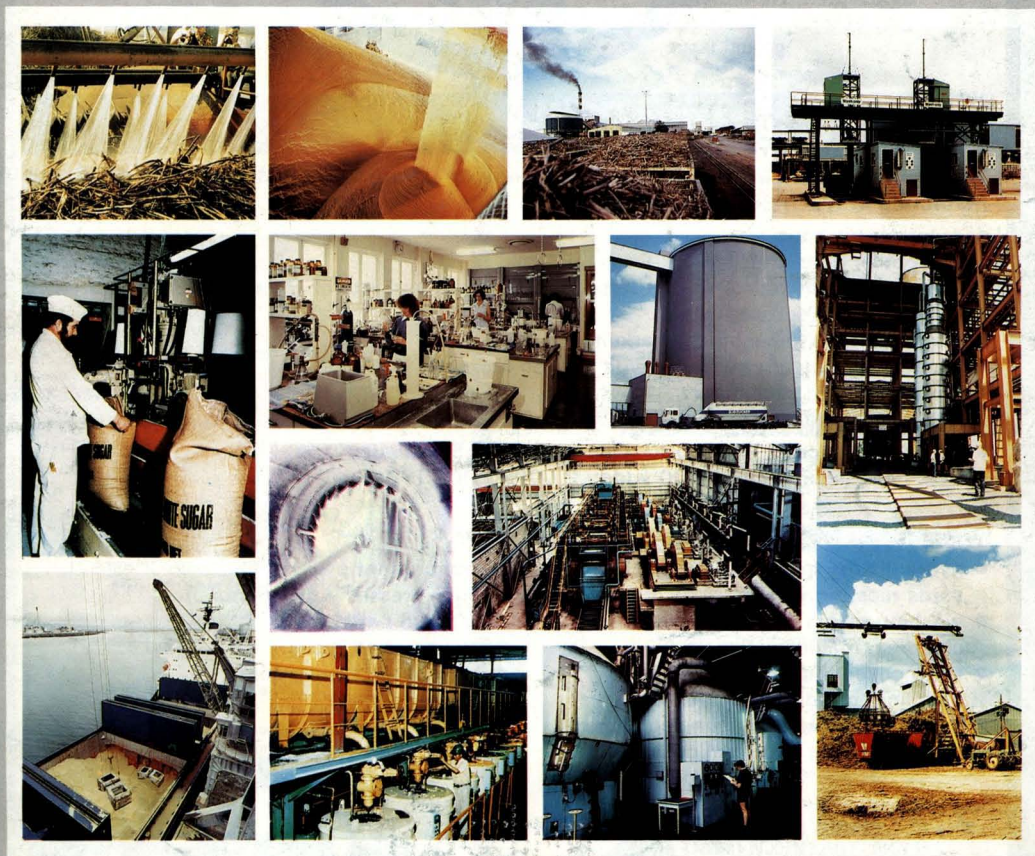
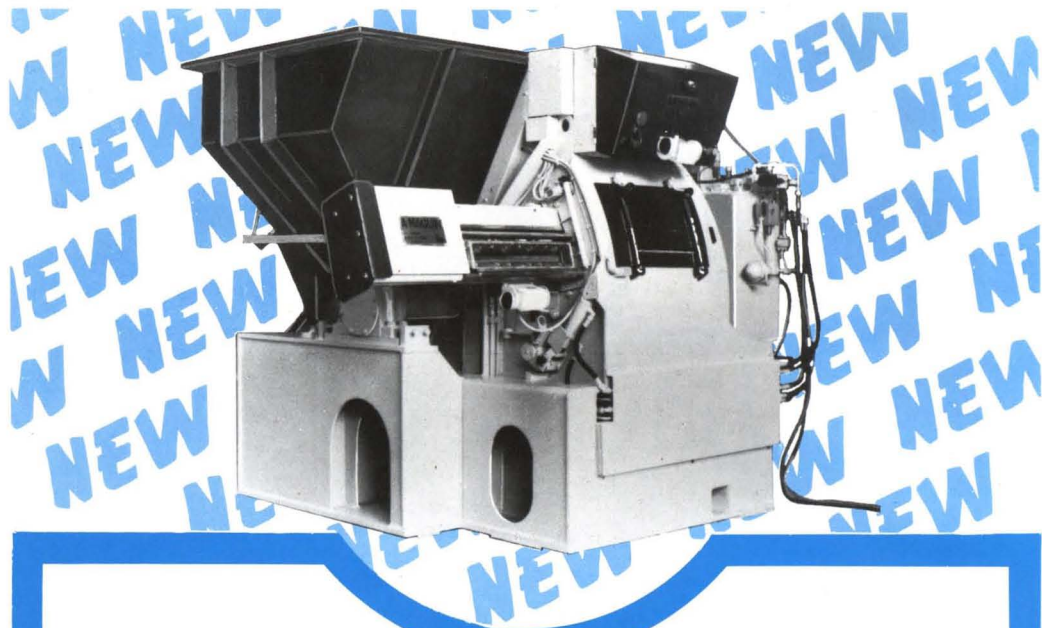


