modern trends in milling

G. K. Chetty. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, E.15 - E.28.

See *I.S.J.*, 1985, **87**, 68A.

Beet sugar manufacture

Beet quality and profitability of the beet-sugar pathway: Introduction. I. Measuring quality components. II. Formulae expressing the technological value of beet. III. Cost of tare in the beet-sugar pathway. IV. Sugar factory manufacturing margins. V. Spread of actual results achieved. VI. Known influence of some factors on quality. VII. Aims of the (sugar) trade. VIII. Some leads for improving beet quality. Annex 1. Factors arising in tare formation

Introduction. P. Devillers. *Sucr. Franç.*, 1986, **101,** 7 - 8. I. Anon. *ibid.*, 9 - 11. II. Anon. *ibid.*, 13 - 15. III. J. M. Boquery and B. Guérin. *ibid.*, 16 - 21. IV. Anon. *ibid.*, 22 - 27. V. Anon. *ibid.*, 28 - 32. VI. Anon. *ibid.*, 33 - 37. VII. Anon. *ibid.*, 38. VIII. D. Bruandet. *ibid.*, 39 - 40. Annex 1. Y. Duval. *ibid.*, 41 - 44 (*French*).

Introduction. The aim of increasing beet quality so as to recover as much sugar as possible at lowest cost is stated; it is pointed out that while sugar recovery per tonne of beet processed rose rapidly from 1850 to 1900, then more slowly up to 1930, in the last 50 years it has remained somewhat stable, with variations caused by climatic factors.
I. In a short survey of beet sampling and analytical methods, it is considered that, because of optically-active components which can affect sugar measurement by polarimetry, it is desirable to use a method for accurate determination of sucrose; however, of the only two mentioned that are accurate and precise, gas liquid chromatography does not give a sufficiently high rate of sample analyses per unit time, unlike enzymatic determination. HPLC is still not precise enough, and isotope dilution takes too long.
II. Five formulae presented for calculation of molasses sugar are discussed, and formulae are derived from melassigenic coefficients for K and Na salts and nitrogenous matter in an average molasses having an alkalinity coefficient of 1.8, >1.8 or <1.8.
III. The nature, importance, quantity and costs of extraneous matter, evaluation of the costs and factors contributing to excessive tare are discussed.
IV. The effects of beet sugar content and of molasses sugar on the manufacturer's gross and net margin are discussed.
V. The effects of year, country, field conditions and of differences in delivery batches on sugar content and extraneous matter are discussed using tabulated data and graphs to demonstrate the scatter that can be expected.
VI. The effects of nitrogen, beet population and uniformity, topping and detrashing, and variety on beet processing quality are discussed.
VII. Short-, medium- and long-term aims are set for beet sugar content (16.5, 17.5 and 18.5%), thin juice purity (92.5, 93.5 and 94.5), molasses sugar (1.9, 1.75 and 1.55%) and extraneous matter (33, 23 and 18%), and the effects of the overall improvement on gross and net margins indicated.
VIII. A general approach to improving beet quality is discussed.
Annex 1. Investigations at eight sites in 1984 to identify soil constituents and determine soil moisture content and beet morphological properties contributing to extraneous matter are reported.

Mathematical modelling of the process of sugar extraction from beet

F. V. Negoda and A. P. Ladanyuk. *Izv. Vuzov, Pishch. Tekh.*, 1985, (4), 64 - 68 (*Russian*).

Development is described of a static model of the diffusion process which has been tested under factory conditions and incorporated in a mathematical scheme acting as basis for optimization and automation of the beet sugar manufacturing process. An algorithm for identification of the parameters used in the model is required because of a drift in evaluation of the coefficients.

Analytical comparison of two methods for extracting sucrose from sugar beet with regard to the amino-acids and organic acids content. I

M. Spanar, Z. Jancekova and M. Kovac. *Bull. Potravin. Vysk.*, 1985, **324,** (2/3), 163 - 171; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (2), Abs. 2 R457.

A new technique for sucrose extraction from beet is reported that has been developed and tested on pilot-plant scale. It is based on extraction with an aqueous solution of an organic solvent of lower polarity than water, so that the quantity of pectins, colloids and other non-sugars passing into solution is reduced. Comparative studies were made of the amino-acid and organic acid content in a number of products (pulp, thick juice and molasses) obtained by the conventional diffusion method and by the new technique; the amino-acids were determined by ion-exchange chromatography, and the organic acids by isotachophoresis. It was found that, using the organic solvent method, there was a 12 - 70% reduction in the quantity of amino- and organic acids entering the juice, while the amount in the pulp was 130% greater than with conventional processing.

Possibilities and limitations of raw juice purification

K. Bohn and R. Schick. *Tagungsber. Akad. Landwirtschaftswiss. DDR*, 1985, **229,** (2), 317 - 331; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (2), Abs. 2 R459.

From analysis of the composition and properties of non-sugars in raw juice, it is concluded that the possibilities of increasing carbonatation efficiency when processing beet of reduced quality are limited. Possible approaches include making better use of the adsorptive property of $CaCO_3$ and increasing the thermal stability of purified juice. In this connexion, the degradation of a maximum quantity of amides is important. Results are reported of investigations on establishing optimum conditions of amide degradation; it is

noted that, to increase the thermal stability of juice, NH_3 must be removed before 2nd carbonatation. Partial salting-out of 2nd carbonatation juice using ion-exchange resin is found to permit improvement in juice quality and reduction in the molasses sugar content.

Relationship between sucrose lost and electricity consumption in sugar beet storage

P. V. Schmidt. *Tagungsber. Akad. Landwirtschftswiss. DDR*, 1985, **229,** (2), 355 - 360; through *Ref. Zhurn. AN SSSR* (Khim.), 1986, (3), Abs. 3 R419.

It is shown that there is a definite correlation between sucrose losses and electricity consumption in beet storage; increase in ventilation rate is accompanied by a fall in sucrose losses and increase in power consumption. Therefore, in calculating the requirement of ventilation plant, account must be taken of sucrose losses in relation to electricity consumption and capital investment.

Cleaning sugar beet by means of an air stream. II. Analysis of the energy consumption of the process

B. Mayrhofer and P. Knedlik. *Zuckerind.*, 1986, **111,** 128 - 132 (*German*).

A mathematical model is presented which describes the cleaning of beets by a horizontal jet of air directed at them as they fall in a vertical stream from the end of a conveyor belt. The model is considerably simpler than an earlier one described by Mayrhofer & Mikus[1] and has the added advantages of permitting direct calculation of the air velocity at the nozzle and allowing analysis of the energy consumption.

Beet yard automation at Königslutter sugar factory

H. F. W. Schramm. *Zuckerind.*, 1986, **111,** 147 - 148 (*German*).

An account is given of the Resyland computerized system for automatic gathering and recording of beet reception data and beet sampling at Königslutter, where an average of 500 vehicles arrive each day during the campaign.

Computer simulation and mathematical modelling of diffusion

G. V. Genie. *Zuckerind.*, 1986, **111,** 149 - 154.

The difference between mathematical modelling and computer simulation of a process is explained and five stages in the simulation of diffusion are indicated: sucrose and non-sucrose transfer in the cossettes, juice enrichment and homogenization, counter-current flow of juice and cossettes, mass balance and heat balance. The major disadvantages of computer simulation (limited memory and the time needed to run a program) are discussed, and details given of programs, one for a rotary and the other for a tower diffuser, developed from mathematical models using empirical relations taken from the simulation programs and thus providing immediate response for purposes of automatic control. Up to 17 or 18 variables can be input (for the rotary and tower units, respectively), and a memory of 15 or 18 kilobytes is required. Results are compared with those given by the Silin and Smet equations, and the effect of cossettes weight loss on exhaustion is demonstrated.

Factory-scale trials of a modified ShI-PAS-6.0 1st carbonatation vessel at Teofipol'skii sugar factory

Yu. V. Anikeev *et al. Sakhar. Prom.*, 1986, (2), 22 - 25 (*Russian*).

The vertical vessel described has an internal coaxial circulation pipe and a sparger system consisting of six parallel pipes arranged across the lower part of the vessel. Upward facing transverse slots in the pipes are kept clear of mud by means of vibratory vanes, one in each slot. Juice is fed via a side port at a point just above the sparger, is forced up the vessel by the action of the gas stream and under the effect of the circulation pipe, and falls in the annular space between the pipe and the wall of the vessel. The model is available in two sizes, corresponding to 3000 and 6000 tonnes of beet per day. Trials with the larger unit in 1983/84 showed that its CO_2 utilization was considerably greater than that of a conventional unit in which gas bubbling using normal jet nozzles has proved inadequate, while juice purity rise was increased and filtration and settling rate improved.

Testing of a vertical flume-wash water clarifier

A. P. Parkhomets, Yu. V. Raskin and V. D. Novoseletskii. *Sakhar. Prom.*, 1986, (2), 25 - 28 (*Russian*).

Results are given of trials with a ShI-POS-3 gravity clarifier in which fractions larger than 4 mm are initially removed in a trap at the water feed, and the water then distributed by a rising element located above the bottom of the tank; an upper slot in the ring is intended for water distribution across the clarifier, while the water emerging from a lower slot pushes the settling mud particles towards the bottom discharge arrangement. The performance of the clarifier, with or without use of coagulant, was better than that of conventional units as used in the Soviet sugar industry.

Raising the efficiency of dust separation systems in the lime-gas stations of beet sugar factories

T. A. Skorik and E. A. Shtokman. *Sakhar. Prom.*, 1986, (2), 32 - 36 (*Russian*).

The concentration of dust in the vicinity of the carbonatation system, particularly in those areas where lime is brought into the factory and slaked and where CO_2 is vented to the atmosphere, are discussed on the basis of actual factory measurements, and the need to provide a high degree of separation is emphasized. An

1 *I.S.J.*, 1983, **85,** 311.

integrated suction and hydrocyclone system introduced at one factory is described and its performance indicated.

Improvement in the control systems at January 9, 1905 sugar factory

Z. S. Voloshin, I. B. Margulis and A. G. Storozhenko. *Sakhar. Prom.*, 1986, (2), 37 - 39 (*Russian*).

Descriptions are given of the automatic system for juice level control in the 1st and 2nd evaporator effects and for monitoring and stabilizing process water feed from the main reservoir, which has resulted in a 20% reduction in consumption.

Setting standards for electrical energy consumption in the sugar industry

B. P. Efanov and A. G. Kutkovoi. *Sakhar. Prom.*, 1986, (2), 39 - 43 (*Russian*).

From data on electricity consumption in sugar factories of varying beet processing capacities, curves have been obtained for determining the norm where the factory is working to its rated capacity and where a 2- or 3-massecuite boiling system is used for the factory refining cane raws. Values of the specific consumption for given process purposes, including pulp drying, are tabulated.

The effect of Pekmez earth on juice purification

H. I. Cengiz, E. Kayimoglu and O. C. Akyar. *Seker*, 1986, **32**, (118), 27 - 31 (*Turkish*).

Tests are reported on the use of a calcareous soil found in a region of Turkey in place of recycled carbonatation mud for juice liming. Soil from the layer 0.080 - 0.050 mm below the surface was used in the experiments; it contained approx. 48% CaO and 8% silica. When added together with lime and in the absence of recycled mud, it often increased thin juice purity and reduced the filtration coefficient, the optimum dosage being 0.2 - 0.3% w/w; however, it had little effect in the presence of recycled mud, indicating that it played the same role as calcium carbonate. Further studies are recommended to evaluate the economics of using the soil.

Study on the future of antisepsis in the sugar industry

E. Duthoit. *Ind. Alim. Agric.*, 1986, **103**, 25 - 31 (*French*).

A study is reported on the types and counts of micro-organisms found in sugar factory juices, and the performances of four unnamed disinfectants are compared to show how to approach the problem of infection and its control.

Obtaining and purifying raw juice in an electric field

M. P. Kupchik *et al. Sakhar. Prom.*, 1986, (3), 16 - 19 (*Russian*).

Trials were conducted on diffusion in a D.C. field in a series of four vertical cells made of resin laminate with stainless steel cathodes at the two opposing walls and a central vertical aluminium anode acting as baffle and extending from the top of the cell almost to the bottom to allow the extractant (initially at pH 6.5 - 6.8 and 75°C) to pass below it on its passage from the feed port at the top of one side to the corresponding discharge point on the other side; the juice was reheated before entering each cell, which had a volume of 0.12 m^3, a total electrode surface area of 0.26 m^2 and specific cossettes load of 0.7 tonnes/m^3. Total diffusion time was 5 - 60 min at a field voltage of 1 - 3 V/cm, giving a raw juice of 11 - 13 °Bx which was subsequently treated by conventional carbonatation. In parallel tests, diffusion was carried out at 70 - 72°C in the absence of an electric field. At an optimum voltage of 1 - 2 V/cm and a total time of 10 - 15 min there was 30 - 50% less colloidal matter, 40 - 50% less colouring matter, 10 - 12% less total N, 10 - 20% less ash and 20 - 30% less lime salts than in the control, while purity was 1.5 - 3 units greater. Electricity consumption under these conditions was 0.61 - 2.64 kWh per tonne of beet, and aluminium consumption was 3 - 6 g/tonne of beet (at a steady current of 17 - 35 A/m^2). Reduction in the lime consumption to below 3% CaO on beet adversely affected the filtration properties of the control 1st carbonatation juice and the quality of 2nd carbonatation juice, which was not the case with the trial juice even when the lime dosage was halved; this had no adverse effect on thick juice, the purity of which was 1 - 1.2 units greater than with the control.

A new ion exchange material for decolorization of sugar solutions

A. A. Slavyanskii, A. R. Sapronov, Yu. I. Sidorenko, V. S. Pavlenko and M. S. Mezhirov. *Sakhar. Prom.*, 1986, (3), 19 -21 (*Russian*).

A synthetic polymeric material with 5 - 10 μm particles of AV-17-2P anion exchange resin incorporated at the rate of 100 - 600% by weight of polymer took the form of a felt-like pad 6 - 8 mm thick which was of high porosity and highly permeable to syrup. Comparative tests with pads containing 100% resin in OH^- and Cl^- form showed that decolorization of sugar solutions proceeded more rapidly than with the resin in the form of 0.25 - 1 mm granules, while the extent of saturation with adsorbed colouring matter was greater than with the normal form of resin. This was attributed to the absence of blinding by colloids and high molecular compounds and to the greater adsorption surface area presented.

Selection of chemical foam depressants for beet sugar manufacture

P. V. Poltorak, B. N. Valovoi, V. G. Yarmilko and N. V. Kulinich. *Sakhar. Prom.*, 1986, (3), 21 - 24 (*Russian*).

Criteria to be applied in the selection of a suitable anti-foam agent are discussed, and the performances of soap stock, AS-60, and a product each from Dow

Corning and Ouvrie are evaluated on the basis of their effectiveness in diffusion. The most effective proved to be the Dow Corning product, followed by the Ouvrie product, AS-60 and soap stock (found to be only slightly effective). However, the Ouvrie product was far cheaper than the Dow Corning and is therefore considered the better buy.

Raising the efficiency of limestone burning and 1st carbonatation juice treatment

A. P. Lapin, I. S. Lapina, V. V. Mank, L. I. Trebin and I. A. Oleinik. *Sakhar. Prom.*, 1986, (3), 27 - 29 (*Russian*).

Wetting the lime kiln charge with sodium chloride solution (0.05 - 0.2% NaCl on weight of limestone) had been found to reduce the adverse effect of silicon oxide formed when the limestone contained 2% or more sand; it prevented clinkering and the formation of calcium silicate which was responsible for hanging of the charge and reduction in active lime yield. Since the sodium silicate formed by the treatment is water-soluble, it did not hamper slaking, while HCl from the reaction raised the surface activity of the limestone and active lime yield. Investigations confirmed the positive effects of NaCl and showed that, within the range 0.05 - 0.50% NaCl on weight of limestone, 0.20% was the optimum at which active lime yield was maximum (91.1% of the total compared with 80.9% without NaCl treatment), after which yield stayed constant with further increase in NaCl application. Tests also showed that 2nd carbonatation juice benefited from the treatment in terms of lower lime salts and colour and higher purity, while molasses sugar also fell. Although the improvement in juice properties was attributed to the elimination of hanging in the kiln, i.e. adhesion of the charge to the wall, it was suggested that another cause was the flocculating effect of products formed by reaction between soluble silicates and compounds in the limestone; this was confirmed by experiments in which the settling rate and filtration coefficient of 1st carbonatation juice obtained by conventional treatment were improved when the limestone was treated with NaCl, while addition of silicic acid caused even further improvement.

Trials on a 2nd carbonatation unit of 3000 tonnes/day beet slice at Tal'noye sugar factory

V. F. Shutka *et al. Sakhar. Prom.*, 1986, (3), 34 - 38 (*Russian*).

A smaller version of the modified carbonatation vessel described earlier[1] was tested on both 1st and 2nd carbonatation juice while operating alongside the conventional vessels at the factory. Filtered 1st carbonatation juice was treated in a vertical liming tank before 2nd carbonatation, after which it was "ripened" (to reduce calcium carbonate supersaturation) in a special circular vessel; this was basically a simplified clarifier in which the mud passed through a gap between an annular gutter and a rotating annular plate beneath it and thus spread evenly over the cross-section of the vessel. The "cleaner" juice flowed from the vessel through a port near the top, while the muddy juice was recycled from the conical bottom to preliming. Results confirmed the benefits of the modified carbonatation vessel and of the 2nd carbonatation juice treatment in regard to 1st carbonatation juice settling and filtration, 2nd carbonatation juice filtration, increased CO_2 utilization, reduced limestone consumption and fall in molasses sugar.

A frame-and-chain trash catcher

E. E. Goncharenko, A. E. Goncharenko, A. P. Motchenko and A. D. Baglyuk. *Sakhar. Prom.*, 1986, (3), 44 - 46 (*Russian*).

Endless chains pass around a driving and a driven wheel at opposite ends of the trash catcher described. From frames connected to the chains are suspended pivoted rake elements with a serrated edge; as the chains pass below the wheels in the same direction as the flow of the beet, these elements hang down in the flume and, because the speed of travel of the chains is lower than that of the beet flow, trap leaves and other trash. As the chains pass above the wheels, the rake elements catch on a vibratory stepped arrangement which teases the trash out of them. Tests have shown that the system separated more than double the trash removed by the existing system at one factory.

Application of tapering means for measurement of juice bulk flow in a tower diffuser system

A. F. Makhlai. *Sakhar. Prom.*, 1986, (3), 46 - 47 (*Russian*).

Use of means such as a diaphragm to measure juice flow in the prescalder of a tower diffuser is suggested.

Model of a sugar factory with low fuel consumption

P. Christodoulou. *Cukoripar*, 1985, **38,** 137 - 144; 1986, **39,** 12 - 19 (*Hungarian*).

See *I.S.J.*, 1985, **87,** 92A.

The growth of sucrose crystals coming from vacuum pans

V. Maurandi, B. Paganelli and A. Rossi. *Ind. Sacc. Ital.*, 1986, **79,** 7 - 10, 12 (*Italian*).

See *I.S.J.*, 1986, **88,** 114A.

The Maguin beet washer line

K. Duffek. *Listy Cukr.*, 1986, **102,** 55 - 61 (*Czech*).

An illustrated description is given of the Maguin beet washing and trash separation system as installed at four French sugar factories. It is pointed out that, while up to 17,000 tonnes of beet can be handled daily as at Connantre, the equipment would present problems for factories having a daily slicing capacity below 5000 tonnes. Beet cleaning performance is very good, with a reduction in mechanical impurities from 35% to 0.2% on beet.

1 Anikeev *et al.*: I.S.J., 1986, **88,**127A.

Starch based sweeteners

Toxicological evaluation of active carbons used for treatment of glucose-starch syrups

E. K. Sidorova, I. P. Dubinskaya and A. Ya. Khesina. *Sakhar. Prom.*, 1986, (3), 52 - 53 (*Russian*).

Analysis of powdered active carbons used to treat glucose syrups revealed 0.00035 - 0.00096 ppm benzopyrene, a carcinogenic substance; treatment with 0.1N HCl (as normally practised in glucose syrup manufacture) or with boiling water for 30 minutes reduced the content by 40 - 50%. Syrup of 50% concentration treated with 1.2% carbon w/w for 30 min at 70°C and subsequently filtered and boiled under vacuum was found to contain a maximum of 0.0003 ppm benzopyrene. The benzopyrene content in treated syrup was independent of carbon source (coke and wood). The maximum benzopyrene content in 11 grades of granular carbon was 0.001 ppm; this was practically unaffected by regeneration, as was the case with syrup treated by regenerated carbon.

Technology assessment. A case study of high fructose corn syrups

S. Pruthi and R. Kundra. *Res. and Ind.*, 1984, **29,** (3), 176 - 181; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (5), Abs. 5 R575.

The need to carry out detailed evaluation of the effects of introducing HFS production in developing countries is noted. The possible consequences of a fall in sugar output and introduction of HFS manufacture in India as an example are shown to be: a standstill in the development of village regions and migration of the village population to seek work in the towns; a fall in output in those branches of industry processing waste products from sugar manufacture; a fall in sugar exports, leading to a reduction in foreign exchange; the need to use alternatives to bagasse as sources of energy; and merging of sugar factories and by-product plants so as to reduce sugar manufacturing costs. The adverse effect of introducing HFS may be minimized by processing sugar cane and sugar to non-food products, e.g. converting cane to cattle fodder without juice extraction, as introduced in Mauritius, or using the sugar for manufacture of polymers for special purposes (e.g. for use as membranes for reverse osmosis, for sea water desalinization and for effluent treatment), of polyurethane resins for use in building materials of good insulating properties, and of preparations such as detergents, non-crease cotton goods, bactericidal paints and modified synthetic fibres.

Kinetics of continuous isomerization of glucose by an immobilized enzyme in a stirred reactor

R. C. Mayer, D. Rouleau, T. Agbebavi and M. Poirier. *Can. Inst. Food Sci. Technol. J.*, 1985, **18,** (2), 178 - 180; through *Food Sci. Tech. Abs.*, 1986, **18,** (1), Abs. 1 L 69.

The kinetics of isomerization of D-glucose to D-fructose catalysed by immobilized glucose isomerase from *Bacillus coagulans* were studied at 50, 60 and 70°C in a continuous stirred-tank reactor. Initial substrate concentrations were 5 - 25% w/v with 0.043 kg immobilized enzyme/litre of reactor. From preliminary studies on the reactor, it was found that at a stirring speed of 2.25 rps and a glucose residence time below 3330 sec, diffusional interferences were negligible. Different rate models were tested, but only the Michaelis-Menten expression without inhibition adequately described the kinetic data. Non-linear estimations of K_m and V_{max} were determined at 50, 60 and 70°C. The apparent activation energy was 46 kJ/mole.

A new regenerable immobilized glucose isomerase

R. L. Antrim and A. L. Auterinen. *Starch/Stärke*, 1986, **38,** 132 - 137.

A new immobilized glucose isomerase of high productivity has been developed, for glucose isomerization to HFS, by electrostatic adsorption of a soluble isomerase (obtained from *Streptomyces rubiginosus*) on a granular DEAE-cellulose composed of fibrous DEAE-cellulose, food-grade polystyrene and titanium dioxide. Since the enzyme is electrostatically adsorbed on the carrier, it can be reloaded with fresh enzyme; this may be repeated several times and thus minimize the costs of the enzyme-carrier system. The enzyme is tightly bound to the carrier during isomerization and is sufficiently compatible with bisulphite in the substrate to stabilize the enzyme and provide a degree of protection against infection at low isomerization temperatures. High purity and high specific activity of the soluble enzyme ensure high activity levels of the immobilized form. There is essentially no elution of colour from the immobilized enzyme in the initial stages of isomerization. As a result of the combination of low compressibility of the particles and high immobilized activity, productivities greater than 9 tonnes of 42% fructose syrup per kg of immobilized enzyme are obtained on a commercial scale.