INTERNATIONAL SUGAR JOURNAL





DRUM BEET-SLICER 1860/600 - 4,500 T/DAY

The new beet-slicer includes the technology of previous MAGUIN beet-slicing machines in the field, characterized by :

- consistent output
- low power consumption
- minimum maintenance thanks to special materials and interchangeable wearing parts.
- reduced space for installation.
- fast automatic knife block changing.
- standard knives of one single type (B type normal).
- repeatability of slice quality.

OTHER MACHINE CAPACITIES :

- Drum beet-slicer 1,430 x 600 wide - 2,500/3,500 T/day.
- Disc beet-slicer 2,200 x 400 wide - 2,000/3,000 T/day.

OTHER MAGUIN SPECIALITIES

- hydraulic dry handling/storage beet yards reception plants.
- washing plants for beets, potatoes, chicoreas, manioc.
- trash collection/treatment with handling, grinding and pressing.
- knives, fraisers, sharpening equipment.
- prescalders for juice and cossettes.
- low content presses.
- filter-presses with membranes.
- vacuum pans.
- mixers of all types.
- barometric condensors.

BP. N 1 - CHARMES 02800 LA FERRE
Tél. (23) 56.20.67.- Télex : MAGUIN 140684 F

maguin

INTERNATIONAL SUGAR JOURNAL



Volume 88
Issue No. 1046

Editor:

D. LEIGHTON, B.Sc., F.R.S.C.

Assistant Editor:

M. G. COPE, M.I.L., M.T.G.

Panel of Referees

K. DOUWES DEKKER

*Consultant and former Director, Sugar Milling
Research Institute, South Africa.*

M. MATIC

*Emeritus Professor and former Director, Sugar
Milling Research Institute, South Africa.*

K. J. PARKER

*Consultant and former Chief Scientist,
Tate & Lyle Ltd.*

R. PIECK

*Former Director of Sugar Technology,
Raffinerie Tirllemontoise S.A.*

T. RODGERS

Former Deputy Chairman, British Sugar plc.

S. STACHENKO

*Président-Directeur-Général,
Agro-Technip, Paris.*

UK ISSN 0020-8841

**Annual Subscription:
£50.00 post free**

**Single Copies
£5.00 post free**

Airmail: £24 extra

Claims for missing issues will not be allowed
if received more than two months from
date of mailing, plus time normally
required for postal delivery of journal
and claim.

Published by
International Media Ltd.,
P.O. Box 26, Port Talbot,
West Glamorgan SA13 1NX, U.K.

Tel: 0639-887498 Telex: 21792 REF 869

CONTENTS February 1986

21 Notes and comments

* * *

Technical articles

23 **Analysis of sugar boiling and
its technical consequences.
Part II. Heat transfer during
sugar boiling**
By K. E. Austmeyer

30 **The use of the impurity
balance to study historical
change in sugar refining**
By C. W. Davis

34 **Instrument error in measuring
sugar colour**
By Frank G. Carpenter

* * *

39 ISSCT 19th Congress

39 Brevities

40 CITS 18th General Assembly

40 ICUMSA 19th Session

* * *

Abstracts section

12A Cane sugar manufacture

15A Beet sugar manufacture

16A Starch based sweeteners

17A Laboratory studies

18A By-products

20A Patents

* * *

viii

Index to Advertisers

Published by
International Media Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.
Telephone: 0639-887498 Telex: 21792 REF 869

US Office: P.O. Box 143773, Coral Gables Station, FL 33114-3773.

Inquiries regarding advertising should be addressed to the
 above offices or to the appropriate representative:

- UK:* T. G. Scott & Son Ltd.,
 30-32 Southampton Street, London WC2E 7HR
Tel: 01-240 2032. Telex: 299181.
- France:* MaG-Watt International,
 6 rue des Acacias, Vert-le-Grand, 91810 Essonne.
Tel: (6) 456-00.15.
- Belgium,
 Holland and
 West Germany:* G. Arnold Teesing B.V.,
 Prof. Tulpstraat 17, 1018 GZ Amsterdam.
Tel: 020-263615. Telex: 13133.
- Japan:* Shinano International,
 Akasaka Kyowa Bldg., 6-14 Akasaka 1-chome, Minato-ku, Tokyo 107.
Tel: (03) 584-6420. Telex: J27850 Sinanoco.
- Latin America:* Mr. Mario A. Mascaró,
 7321 S.W. 82nd Street No. 2, Miami, FL, U.S.A. 33143.
Tel: (305) 667-1724.