Glucose isomerization with immobilized whole *Streptomyces bambergiensis* bacterial cells: activity and efficiency of glucose isomerase

B. Husadzic *et al. Kemija u Industriji*, 1985, **34,** (1), 45 - 49; through *S.I.A.*, 1986, **48,** Abs. 86-423.

Glucose isomerization to fructose, catalysed by whole-cell immobilized glucose isomerase, was performed in a batch-recycle reactor at 70°C and pH 7.5. The system can be represented by a porous sphere model to account for the effects of internal diffusion. The efficiency factor, calculated by an equation which is given, was 0.9925; this shows that the effect of intraparticle diffusion resistance on overall reaction rate was small. The efficiency factor of immobilization was only 0.3; that is, the immobilized enzyme had only 30% of the activity of the free enzyme.

Laboratory studies

Analysis and recommendations for the detection and control of sucrose in our (Cuban) sugar factory condensates

E. Angulo A., F. Pérez S. and A. Armario A. *CubaAzúcar*, 1984, (July/Sept.), 3 - 7 (*Spanish*).

Determination of sucrose in condensates is currently carried out using the ammonium molybdate method but a survey of results obtained for known samples by a number of factory laboratory workers has shown this to be unsatisfactory owing to the lack of a wavelength of peak absorption and the formation of a precipitate which interferes with the colour measurement. It is considered that a method using sodium malonate and sulphuric acid would be more suitable.

Influence of the lime-heat and heat-lime alkalization schemes on starch removal

R. González Z. and E. Angulo A. *CubaAzúcar*, 1984, (July/Sept.), 16 - 20 (*Spanish*).

Examination of juice samples from factories using cold and hot liming methods showed that hot liming removed more starch than cold liming.

Study of the interaction of coloured polymers from molasses and micro-organisms

M. López B. and E. L. Ramos S. *CubaAzúcar*, 1984, (Oct./Dec.), 36 - 42 (*Spanish*).

Colouring matter was isolated from molasses using a Sephadex column and was added to sucrose solution subjected to fermentation with yeast. It was found that the polymeric colouring matter did not influence the growth of the yeasts; in fact, it was partly degraded.

Study on the correlation between sucrose concentration and other substances in cane sugar factory condensates

E. Angulo A., F. Pérez S. and A. Armario A. *CubaAzúcar*, 1984, (Oct./Dec.), 43 - 47 (*Spanish*).

Indirect methods of determining sucrose in condensates are widely used, but a study in Cuba of the sucrose, sodium, potassium, copper, chloride and ammonia contents as well as pH and conductivity showed that neither of the last two nor any of the non-sucrose materials was sufficiently well correlated with the sucrose content to make them a suitable criterion for assessment of sugar contamination of the condensates.

Determination of the granulometry parameters of sugar crystals in a massecuite

A. P. Kozyavkin, V. N. Kushkov and V. G. Tregub. *Sakhar. Prom.*, 1986, (2), 20 - 22 (*Russian*).

A microscopy method of measuring sugar crystal size distribution is described in which the mother liquor is separated from the pan sample (the method is also applicable to final sugar) and the residual crystals washed with a sugar-saturated 1:1 glycerine:methanol mixture before being evenly spread over the bottom of a glass cell having side walls at least 3 mm high. The mean linear size of a given number of crystals is measured and the coefficient of variation calculated. From the maximum relative error and the root mean square deviation is found the minimum number of crystals requiring measurement in a given sample. The appropriate formulae may be incorporated in a scheme for use with a programmable micro-calculator. Results are given for an *A*-massecuite by way of example.

Behaviour of non-sugars during raw juice purification. IV

A. Stechova, J. Copikova, F. Kvasnicka and P. Kadlec. *Listy Cukr.*, 1986, **102,** 36 - 42 (*Czech*).

Liquid chromatography and isotachophoresis were used to determine the contents of adipic, citric, malic, succinic, lactic and pyrrolidone carboxylic acids in samples of raw, prelimed, limed, 1st carbonatation and thin juices taken at various points in Basnice sugar factory. The results are tabulated and graphed, and the fate of each acid throughout purification expressed mathematically by equations obtained by linear and non-linear regression.

A review of the methods of estimation of reducing sugars. I. Reduction methods

G. Majumdar and S. Bose. *Indian Sugar*, 1985, **35,** 349 - 354.

The survey includes methods using a definite volume of copper reagent (of which only the Lane & Eynon technique and its modifications, particularly the constant volume method, are used) and those using an excess of reagent; this category is sub-divided into gravimetric and iodometric methods. The Lane & Eynon method is suitable for determining high contents of reducing sugars, while moderate amounts (0.2 - 10%) can be successfully found by the Berlin Institute method of Spengler *et al.* or by the Ofner method. The Knight & Allen method is suitable for determination of up to 0.2% reducing sugars.

New method for ash determination in starch hydrolysates by means of conductivity measurement

G. Tegge and G. Richter. *Starch/Stärke*, 1986, **38,** 137 - 142 (*German*).

Sulphate ash in starch hydrolysates of 27 - 30% refractometric dry solids was measured indirectly by a conductimetric method which is described. Studies showed that there was a maximum conductivity which was unaffected by mineral content, ion composition and viscosity of the non-conductors. The sulphate ash content can be read off straight-line graphs based on this finding. The method is easier to apply, less time-consuming and gives results of higher reproducibility than gravimetric determination.

By-products

Application of carbonatation lime in liquid form

H. Mugele. *Die Zuckerrübe*, 1986, **35**, 120 - 121 (*German*).

At Jülich sugar factory, filter cake is fed to a 600-tonne stirred tank where it is brought to a uniform consistency of approx. 48% dry solids to allow it to be transported by road tanker to fields for spraying on the land at the rate of 3 - 20 tonnes/ha, thereby avoiding the disadvantage of intermediate storage at the edge of the field. The filter cake is of benefit as a low-cost fertilizer and soil improver.

Sugar cane by-products as a renewable energy source — an assessment

H. G. More, L. R. Kanawade and N. J. Ingle. *Indian Sugar*, 1985, **35**, 205 - 209.

Cane crushing data obtained from Rahuri sugar factory for three seasons (1980/83) are analysed for total quantities of bagasse and molasses, and from these are calculated the energy that could be produced in the form of steam from bagasse fuel and alcohol from molasses. The figures are extrapolated to a national scale to show that an estimated 8.96×10^{11}MJ of power could be produced surplus to sugar factory requirements.

Failure of molasses tanks at Glinojeck sugar factory

W. Ziolkowski. *Gaz. Cukr.*, 1985, **93**, 156 - 158 (*Polish*).

A detailed account is given of the complete collapse of a molasses tank and consequent rupture of the side wall of an identical tank adjacent to it. Each tank had a holding capacity of 10,200 tonnes and received molasses from four factories as well as Glinojeck. About 12 months before the accident, a split had occurred in the weld of the first tank, but storage had been resumed after the tear had been patched with sheet metal. The result of the accident was leakage of over 13,000 tonnes of molasses which flowed up to some 3 km from the factory to enter the local river as well as spreading over grassland at a nearby hamlet; the plant for treatment of drinking water at the factory was also partly put out of action. Approx. 73% of the molasses was recovered and transported to distilleries; the rest of the molasses was gathered, where possible, into piles for systematic application to the soil. The results of an investigation into the accident and recommendations based on it are presented.

Vinasse as a possible improver of the biological properties of a typical Solonchak soil

F. J. Arcia, A. J. Guzmán and V. Martínez. *Cienc. Agric.*, 1983, (17), 116 - 119 (*Spanish*).

The soil in three columns was washed, respectively, with water equivalent to 2200 m³/ha, and vinasse equivalent to 2200 and 3300 m³/ha. The vinasse produced a notable increase in the populations of bacteria and fungi and in CO_2 evolution (attributed to removal of soluble salts) while inhibition of actinomycetes was observed (attributed to the influence of the vinasse pH).

Synthesis of some sucrose esters in the absence of solvent

P. L. Gutiérrez M., L. R. de la Nuez F., M. López L. and G. Lago M. *Centro Azúcar*, 1983, **10**, (3), 89 - 94 (*Spanish*).

Sucrose esters of a number of fatty acids were produced by reacting together for 8 hours at about 125°C the methyl esters of the acids with sucrose in the presence of potassium carbonate and some of the required ester, prepared previously. The reaction products include unreacted methyl ester, sucrose and potassium soaps as well as the sucrose ester, the highest yields (32.9% and 22.4%) being given with palmitate and stearate, respectively. 1% solutions of the crude reaction products were made; their surface tensions demonstrated the surface activity of the esters.

Morphological investigations of aqueous prehydrolysis and cooking of sugar cane bagasse

E. Ramírez, D. Paul, C. Paul and B. Tormo. *CubaAzúcar*, 1984, (Jan./March), 17 - 23 (*Spanish*).

Changes in the cell wall structure of bagasse during prehydrolysis and sulphate cooking have been studied using electron microscopy, and are discussed.

Industrial feasibility of the bleaching of bagasse pulps with oxygen

O. L. García. *CubaAzúcar*, 1984, (Jan./March), 47 - 52 (*Spanish*).

Contrary to reports in the literature, ICIDCA research workers were able to bleach bagasse pulp successfully using oxygen in a process which is described. Application of the process on the industrial scale is discussed, as is its effect on the quantity and BOD and COD of the effluents.

Coating of paper made from short-fibred pulps

A. Hernández and M. Rodríguez. *CubaAzúcar*, 1984, (July/Sept.), 7 - 12 (*Spanish*).

Surface applications of mixtures of binders and pigments to form a coating improves paper quality in respect of appearance and printing properties, and permits the use of a poorer quality base paper. Bleached chemical pulps from bagasse and short-fibred hardwood were prepared and mixed in various proportions to prepare different types of base paper, the properties of which were compared.

Biogas from sugar industry wastes

A. G. Núñez, M. S. Leal S. and M. T. Hernández. *CubaAzúcar*, 1984, (July/Sept.), 12 - 16 (*Spanish*).

A series of experiments was carried out on the anaerobic fermentation of sugar

factory waste water mixed with other materials. It was found that increasing the amount of filter-cake present reduced methane yield, that the addition of pith favoured methane production but not substantially, and that use of a temperature of 37°C rather than 28 -31°C and initial addition of lime at 5g/litre increased yields significantly.

Conversion of a pulp drying plant to lignite dust firing

J. Hiss and G. Baginski. *Zuckerind.*, 1986, **111,** 242 - 243 (*German*).

Details are given of the conversion of a two-drum pulp drying station to the use of lignite dust in place of oil. Operation of the modified plant in 1985 showed that it fulfilled all guarantees and proved highly reliable. Calculation of the capital and running costs indicate a sufficient saving on fuel costs to pay for the scheme within three campaigns.

Introduction of recent innovations in the sugar industry

M. S. Naik. *Maharashtra Sugar*, 1985, **11,** (1), 153, 155 - 156, 158.

The merits of the Biostil continuous fermentation system for alcohol manufacture from molasses and of vinasse concentration and incineration in a KTI unit are discussed.

Sugar cane extractives: alternative uses and technological options

J. V. Rajan and N. R. Ayyangar. *Maharashtra Sugar*, 1985, **11,** (2), 11, 13 - 14, 16 - 21, 24 - 31, 33, 35 - 36, 39 - 40, 42, 45 - 46, 48.

A review is presented of the literature (65 references) on sucrose and molasses by-products, molasses sugar recovery methods and fermentation techniques for yeast and alcohol manufacture.

Performance test on the productivity of new *Saccharomyces* hybrids

Anon. *Gordian*, 1985, **85,** (10), 207 - 208; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (7), Abs. 7 R357.

One important criterion for testing the productivity of N yeasts is the fermentability of highly concentrated sugar solutions and wort. Model tests on fermentation of N yeasts in highly concentrated sugar solutions are described, and the effect of varying conditions of growth on the productivity of yeast hybrids A, B and C is discussed.

Temperature conditions for evaporation of post-yeast molasses vinasse using low-temperature fuel combustion products

Yu. M. Rabiner and V. P. Troino. *Pishch. Prom.*, 1985, (4), 38 - 41; through *Ref. Zhurn. AN SSSR*, 1986, (7), Abs. 7 R359.