INTERNATIONAL BUSINESS ASSOCIATES

International Business and Economic Consultants

Confidential appraisal of business
 strategies and political, economic
 and marketing risks in the United
 States and Latin America.

International Business Associates
 is action and results oriented.

INTERNATIONAL BUSINESS ASSOCIATES

**2915 Monroe Street
 Columbia, SC 29205
 U.S.A.**

Tel: (803) 254-5555

International Business Associates is a subsidiary of Kuhne
 International Holdings

The Australian Sugar Journal

A MONTHLY JOURNAL issued by the
 AUSTRALIAN SUGAR PRODUCERS
 ASSOCIATION LTD.

Circulates throughout the sugar-producing
 districts of Australia

*It has in addition a substantial
 International subscription list*

Subscription Rates:

A\$21.60 per annum

For advertising rates, write:

G.P.O. Box 608, Brisbane, Queensland

Suma Products

WET DISINTEGRATOR

The Suma wet disintegrator can handle 5 kg cane samples with 10 kg water and disintegrate in about 5 minutes. This provides greater accuracy in cane analysis than do most current machines which, because of their limited capacities, necessitate sub-sampling.

Maintenance of the disintegrator is minimal, there being only one greasing nipple. A safety microswitch in the electrical circuit cuts off current supply in the event of a blockage; when this occurs, a tool slides over the lower end of the drive shaft and releases the jammed cane. A further safety



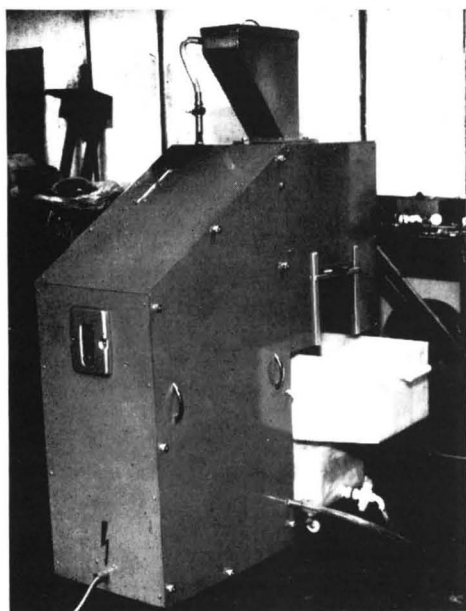
Disintegrated cane

device in the motor starter housing is a button which is depressed and turned to a locking position. The motor cannot start until the button is returned to its original position.

All parts of the Suma disintegrator which are in contact with liquor are made of stainless steel or highly polished aluminium.

In tests, a disintegration value of 99.36% on Brix, as determined with a special silica prism refractometer, has been obtained. This same refractometer, used in conjunction with the disintegrator, will ensure determination of % soluble solids to within ± 0.01 .

Write now for our literature on this and other Suma Products



The Sugar Manufacturers' Supply Co. Ltd.

18 CITY ROAD, LONDON, ENGLAND EC1Y 2AP

Telephone: 01-638 9331.

Cables: Vairon, London, Telex

Telex: 886945

We have done our homework in the Sugar Industry

1500 series



Contra-Shear Screens from 50 litres
to 40000 litres per minute



**Contra-Shear a leading designer of
screens being used in the following
areas:-**

- Cush section (mixed juice) — with single stage screening 87% fibre removed, up to 400 tons/hour throughput.
- Clarified juice — up to 600 cu M³/hour.
- Removal of coarse trash such as rocks and cane trash, from waste streams.

Reliable and proven screening technology means:-

- You protect your production by controlling the fibre content in your juice.
- You remove the necessary amount of trash, as required, from your effluent.
- You reduce your capital and processing costs.

Because we are specialists in the screening industry you should contact us without delay.

For further information and specifications phone or write:-

Contra-Shear

CONTRA-SHEAR DEVELOPMENTS LTD.
P.O. Box 1611, AUCKLAND, NEW ZEALAND
Telephone: (09) 818-6108 (3 lines)
Telex: NZ 60221 CNS

Contra-Shear Screens and Equipment are covered
by various patents and patents pending throughout the world.