Results are given of investigations on the temperature conditions in the concentration of vinasse of 0 - 50% dry solids using direct contact heat exchange with low-temperature combustion products from gaseous fuel at 100 - 300°C and an excess air coefficient of 1.4 - 2.5. It was found that the vaporization temperature of vinasse was in the range 49 - 71.7°C and that the mean difference between the discharge temperature of the vapour-gas mixture and the vaporization temperature of the vinasse varied from +0.59°C to –4.39°C as a function of vinasse concentration. Formulae have been developed for calculation of these factors, and a nomogram constructed for determination of the vaporization temperature of vinasse.

By-product utilization in cane sugar manufacture. III

D. P. Kulkarni. *Bharatiya Sugar*, 1986, **11,** (3), 9 - 11, 13 - 14.

Utilization of filter cake as fertilizer and extraction of wax from it are discussed, as well as the use of cane tops and trash as animal fodder.

Fermentation properties of rum distillery yeasts

L. Fahrasmane, A. Parfait and P. Galzy. *Ind. Alim. Agric.*, 1986, **103,** 125 - 127 (*French*).

A comparative study was made of the fermentation properties of *Schizosaccharomyces pombe* (once the dominant yeast for rum manufacture in the French West Indies) and of *Saccharomyces cerevisiae*, with cane molasses and juice used as substrates. While *S. pombe* gives a high ethanol yield and relatively low yields of higher alcohols and fatty acids, fermentation with it is slow and the risk of bacterial infection thus increased. *S. cerevisiae* gives relatively low yields of ethanol and greater quantities of higher alcohols and fatty acids; however, fermentation with it is rapid, so that the risk of accidental infection is much reduced and relatively light rums are obtainable. With the deterioration in the sugar situation and increased demand for lighter rums, direct fermentation of cane juice has proved more attractive; however, juice lacks the mineral salts and nitrogenous material needed by *S. pombe*, so that the use of *S. cerevisiae* has become of primary importance.

The effect of heavy metals on the kinetics of *Saccharomyces cerevisiae* yeast growth on a molasses medium

J. Krizasnic and C. Vlasta. *Prehramb. Tehnol. Rev*, 1985, **23,** (1/2), 55 - 58; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1986, (10), Abs. 10 R435.

Investigations of the As, Cu, Fe, Cd and Hg contents in $(NH_4)_3PO_4$ and $(NH_4)H_2PO_4$ used as natural sources of N and P in the cultivation of *S. cerevisiae* on molasses media showed that yeast growth, sugar conversion and biomass yield were lower by 50% when the salts were of Yugoslavian origin. The As content in the biomass was in the range 0.06 - 0.58 ppm and reached 16.7 ppm when the yeast was cultivated on a medium enriched with 0.198 mg/litre As. Details are given of the contents of the metals in the salts, culture media and yeasts.

Patents

UNITED STATES

Sucrose recovery from molasses

S. Kulprathipanja, of Des Plaines, IL, USA, *assr.* UOP Inc. **4,405,378.** September 28, 1981; September 20, 1983.

Sucrose is recovered from beet or cane molasses solution by passage at 20 - 200°C and a pressure ranging from atmospheric to 500 psig over an adsorbent comprising powdered active carbon bound with a water-permeable organic layer, e.g. a cellulose nitrate, cellulose ester or a mixture of these. The sucrose is recovered by desorption with a methanol:water mixture having a volume ratio of 1:1 (3:7).

Fructose and glucose separation

M. Ando, T. Hirota and K. Shioda, *assrs.* Mitsubishi Chemical Industries Ltd. **4,405,455.** January 6, 1982; September 20, 1983.

Fructose and glucose in a mixture such as HFS can be separated by adsorption on a packed bed of cation exchange resin in Ca^{++} form, while sucrose can be recovered from molasses solution by treatment with resin in Na^{+} form, wherein a fluid passage connecting the front and rear ends of the packed bed permits the fluid to circulate. The initial feed is introduced to an intermediate position in the bed, while a fructose-, glucose- or sucrose-rich fraction is withdrawn at a point downstream from the feed point. Both feeding and withdrawing are stopped as a second stage in the process to allow the fluid in the column to be moved down the bed, while the third stage involves introduction of a desorbent and simultaneous withdrawal of a component-rich fraction from at least two points in the system.

Continuous centrifugal

H. Schaper, of Brunswick, Germany, *assr.* Braunschweigische Maschinenbauanstalt AG. **4,409,031.** February 16, 1982; October 11, 1983.

See UK Patent 2,093,364[1].

Alcohol from bagasse

R. S. Silver, of Monroeville, PA, USA, *assr.* Gulf Research & Development Co. **4,409,329.** July 15, 1982; October 11, 1983.

The sugars yielded by hydrolysis of bagasse using a cellulase-producing microbe, e.g. *Trichoderma reesei*, are subsequently fermented by *Saccharomyces cerevisiae*, *Candida brassicae*, *Zymomonas mobilis* or *Rhizopus javanicus* to give ethanol. Contact between the *T. reesei* slurry [of 30 - 80% (3 - 20%) cellulase content by weight] and the bagasse takes place at a mechanically produced shear rate of 50,000 - 200,000 ft/min/ft; the *T. reesei* concentration is >0.1 units/ml of slurry, and the bagasse feed has a mean particle size of 0.01 - 1 in.

Amino-acid production

K. Hirakawa, R. Takakuma, K. Nomura, M. Katoh and K. Watanabe, *assrs.* Kanegafuchi Chemical Industry Co. Ltd. **4,411,991.** September 17, 1981; October 25, 1983.

An amino acid such as L-lysine, L-glutamic acid, L-phenylalanine, etc., is produced by aerobic cultivation at pH 4.5 - 7.5 (5.5 - 7.0) and 25 - 55°C on a medium containing glucose, fructose, sucrose or molasses, etc., of an amino-acid-producing micro-organism, e.g. a *Bacillus* sp., *Brevibacterium* sp., *Corynebacterium* sp., *Flavobacterium* sp., *Micrococcus* sp., *Microbacterium* sp., *Saccharomyces* sp., etc., and a lactic acid-producing micro-organism, e..g. a *Lactobacillus* sp., *Streptococcus* sp., *Leuconostoc* sp., *Bacillus* sp., etc. The lactic acid concentration is maintained at not more than 1.5% w/v during fermentation.

Glucose isomerization

N. E. Lloyd, of Clinton, IA, USA, *assr.* Nabisco Brands Inc. **4,411,996.** June 30, 1982; October 25, 1983.

See UK Patent 2,148,298[2].

Lysine production

K. Shimazaki, Y. Nakamura and Y. Yamada, of Saga, Japan, *assrs.* Ajinomoto Co. Inc. **4,411,997.** December 22, 1981; October 25, 1983.

L-Lysine is produced by aerobically culturing a mutant of the *Brevibacterium* or *Corynebacterium* genus on a medium containing glucose, fructose, sucrose or molasses, etc., at 24 - 37°C (31°C) and pH 5 - 9 (7.2 - 8.0) for 2 - 7 days (3 days).

Alcohol fermentation

N. Y. Chen and J. N. Miale, *assrs.* Mobil Oil Corporation. **4,420,561.** February 2, 1981; December 13, 1983.

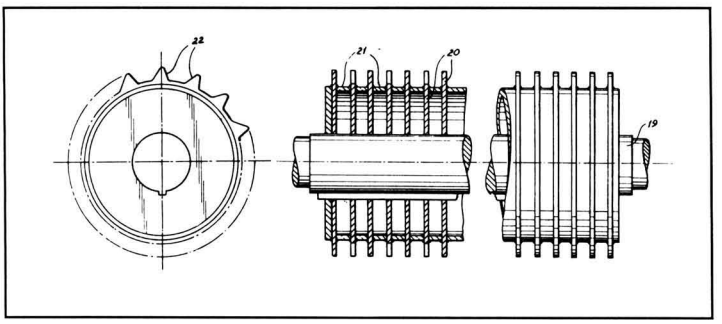
During ethanol manufacture from e.g. sugar cane, the alcohol concentration in the fermentation zone is maintained at a level of not more than 5% (not more than 2%) by weight of aqueous solution by intermittent or continuous withdrawal of a portion of it which is passed through a column of adsorbent (crystalline aluminosilicate). Desorption is effected by stripping with a carrier gas, and the ethanol is then brought into contact with a dehydration catalyst to convert it into organic compounds having a higher C:O ratio than ethanol and by-product gas which is used for the stripping stage.

Cane mill roller

R. W. Trimmer and M. B. McCullagh, *assrs.* Polymex Pty. Ltd. **4,420,863.** July 10, 1981; December 20, 1983.

Discs 20 coaxial with the shaft 19 of the feed roller of a cane mill and rotating with the shaft to which they are keyed extend radially from the shaft and carry teeth at their periphery. The discs are secured together by spacer rings 21 which may be welded to the discs. A pair of these rollers is mounted adjacent to the feed chute which may be shaped at its end so as to have fingers extending between discs 20. Because of their relatively low weight, the rollers may be

1 *I.S.J.*, 1986, **88**, 20A.
2 *ibid.*, 121A.



mounted on a single beam with no setting adjustments and the chute fitted so as to have a minimum length and thus reduce friction loading.

Enzyme immobilization

M. J. Daniels and D. M. Farmer, of Reading, England, *assrs.* Tate & Lyle Ltd. **4,421,850.** February 24, 1981; December 20, 1983.

An enzyme such as an amylase, amyloglucosidase, dextranase, invertase, isomerase, etc., may be immobilized by adding an aqueous solution of it, containing at least 25% (35 - 60%) dissolved solids, to a mixture of water-miscible organic solvent (a ketone or lower alcohol) (acetone) and bone char, after which the enzyme is cross-linked and insolubilized by contact with e.g. glutaric aldehyde to form a gel of 50 - 90% moisture content.

Carbonatation

H. Schiweck and G. Witte, *assrs.* Süddeutsche Zucker-AG. **4,424,078.** August 6, 1982; January 3, 1984.

In two-stage carbonatation, the exhaust gas from 2nd carbonatation is recycled to 1st carbonatation, the exhaust gas from which is passed through a heat exchanger where it is cooled by losing heat to raw juice, thin juice, CO_2-containing gas (as from the lime kiln), etc.

Alcohol fermentation

A. M. Neves, of Ogden, UH, USA. **4,425,433.** October 20, 1980; January 10, 1984.

Alcohol is continuously produced from e.g. bagasse by a process which includes delignification, in which the feedstock is subjected to steam treatment at 250 - 1500 psi (600 - 800 psi) and 400 - 600°F (480 - 520°F) for 3 - 30 (10 - 15) minutes, followed by treatment at a considerably reduced pressure of 5 - 50 psi (15 - 200 psi) and 200 - 400°F (200 - 300°F) for 2 - 10 minutes; the hemicellulose and cellulose are then readily hydrolysed with sulphuric acid at 0.5 - 10% by volume to yield simple sugars that are fermented with a suitable yeast. Delignification may be carried out after the acid hydrolysis as an alternative.

Glucose isomerization

Nabisco Brands Inc., of Parsippany, NJ, USA. **4,411,996.** June 30, 1982; October 25, 1983.

See UK Patent 2,148,298[1].

Alcohol fermentation

D. M. Donofrio, of Scotts Valley, CA, USA, *assr.* Fermentec Corporation. **4,426,450.** January 18, 1982; January 17, 1984.

The rate of yeast generation and hence the productivity of an aerobic vessel used for alcohol fermentation is largely governed by the rate at which oxygen is dissolved. For more efficient dissolution in a continuous process, yeast such as *Saccharomyces cerevisiae* is grown on an aqueous solution of e.g. molasses containing 5 - 30% (15 - 30%) (10%) fermentable sugar under optimum aerobic conditions in a vertical closed cylindrical vessel provided with a jet mixer having at least 3 (at least 8) nozzles and located in the lower 20 - 50% (preferably lower 15 - 30%) of the distance from the bottom of the vessel to the normal liquid surface level. The jet mixer consists of a mixing chamber in which the air, at preferably atmospheric pressure, is mixed with the liquid and to which the liquid is introduced via a venturi at a velocity sufficient to create turbulence in the chamber; the air-liquid mixture leaves the chamber via the nozzles at a speed that creates a mixing plume which extends horizontally from the mixer and then rises to the liquid surface. The contents of the vessel pass continuously to another vessel for anaerobic fermentation where they are mixed with substrate which has bypassed the aerobic stage; the fermented stream is continuously withdrawn and at least some of it recycled to both fermentation stages.

Bagasse hydrolysis

F. J. Reitter, of München, Germany. **4,427,453.** February 21, 1981; January 24, 1984.

In the first stage of a 2- or 3-stage continuous process for bagasse saccharification, the hemicellulose and some of the cellulose are hydrolysed to pentoses and hexoses with dilute sulphuric acid or HCl at 135 - 190°C (180°C) for 0.05 - 5 minutes (2.5 minutes) (20 minutes) and the cellulose then hydrolysed to hexoses at 210 - 250°C (235°C) for 4.5 minutes as in Stage 1. (Prior to this stage the bagasse may be pre-impregnated with the acid for 1 - 6 minutes and SO_2 may be used as catalyst instead of sulphuric acid.) Each hydrolysis stage takes place in a horizontal, steam-heated tube digester into which the bagasse or hydrolysate is injected by a screw feeder which moves it through the digester under high compression to a smaller end where the material is forced through the exit sleeve as a plug. Separation of the hydrolysate after each stage is effected by adding fresh water and liquid separated in the

1 *I.S.J.*, 1986, **88**, 121A.

preceding stage. Except for the last stage, the hydrolysate from each subsequent stage is used as dissolving liquid in the preceding stage.

Reduction of massecuite viscosity

Y. Oyama, Y. Matsuo and H. Nishi, *assrs.* Riken Vitamin Oil Co. Ltd. **4,427,454.** June 8, 1982; January 24, 1984.

The viscosity and foaming of massecuite in a vacuum pan are reduced by addition of (0.001 - 0.1%) (0.0025 - 0.005%) (0.002%) (0.001 - 0.002%) glycerol monoaceto-monofatty (lauric, stearic or coconut oil) acid ester and/or glycerol monoaceto-difatty acid ester and/or glycerol diaceto-monofatty acid ester in which the fatty acid has 12 carbon atoms or the ester is of a mixture of fatty acids including at least 40% of a fatty acid containing 12 carbon atoms and the rest fatty acids having 8 - 14 carbon atoms. Boiling time is reduced by 30%.

Glutamic acid production

T. Tsuchida, K. Miwa , S. Nakamori and H. Momose, *assrs.* Ajinomoto Co. Inc. **4,427,773.** April 17, 1981; January 24, 1984.

Glutamic acid is produced in a high yield by cultivation of a micro-organism of the *Brevibacterium* or *Corynebacterium* genus (e.g. *B. lactofermentum* or *C. glutamicum*) on a carbon-containing substrate such as glucose, sucrose, molasses or starch hydrolysate at 30 - 37°C (31°C) and pH 6 - 8 (7) for 48 hours.

Arginine production by fermentation

H. Momose, M. Ishida and M. Terabe, *assrs.* Ajinomoto Co. Inc. **4,430,430.** June 10, 1981; February 7, 1984.

L-Arginine is produced by cultivating a micro-organism of the *Escheri chia* genus (e.g. a strain of *E. coli*) on a substrate such as glucose, sucrose, molasses or starch hydrolysate at 30°C for 3 days.

Sugars separation

S. Kulprathipanja, of Hoffman Estates, Il, USA, *assr.* UOP Inc. **4,431,456.** June 11, 1982; February 14, 1984.

Separation of sugars in an aqueous mixture of e.g. fructose, glucose and sucrose may be effected by bringing the mixture at pH 5 - 8 , 20 - 200°C (20 - 100°C) and a pressure in the range from atmospheric to 500 psig (atmospheric - 250 psig) into contact with an adsorbent prepared by mixing together a powdered zeolite in the X or Y group (containing alkali metal and alkaline earth metal cations at the exchangeable cationic sites), a powdered water-permeable organic polymer (a cellulose ester or cellulose nitrate) and a liquid organic solvent (*p*-dioxane, methyl ethyl ketone, ethyl acetone, acetone, chloroform, benzyl alcohol, cyclochexanone or formamide). The polymer constitutes 3 - 50% by weight of the adsorbent mixture.

Animal feed supplement

J. J. Schroeder and J. E. Findley. **4,431,675.** November 15, 1982; February 14, 1984.

A solid feed supplement is prepared from 60 - 85°Bx molasses by adding 1 - 5% (1 - 3%) by weight of $Ca(OH)_2$ or preferably CaO, 1 - 6% (1 - 5%) (0.5 - 5%) by weight as P_2O_5 of a soluble phosphate or phosphoric acid (for solidification) and 2 - 15% (2 - 10%) (4 - 10%) of finely divided MgO. Before solidification of the mixture, discrete pulped cellulose fibres measuring $^1/_{16}$ - 1 inch may be added at 0.1 - 2.5% by weight to inhibit the formation of cracks, as well as 2 - 3% of a fat, 0.05 - 1% of an emulsifier and 5 - 40% equivalent protein. The blocks can be hardened at 70 - 95°F for 1 -24 hours.

Fructose production from starch

R. O. Horwath and R. M. Irbe, *assrs.* Nabisco Brands Inc. **4,431,733.** June 30, 1982; February 14, 1984.

Fructose is prepared from liquefied starch by hydrolysing the latter with gluco-amylase at 55 - 60°C and pH 4 - 5 for 15 - 75 hours and isomerizing at least part of the resultant glucose with glucose isomerase at 60°C for 3 hours. Both enzymes are obtained from one of the Basidiomycetes class of fungi.

Bagasse saccharification

A. I. Nuuttila and V. J. Pohjola, *assrs.* Oy. Tampella AB. **4,432,805.** June 23, 1982; February 21, 1984.

Bagasse is continuously saccharified by preheating with steam to approx. 90°C and feeding it into a tube reactor together with recycled bagasse (representing 60 - 90% of the solids discharged from the reactor), steam and 3% sulphuric acid solution at a liquid:solids weight ratio of 1 - 5 (2.5 - 3) and a sulphuric acid content of approx. 0.25 - 1% (0.5 - 2%). Hydrolysis takes place at 180 - 200°C (150 - 200°C) and the residence time is maintained at 5 - 20 (7 -15) minutes, depending on the recycle ratio, by adjustment of the rotary speed of the screw feeder. The solids and hydrolysate are blown continuously by expansion into a blow tank where the steam evaporates at 100°C; the solid fraction is sufficiently diluted with hot lignin wash water and hydrolysate to allow it to be pumped. The suspension from the blow tank plus water at 90°C are pumped to a 1st stage separator, from which the liquid fraction (hydrolysate plus a fine solid fraction containing mainly lignin) is pumped to a 2nd stage separator where the lignin is removed, leaving a solid fraction two-thirds of which is composed of sugars which are recovered by dilution with hot wash water and 3rd stage separation, after which the liquid fraction (containing most of the sugars) is transferred to the blow tank where it is diluted and the sugars recycled.

Beet juice purification

R. F. Madsen, W. K. Nielsen and S. Kristensen, *assrs.* A/S De Danske Sukkerfabrikker. **4,432,806.** January 8, 1982; February 21, 1984.

See UK Patent 2,090,861[1].

1 *I.S.J.*,1986, **88**, 11A.

4. For determining the rheological properties of massecuites, the pipeflow and other viscometric methods, such as the ultrasonic viscometric method, should be evaluated with a view to developing them as standard techniques.

Subject 24: pH and ion selective electrodes
Referee: J. P. Lescure (France)

1. A more precise report on the continuous flow method for the determination of pH of white sugars, presented as Appendix 1 of the Report on Subject 24 at the 18th Session, should be proposed to allow further collaborative tests.

2. The continuous flow method presented as Appendix 1 of the Report on Subject 24 at the 18th Session and the Dubourg *et al.* method may both be used as Tentative methods.

Subject 25: Crystallizing qualities of sugar solutions
Referee: F. Heitz (France)

1. Inter-laboratory tests using the Wagnerowski method and /or the saturoscope method should be repeated.

2. Appropriate methods for studying the rate of crystallization, the rate of dissolution, crystal habit, incrustation and surface quality of sugar crystals must continue to be investigated.

Subject 27: Refining qualities of raw cane sugar
Referee: R. J. McCowage (Australia)

1. The Tentative status of the "haze" assay for dextran-like material in raw cane sugar is withdrawn but further studies should be carried out on an immunochemical test for dextran on an urgent basis.

2. Collaborative studies should be undertaken on the method for affination and crystal purity of raw cane sugars, Tentatively adopted at the 11th Session in 1954.

3. Methods for carrying out a standard affination of raw cane sugars should be studied.

4. Further work should be carried out on the HSPA grist procedure, Tentatively adopted at the 15th Session in 1970, to overcome the formation of conglomerates during washing and drying.

5. Collaborative studies should be carried out on the SMRI and CSR tests for starch in raw cane sugars.

6. Studies should be undertaken into crystal-habit-modifying impurities in raw cane sugars.

Subject 28: Bone charcoal and other adsorbents
Referee: C. C. Chou (USA)

1. The ASTM method as described in ASTM Bulletin D2187-82, for the determination of anion exchange capacity, should be studied with reference to sugar products.

2. Subject 28 is to be renamed "Bone charcoal and other decolorizing agents".

Subject 29: Starch hydrolysis products
Referee: P. F. Method (USA)

1. Note has been made of the standard tables for density/refractive index/dry substance, generated for commercial corn syrup and corn syrup - sucrose blends, described by Wartman *et al.* in 1976, 1980 and 1984, as well as by the ISO in 1982 (Standard 1743).

2. Note has been made of the HPLC method of Engel *et al.* of 1984, for determining minor saccharides in high-dextrose corn syrups.

3. Note has been made of the method for titratable acidity in high-fructose corn syrup, using an electrometric end point of pH 6.0.

4. Methods for the determination of sulphur dioxide (or total sulphites) in starch-derived sweeteners should be further studied.

Facts and figures

A/S De Danske Sukkerfabrikker Report, 1985/86

The 1985 beet harvest was large and of good quality and, at 456,000 tonnes, sugar production almost matched the record 1984 production level. Continued improvement of the company's five factories, and slightly lower fuel costs meant that profit levels were of the same order as in the previous year, modest earnings from over-quota production (sold on the world market) and maximum production levies having reduced the benefit of quota sugar sales. A special method for dealing with juice from frozen beet was tested in 1985 and permitted completion of the campaign without notable delays. Domestic sales amounted to 195,000 tonnes while exports reached 275,000 tonnes, of which 117,000 tonnes went to traditional markets in Norway, Iceland and the UK.

Guyana sugar production, 1985

In 1985, the ten sugar factories of Guyana Sugar Corporation Ltd. crushed a total of 3,217,986 long tons of cane, to produce 234,000 tons of sugar having an average pol of 98.16; this compares with 241,861 tons of sugar, of average pol 98.06, obtained from 3,468,619 tons of cane in 1984. Recovery of pol in sugar % pol in cane rose to 76.21 from 74.26 in 1984 while losses in bagasse and molasses and undetermined losses were 10.90, 11.32 and 1.09%, respectively, in 1985 against 11.48, 12.40 and 1.42% a year earlier. Time lost through factory causes fell from 13.18 to 12.17% of nett grinding time, but nett grinding time fell to 62.90% of the gross time from 68.99% in 1984, largely owing to greater time loss out of cane and through strikes.

Guatemala sugar expansion[1]

Production of sugar in Guatemala in 1985/86 amounted to around 570,000 tonnes, despite early fears that very dry conditions would limit output to less than 500,000 tonnes. These weather conditions have continued and this has caused some concern over prospects for the new crop. Nevertheless it is now clear that the government's new financial measures have favoured the production of sugar, which is contrary to what had been expected, and a small increase to around 600,000 tonnes is forecast. The government has permitted exporters to continue to convert foreign earnings at a preferential exchange rate, currently 2.5 times the base level. This has encouraged an expansion in cane area, primarily at the expense of cotton. There is an export tax, but it is on a sliding scale related to the world price of sugar; currently its effect is quite negligible. Production costs ex-factory are around 12/13 cents/lb; given the high internal price, the return on sales against the US quota and the favourable exchange rate, sugar remains a profitable commodity.

Canadian ban on South African sugar imports[2]

The Canadian government announced that imports of South African agricultural products, uranium, coal, iron and steel would be banned as from October 1. The decision will affect an estimated US$87.5 million of imports a year, most of which will be accounted for by the ban on agricultural imports which provide 40% of all South African sales to Canada. South African has supplied 20% of Canada's sugar imports.

1 *Carnikow Sugar Review*, 1986, (1753), 135.
2 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 523 - 524.

Energy reduction and process integration

By N. R. Twaite, H. J. Davenport and E. K. Macdonald

(*Continued from page 219*)

At the same time, a pilot plant test has been carried out on the same juice using a six-tube Eskla BV fluid bed heat exchanger. The results of the test are also shown in Figure 3. These reveal less than a 2%/day drop in overall heat transfer coefficient even with a higher starting value. The Eskla unit under test (see Figure 4) consisted of six stainless steel tubes, 4 m in length by 40 mm diameter, with a total area of 2.3 m². The cleaning media used were aluminium cylinders with a diameter and height of 3 mm. Around day 6 a sharp decrease in the OHTC was noted until a second "plateau" of around 0.75 kW/m²/°K was reached. As this sudden drop could not be explained, after day 12 the unit was shut down and inspected. It was found that one tube was completely blocked with the aluminium cleaning media. Some damage was done to the top tube plate during the unblocking of the tube so the unit could not be put on a second test before the end of the campaign. The reason for the blockage is not known and the only hypothesis so far advanced is that the raw juice foam was a contributory cause.

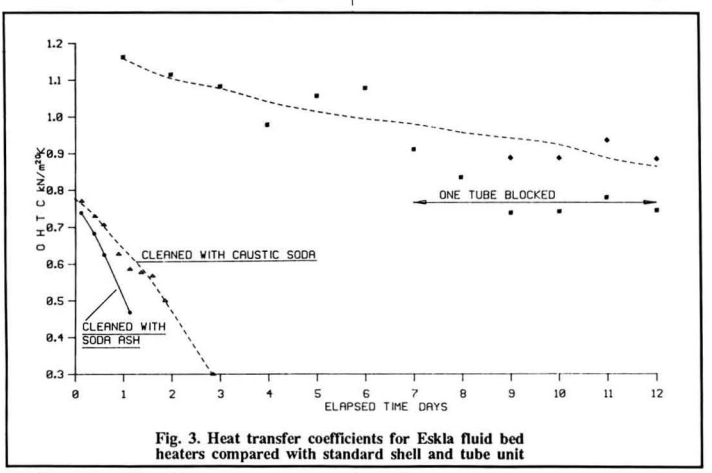


Fig. 3. Heat transfer coefficients for Eskla fluid bed heaters compared with standard shell and tube unit

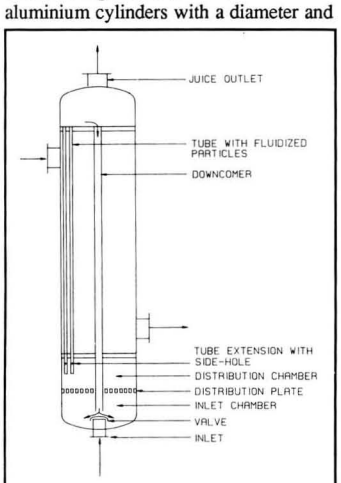


Fig. 4. Eskla fluid bed heat exchanger

At another factory Barriquand plate heaters have also been used on raw juice through the critical temperature range with pan vapour as the heating medium. Four heaters were fitted on the white vacuum pans, with raw juice piped in series. It has been found necessary to clean the heaters on a regular basis. Figures recorded during the 1985/86 campaign are shown in Table III. Also, a GEA "Freeflow" heat exchanger has been tried on raw juice at an RT diffuser factory, with raw juice over 70°C, which is outside the protein deposit range. In this case the heating medium was condensate. Results of the test are shown in Table IV.

The results shown in Test 1 were taken after 15 days of operation. Inspection of the unit revealed that it was badly fouled with a combination of fibrous material (probably from remelt sugars via the Schenk filters), calcium carbonate and calcium oxalate scale. High pressure water jet cleaning was carried out and the unit put back into service.

Test 2 results were obtained after another 15 days of operation, this time with a backflush every 8 hours. Pressure drop figures showed this had been successful in preventing the blockage but not the scaling. The unit was chemically cleaned with soda and EDTA (ethylene diamine tetraacetic acid) followed by water jet cleaning, and put back into service again. The "clean" result in the table shows the unit just back in service. It was decided to operate with backflushing at the reduced rate of once per day.

Tests 3A and 3B are results taken after 11 days in service just before and after backflushing. The thermal performance has been maintained and the unit has continued to operate satisfactorily for the remainder of the campaign.

The 1986 Bury design

With the energy reduction schemes at Bury, two major problems were being encountered:

(a) Thick juice Brix was dropping, hence more and more steam had to be sent to the evaporator condenser to make up the necessary evaporation. The factory was thus unable to utilize the

Table III. Performance of Barriquand plate heat exchangers

	Design	Measured
Juice flow, kg/sec	98	89
Inlet juice temp., °C	25.0	28.8
Outlet juice temp., °C	62.0	64.8
Overall HTC (dirty), kW/m²/°K	1.18	1.34
Pressure drop (4 units), bar	2.20	1.78

Table IV. Performance of GEA Freeflow plate heat exchanger

Test	Design	1	2	Clean	3A	3B
Heat transferred, kW	2145	675	1158	2604	1518	2530
Juice flow, kg/sec	140	136	137	136	132	132
Juice temp. in, °C	72	73	72	72	70	70
Juice temp. out, °C	76	74.4	74.3	77	73	75
Juice pressure drop, bar	0.6	1.6	0.85	0.75	0.59	0.75
Condensate flow, kg/sec	106	101	106.5	103.9	90.7	151.3
Condensate temp. in, °C	85	80.8	85.5	85	78	81
Condensate temp. out, °C	80	79.2	82.9	79	74	77
Condensate pressure drop, bar	1.0	0.7	0.65	0.5	-	-
OHTC (Clean),kW/m²/°K	3.4			3.9		
OHTC (Dirty), kW/m²/°K	2.8	1.2	1.2		3.8	4.4

large quantity of available heat in condensate.

(b) The electrical power requirement was rising, particularly with the introduction of the two large hot gas generators for animal feed drying. Even with some grid import, it was not unusual for exhaust to be blown off to atmosphere at peak demand time.

For this reason the use of thermocompression at Bury, whether driven by steam turbine or electric motor did not make economic sense. Thus it was decided to remove the vapour compressor and turn the two bodies into second effects; also to remove the small fifth effect and replace it with a larger, falling film evaporator to act as a sixth effect. The insertion of the new second effect would transfer the pan floor and juice heating duties to one lower grade vapour which would make up for the evaporation lost by the removal of vapour compression and the reduction in steam used and to the condenser.

A considerable rebalance of the electrical power side has proved to be necessary. The 12 MW set will be uprated to around 13.4 MW and run in parallel with the grid supply. The present 5 MW set will be a standby.

A design balance was prepared on the above basis and gave a steam requirement of around 20% on beet based on the chosen thin juice feed conditions. The whole scheme appeared to be very practical and was thought to represent the best possible thermodynamic solution for the existing process parameters at Bury. However, it was decided to apply the total energy design concept embodying the "pinch" technique.

Until recently, the analysis of complicated heat/power systems has not been subjected to systematic thermodynamic analysis and no proven techniques have been available. Work by Linnhof[3] and Linnhoff & Flower[4] at Leeds Univerisity, and subsequently by Boland & Linnhoff[5] and Linnhoff *et al.*[6] in the ICI Corporate Laboratory, has produced a technique to facilitate this. Fundamental to this work is the discovery of the heat recovery "bottleneck" or "pinch" and the understanding of its thermodynamic significance for the design of optimal heat exchanger networks. It is now apparent that this same technique can be used for the design of optimal heat and power networks.

ICI established a process integration applications team within its Petrochemicals and Plastics Division and members of this team joined forces with the Harwell Laboratory in late 1983 to create the Energy and Process Integration Service. EPI offers a specialized consultancy service to a wide range of process industries. British Sugar engaged the services of the unit to examine the Bury 1986 design to check whether the proposals fitted the thermodynamic minimum for the given process conditions. The various heat balances and process parameters were given to the Harwell engineers and Table V gives the main findings of the study, from which it was concluded that the proposed design represented the best thermodynamic arrangement of energy usage for the specified process and plant.

The technique of process integration

Introduction

Process integration is a relatively new method of designing process plants to maximize their energy efficiency. Using thorough scientific techniques and advanced computer software, the precise amount of energy inherently required to run a complex process plant can be calculated and a design readily produced to approach this target closely. This is a major advance on previous design methods which relied on the engineer's intuitition, experience and random search computer methods, and where there was no way of determining just how close a design was to the real minimum energy requirement. Now, by applying the results of several years research investment, it is possible to balance energy cost savings against capital investment and other business and operating constraints to identify the most cost-effective design in any given siutuation. For a new process design the optimum configuration is easily identified; for existing processes it is a simple matter to define a comprehensive energy saving strategy, instead of relying on piecemeal projects which experience shows in the long run may have conflicting objectives.

Energy targets

The key to applying process integration successfully lies in understanding how and where available energy can best be supplied and re-used within the process, and at what temperature level it should be rejected from the process. This is best demonstrated using the graph in Figure 5 which is constructed from heat and mass balance data consisting of the flowrate, specific heat, supply and target temperatures for each process stream. The two lines shown in this plot of cumulative heat load against temperature are the hot and cold "composite curves". The hot composite simply represents the

3 "Thermodynamic analysis in the design of process networks", *Ph.D. Thesis* (Leeds University), 1979.
4 *AIChE Journal*, 1978, **24**, 633 - 654.
5 *Chemical Engineer*, 1979, (April), 222 - 228.
6 *Comp. and Chemical Eng.*, 1979, **3**, (1 - 4).

Table V. Comparison of target energy with existing energy use

	Current proposed energy use, MW	Target energy use, MW
Existing process including mechanical vapour recompression	70.62 (23.54)	70.50 (23.50)
1986 design (19.99)	59.97 (20.03)	60.10

Figures in parentheses refer to steam consumption % beet sliced

total amount of heat available within the process, at the various temperature levels indicated on the y-axis, which must be removed to allow hot process streams to cool to their desired temperatures. It is therefore the overall heat rejection profile of the hot process streams. The cold composite represents precisely the opposite – the total heating requirements of all the cold process streams which need to be heated as part of the process. The cold composite is therefore the overall heat acceptance profile of the cold process streams. Left to themselves, the cold process streams would need to be heated using primary fuel, and the hot process streams would need to be cooled using cooling water. To reduce the amount of fuel consumed it is therefore sensible to try to use some of the heat available in the hot streams to provide heat for the cold streams. Indeed, this is a logical and normal procedure for reducing fuel consumption. However, to ensure that the correct heat recovery options are chosen at an early stage is a critical step in the successful design of processes, and this is where process integration is an advance on conventional process design.

It should be clear from Figure 5 that it is advantageous to match up the available heat in the hot streams with the heating needs of the cold streams. This is represented by drawing the hot and cold composite curves relative to each other to create an area of overlap which represents the potential for heat exchange. The absolute limit to this is when the two lines touch, which implies

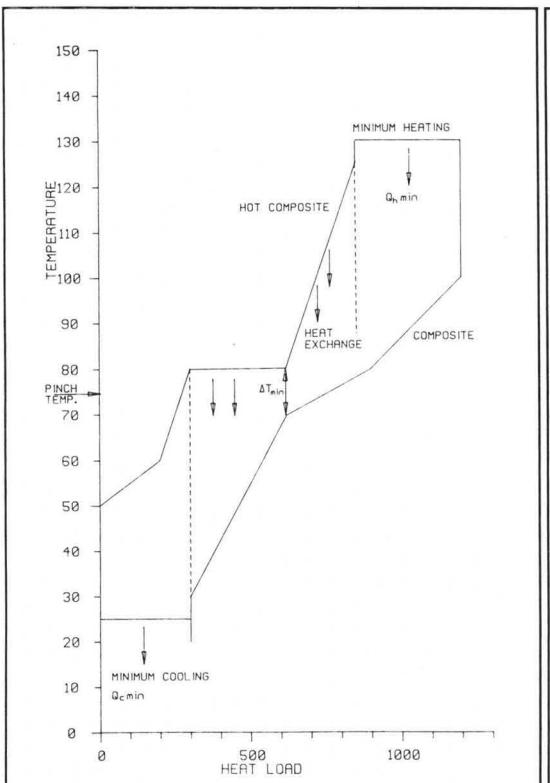


Fig. 5. Representation of hot and cold process steam heat duties – composite curves

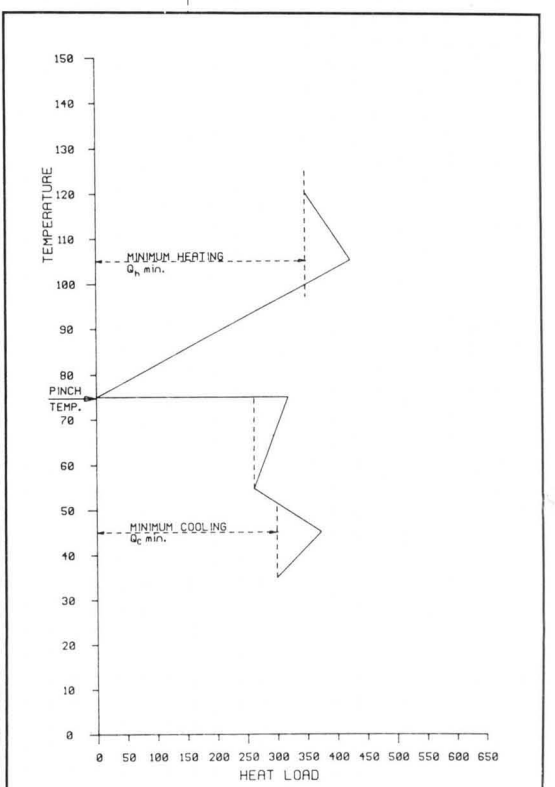


Fig. 6. Representation of overall process steam flows – grand composite curve

no temperature difference and therefore infinite heat transfer surface area. However, a practical limit can be set by selecting an acceptable temperature difference (ΔT_{min}) between the hot and cold streams. Once this is chosen, the relative positions of the hot and cold composite curves become fixed and we have defined targets for the process for the supply, exchange and removal of heat.

The area of overlap represents heat exchange, but it can also represent heat exchange area and therefore capital cost. Using powerful optimization routines, it then becomes possible to study the change in energy and capital costs as a function of the minimum temperature difference and select an *economic* optimum value of ΔT_{min}. Therefore, the minimum energy and capital targets are optimized based on economic criteria. The key point to understand is that at this stage no design work has been required – the analysis is based on a heat and mass balance and the cost of energy and exchanger area. Only when we are certain that the energy and cost targets are realistic do we proceed with the design stage.

Design guidelines

Having determined the minimum energy and area targets based on sound economic criteria, we now proceed to develop process designs which for new plant should achieve the desired targets, but which for existing processes may need to be modified slightly to account for the existing process configuration.

To understand how the design task is approached, we turn once again to the composite curves. The point on the graph at which the hot and cold composite curves are separated by the selected minimum temperature difference is known as the "pinch". It is an understanding of the significance of the pinch which has led to the development of process integration as an effective design tool.

The pinch effectively divides the process into two distinct regions. In the process region above the pinch all the heat available in the hot streams can be used to provide heat to the cold streams, but additional heat (as fuel) must also be supplied to satisfy the remaining heating needs of the cold streams. There is an overall shortage of heat which is fulfilled by supplying fuel, and this region is a net heat sink. Below the pinch the opposite is true, in that there is plenty of heat available in the hot streams at temperatures high enough to satisfy the needs of the cold streams, and the surplus heat is finally rejected to cooling utility. This region therefore is a net heat source.

If the process is to be designed to meet its minimum energy and capital targets it is vital that the heat available within the process is used at the correct temperature level. This leads to a design rule that hot streams above the pinch must only heat cold streams above the pinch, and cold streams below the pinch must only accept heat from hot streams below the pinch. In short, there should be no heat transfer across the pinch, no use of heating utility below the pinch and no use of cooling utility above the pinch. Each of these "pinch violations" will cause the process to use more energy than the calculated target, and the process will also require more installed heat exchanger area. It is important therefore in a new design to avoid pinch violations, and in an existing plant they must be identified before any retrofit projects can be developed to eliminate them.

Cogeneration systems

More recent developments in process integration techniques have led to better ways of assessing opportunities for combined heat and power (CHP) generation. Once again this problem is appproached in a systematic way to ensure that the chosen power generation cycle is appropriately matched to the process. In this way, questions such as the choice of steam levels, the use of gas turbines or diesels, and the effectiveness of organic Rankine cycles are easily answered.

The most convenient tool for the analysis of CHP options is the grand composite curve (see Figure 6). This representation of the process is derived from the composite curves and shows the same essential features – the minimum heating and cooling requirements, and the location of the pinch. Above the pinch, the line represents the overall heating requirement of the process heat sink assuming all heat exchange opportunities in this area of the process are achieved.

The pinch itself is immediately obvious, being the point where no heat is supplied to or removed from the process and the graph meets the temperature axis. Below the pinch, the line represents the overall heat rejection profile of the process heat source, again assuming that all heat exchange opportunities are achieved. The advantage of this representation over the simple composite curves is that it is easier to see at what temperature levels heat must be supplied to or removed from the process. For sites with more than one level of process steam produced from pass-out turbines it becomes possible to target for the maximum use of the lowest level of steam [*above* the pinch, of course – Figure 7(a)] and hence calculate power generation targets, again prior to design.

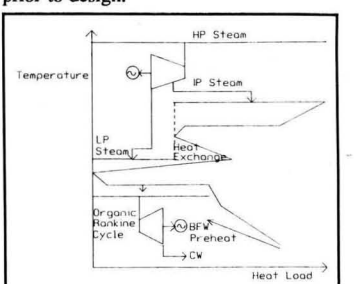


Fig. 7(a). Opportunities for CHP generation

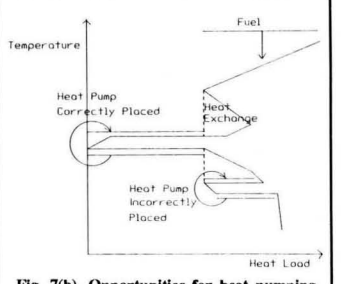


Fig. 7(b). Opportunities for heat pumping

This illustrates the importance of understanding the pinch when considering CHP opportunities. If the exhaust heat from the CHP cycle (e.g. gas turbine exhaust or steam turbine pass-out steam) is used below the pinch it has the same effect as process heating below the pinch and in fact saves no energy at all. If, on the other hand, the "waste heat" from the power cycle is usefully recovered above the pinch then it is effective in replacing primary process heating and the result can be a significant reduction in overall energy costs.

Another energy saving technology which is critically dependent on an understanding of process integration is the heat pump. In addition to the design limitations which exist in the current generation of industrial heat pumps, if they are not correctly placed within the process they cannot save energy – and electrically powered heat pumps and mechanical vapour recompression cycles will probably cost more to operate because of the relative costs of fuel and power. It shuld be clear by now that for a heat pump to be effective it must take heat from *below* the pinch (where there is a surplus) and upgrade it for use *above* the pinch where there is a shortage. This is the only effective use of a heat pump and probably explains why, without a detailed understanding of process integration, economical industrial heat pump applications are few and far between. This is shown in Figure 7(b).

Methods of application

To summarize, process integration is a systematic approach to the design of energy-efficient plant, which gives a scientific rationale to the hitherto *ad hoc* application of heat recovery techniques. The use of process integration can bypass the learning-by-experience approach that is a result of traditional process design methods. As successive generations of process plant are built, the operators and designers learn from their mistakes, and are driven by a desire to improve on the previous unit. Only after several generations of process plant have been constructed will the performance approach the minimum energy consumption. By using process integration it is possible to identify immediately the minimum energy target, and plan a campaign of investment to approach the target in a controlled, structured and rapid manner. Alternatively (as was the case at Bury St. Edmunds)

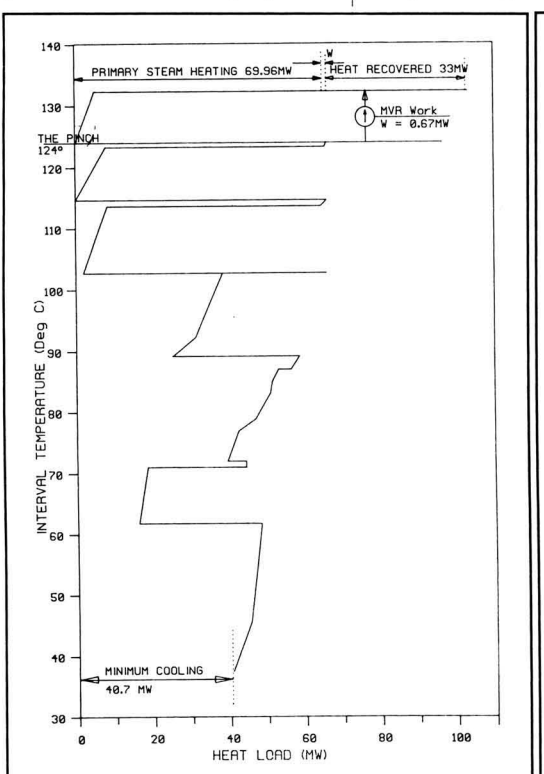


Fig. 8. Existing process (incl. MVR) – grand composite curve

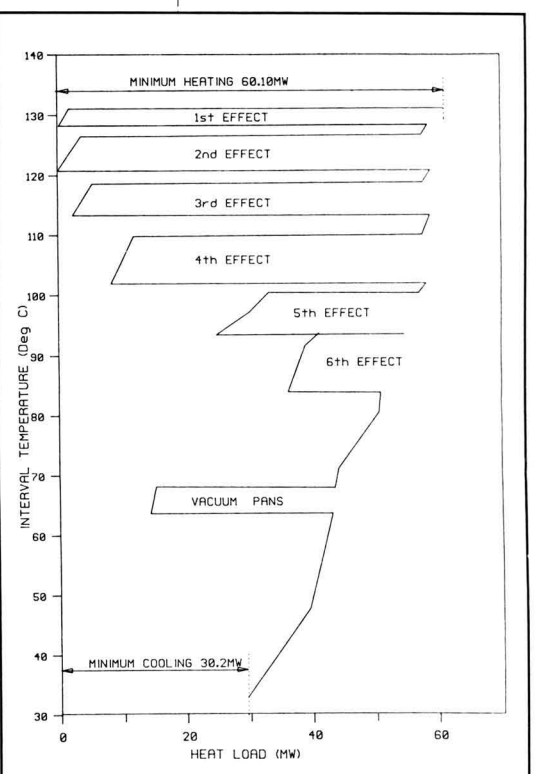


Fig. 9. Proposed process – grand composite curve

the process is seen to be operating close to minimum and any improvements can be achieved only by studying alternative processing routes or the installation of new unit operations and equipment. At this point the problem is re-defined with a new set of operating data. Process integration techniques can then be re-applied to ensure that the proposed changes can be implemented without introducing pinch violations and reducing the effectiveness of the proposed changes.

The EPI study at Bury St. Edmunds

EPI were commissioned to study the process at Bury St. Edmunds with three main objectives: (1) to examine the existing process and identify the potential for energy cost reduction; (2) to examine proposed plant modifications and comment on their suitability; and (3) to study the existing CHP installation and appraise alternative power generation cycles.

British Sugar were, in effect, seeking a thermodynamic audit of their proposed plant developments prior to implementation. The results of the energy targeting phase confirmed that the scope for savings on the existing plant was limited, and that BS had identified the correct process changes to improve the energy efficiency of the process with the new design.

The thermodynamic rationale behind the process development is of particular interest. The existing process energy consumption was dominated by a quintuple-effect evaporator, with vapour recompression on the first effect. The grand composite curve representing this process is shown in Figure 8. The pinch is caused by the condensation of the first effect vapours. Because of the need to supply the MVR with first effect vapour, there is an unually large evaporation load on the first effect which results in an evaporator design which is sub-optimal, because not all the first effect vapours are re-used in other evaporator effects, and an ideal evaporator is one in which the evaporation load is evenly distributed across all the effects. Given the uneven distribution, the MVR cycle is saving energy (more than 30% of the evaporator load, in fact) and it is appropriately placed across the pinch but the process could be improved by re-distributing the evaporator load. The consequence of redistribution was that there would be no spare first effect vapour to recycle in the vapour compressor, which would therefore become redundant. To compensate for the necessity of supplying all the heating duty with exhaust steam it would be necessary therefore to reduce steam consumption by adding an extra evaporator effect.

The addition of an extra evaporator effect had additional benefits. There then became available an additional vapour level for supplying raw juice and thin juice heating. The detailed consequences of this have been discussed elsewhere in this paper, but the impact on the process integration analysis was that, to make a full use of the additional vapour level, lower approach temperatures would have to be accepted throughout the thin juice and raw juice heating system. This in turn led to the necessity to install additional heat transfer surface area to counteract the reduced driving forces.

The result of the proposed changes can be seen in the grand composite curve in Figure 9. The pinch is still being caused by the first effect vapours, but with a much more even evaporation load distribution across the first three effects, there is no longer any real scope for vapour recompression. Indeed, to gain any real benefit, a vapour recompression cycle would need to take heat from the vacuum pan vapours and up-grade it by over 70°C to enable it to be used in the first effect of the evaporator, replacing exhaust steam.This is certainly beyond the economic limits of existing industrial heat pump technology. Figure 5 also shows that there is no benefit in using a vapour recompression cycle around the vacuum pans as there is clearly plenty of heat available from the fourth and fifth effect vapours to fulfill this heating duty. However, this is not meant to imply that such a situation could never arise. If, for example, there were a significant additional heating requirement in the temperature range 70° - 100°C it is conceivable that the pinch could be caused by the vacuum pans and, under these circumstances, a heat pump cycle could have important economic advantages. This is an important caveat when using process integration; similar processes may require vastly different projects to fulfil the minimum energy requirements, and each process must be studied individually, taking into consideration local energy costs and equipment costs as as well as apparently minor differences in operating conditions.

The results of the study confirmed that the BS approach had been correct and that by a combination of experience and intuition they had developed a design which was very close to minimum energy requirements, as shown in Table V. However, analysis of the CHP systems revealed some additional savings. These are briefly summarized below:

(1) *Fuel gas to replace oil.* At the prevailing energy prices this was an obvious step to take, saving 25% of the factory fuel costs, and in addition allowed consideration of other projects.

(2) *Boiler air preheating using boiler flue gases.* This was only feasible if the gas firing option were pursued and would increase boiler efficiency by about 5% with a payback period of around 1 year.

(3) *Pulp dryer air preheat using exhaust steam.* This again was only feasible if gas were fired on the boilers. The payback was less attractive than the boiler air preheat option as the fuel saved on the pulp dryers was coal.

(4) *Gas turbine options were evaluated but rejected.* The use of a gas turbine would have been an attractive option if the site had been operating continuously, but the campaign nature of the beet sugar process made the payback time on a gas turbine unacceptably long.

(5) *Use of exhaust steam in the boiler deaerators.* This would replace the current practice of using HP steam in the deaerators and would result in increased power generation at zero fuel cost.

Conclusions

The beet sugar industry appears to be a classic case of an industry well

down the "learning curve". Because of the seasonal nature of the industry it is possible to make changes to the process on an annual basis and, as a result, the most efficient factories are now operating very close to the minimum energy requirement. This has been achieved by a combination of experience and intuition, and significant capital expenditure. However, the use of process integration analysis still proved beneficial to British Sugar in two ways. First, there are the obvious tangible benefits to be obtained by implementing the energy saving measure recommended for the boilers. Second, and perhaps more important, is the knowledge that their proposed design is thermodynamically sound and that BS can proceed in confidence with their investment plans if these satisfy the company's own economic criteria.

What further improvements can British Sugar (or indeed any other beet sugar producer) expect to make? With the existing process, no benefits can readily be seen simply by increasing heat recovery within the evaporator, for example.

In general, to make any further advances, the process will need to be changed yet again. This could mean changing unit operations such as the pulp dryers, or changing process conditions such as higher concentrations of thin juice fed to the evaporator. A seventh evaporator effect would undoubtedly save energy and they are not uncommon in other areas of the food industry such as dairies. However, there will still be a need, when these changes are being considered, to analyse the results using process integration techniques, if only to ensure that what is apparently a major technical achievement is not hiding a backward step for the overall site energy consumption

Summary

A detailed study of the Bury St. Edmunds reconstruction is given. Consideration of the Bury results is used as an example of the company process energy reduction exercise. The methods by which the reductions were achieved are highlighted and the various types of heaters available for raw juice heating compared. The proposals to remove the vapour thermocompressor in favour of a sextuple-effect evaporator are discussed and results of the design check by the process integration technique are given. The technique of process integration is described in more detail in relation to energy targets and design guidelines. The use of hot and cold composite curves and the "pinch point" are developed and the uses explained. The results of this study as applied to Bury are then given with some of the benefits identified.

Facts and figures

BSSCT Autumn 1986 meeting

The second of the 1986 meetings of the British Society of Sugar Cane Technologists was held on October 31 at the Royal Commonwealth Society in London and was opened with a welcome from the President, Dr. M. C. Bennett. Dr. R. A. Yates took the chair and a series of presentations were made on the recent Congress of the ISSCT in Jakarta. Dr. Bennett gave an account of the major changes to the Constitution which were adopted and which have become effective since the Congress, while Mr. G. Scott described the sessions on engineering and energy, with an indication of the papers which he found the most important and interesting. Similar treatment was then given to the other sections with reviews by Dr. N. Coote on processing and by-products, Dr. G. James on cane pathology and entomology, and Dr. Yates on the general agricultural section. The general picture was then summed up by Dr. Bennett before the meeting was closed.

CITS 18th General Assembly, 1987

As reported earlier[1], the next General Assembly of the Commission Internationale Technique de Sucrerie will be held in Ferrara, Italy, during June 8 - 12 next year. The provisional program includes a reception on the evening of Monday June 8; working sessions on Tuesday, Wednesday morning and Thursday, during which about 30 papers will be presented and discussed, with simultaneous interpretation into English, French and German; a ballet at Ferrara Opera House on Tuesday evening; an excursion for all participants on Wednesday afternoon; a banquet on Thursday evening hosted by the Italian sugar industry; and a visit to a modern Italian sugar factory on Friday June 12. A special ladies program, including visits to Venice and Bologna, is to be provided. There is no fee and registration forms may be obtained from CITS Ferrara 1987, c/o A.N.T.Z.A., Via Tito Speri 5, 44100 Ferrara, Italy.

South African Sugar Technologists Congress, 1987

The annual congress of the S.A.S.T.A. will take place during June 22 - 25 next year, the opening and first technical session being held at the Maharani Hotel in Durban. Factory sessions will take place at the Mount Edgecombe Experiment Station on June 23 and 24 and agricultural sessions at the Huletts Country Club on June 24 and 25. It is planned to include a symposium and/or panel discussion while the Organizing Committee has indicated that contributions from authors outside South Africa will be welcomed. Information on papers and their presentation may be obtained from the SASTA Secretaries, SASA Experiment Station, Mount Edgecombe, Natal, South Africa 4300.

World food technology congress

The Second World Congress of Food Technology is to be held in Barcelona during March 3 - 6, 1987 and will include plenary lectures, round tables, poster sessions and presentations on horizontal (e.g. microbiological alteration of food) and vertical topics (e.g. meat industries). Sugar is not one of the vertical topics but readers can discover more by application to the Technical Secretariat, Inter-Congres, Gran Via 646 - 4°, 4ª, 08007 Barcelona, Spain.

PERSONAL NOTES

Dr. A. Bernard Ravnö left the Sugar Milling Research Institute on November 1 after seven years as Director, to take up a management position at the Sezela sugar factory of C. G. Smith Sugar Ltd. The Deputy Director, **Dr. Jaap Bruijin,** has taken over the reins of the Institute until he retires at the end of 1987. The Board of the Institute has decided to appoint a Director-Designate in the very near future to understudy Dr. Bruijn and to take over from him at the end of next year, with the aim of achieving a very orderly transition of control at the Institute. During Dr. Ravnö's period of office the SMRI has continued the high standard of excellence established by his predecessors and no doubt will remain an eminent centre of technical achievement in sugar manufacturing research.

In September, **Dr. Henning Brüniche-Olsen,** Managing Director of A/S De Danske Sukkerfabrikker, retired after 42 years with the Danish sugar company. He has been a prolific contributor to the technology of beet sugar production and to the application of his company's diffuser designs in cane sugar extraction. He was the author of an important work published in 1962 on "Solid-liquid extraction".

1 *I.S.J.*, 1986, **88,** 40.

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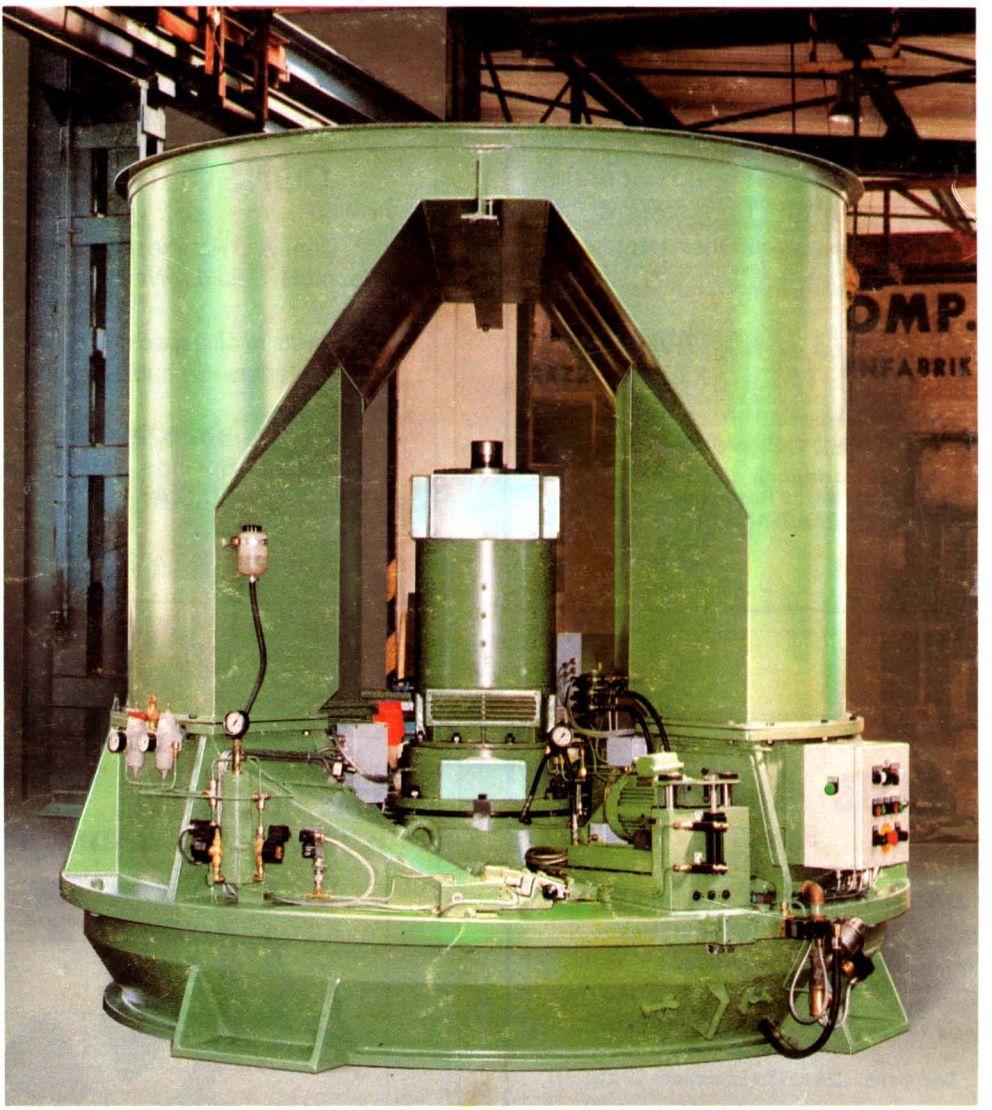

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