Techart 528A

Chain for Cane

THE 2000 SERIES CHAINS

FOR THE CANE SUGAR INDUSTRY



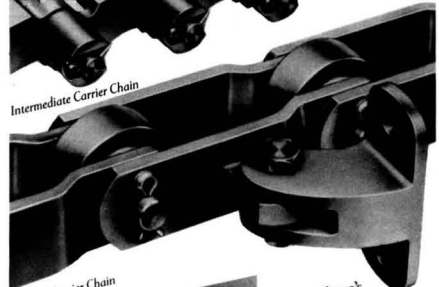
Cane Harvester Elevator Chain



Cane Carrier Chain



Intermediate Carrier Chain



Bagasse Carrier Chain



There's simply no match for the Renold 2000 range of conveying chains in terms of economy, durability and speedy detachability.

They're backed by over a century of expertise and designed to meet the toughest demands of modern mills. Chain replacements and spares are readily available and steel or cast iron sprockets can be supplied to meet individual needs.

For full details and prices contact:
RENOLD CONVEYOR Horninglow Road, Burton upon Trent,
Staffordshire DE14 2PS, England. Tel: (0283) 32881
Telex: 341301

RENOLD
Renold Conveyor



RPT35

Notes and comments

World sugar balance, 1985/86¹

F. O. Licht's first estimate of the world sugar balance for the 1985/86 crop period has recently been published and is reproduced below, with corresponding figures for the previous two crop years.

	1985/86	1984/85	1983/84
	—tonnes, raw value—		
Initial stocks	41,017,000	39,901,000	38,563,000
Production	98,540,000	100,368,000	97,988,000
Imports	25,772,000	28,297,000	29,721,000
	165,329,000	168,566,000	166,272,000
Consumption	99,523,000	98,325,000	96,470,000
Exports	26,453,000	29,224,000	29,901,000
Final stocks	39,353,000	41,017,000	39,901,000
„ „ (%) consumption	39.54	41.72	41.36

The final stocks show a welcome reduction, especially when expressed as a proportion of consumption which is set at the lowest figure for four years. Consumption growth is set at only 1.22%, however, and this is mostly from Africa, Asia and South America; in the developed countries consumption is static or even falling as a consequence of substitution by HFS and synthetic sweeteners. Nevertheless, low per caput consumption figures in the developing countries indicate the enormous potential for growth there.

Indian sugar production, 1989/85²

Provisional figures for the recently concluded 1984/85 sugar season in India show an outturn of 6,143,000 tonnes, a slight increase of 226,000 tonnes or 3.82% on the 1983/84 figure of 5,917,000 tonnes. The 1985/86 season has started with bleak conditions in all parts of the country except Tamil Nadu, with pests, diseases and floods affecting northern states, and drought in Maharashtra, so that production is not expected to exceed 6 million tonnes.

On the other hand, consumption rose during 1984/85 by 499,000 tonnes compared with 1983/84 and carryover

stocks fell by 766,000 tonnes in spite of imports of 1,097,000 tonnes. Owing to shortages, prices registered marked increases averaging 20% higher than in 1983/84. The Union government has announced a new sugar policy, aimed at increasing production, which will provide a considerable increase in the

statutory minimum price of cane and a change in the ratio of levy quota to free-sale sugar from 65:35 to 55:45. At the same time the retail price of levy quota sugar has been raised from Rs. 4.40 to 4.80 per kg, as from December 1985. The cane price has been raised from Rs 14.00 to Rs. 16.50 per quintal (100 kg), linked to a basic recovery of 8.5% and with a premium for higher recovery. It has also been decided that for the 1986/87 season the cane price will be raised to Rs. 17.00 per quintal.

World sugar production and consumption in 1985/86³

Since the initial Czarnikow forecasts of sugar production were made in August 1985, weather conditions have favoured crops, particularly in West Europe where dry sunny weather in September and October raised the sucrose content of the beets and allowed harvesting in dry weather with low dirt tares and higher recovery. Reports from the USSR also indicate an improvement in the crop there by comparison with recent campaigns.

On the other hand, drought in the Caribbean has led to a reduction in Czarnikow's estimate of production in the current season, particularly for

Cuba and the Dominican Republic, whereas production in Mexico is expected to match last season's and in Venezuela and mainland USA to show increases. Small adjustments have been made to the forecasts for Africa but there are considerable doubts about prospects in several Asian countries. The forecast total production is now set at 97,406,000 tonnes, raw value, against 95,825,000 tonnes in the earlier estimate, and an amended 1984/85 total of 100,626,000 tonnes. The beet sugar total is estimated at 37,112,000 tonnes and that for cane sugar at 60,294,000 tonnes. The total is nevertheless the fourth largest of all time.

To judge from actual figures, the methods used by Czarnikow to forecast 1985 consumption have worked well and it is now expected that 1986 consumption will pass the 100 million tonnes mark, providing a substantial excess over crop year production in 1985/86. From an initial stock figure of 41.0 million tonnes (Licht's figures, considered a worst-case choice), predicted movements result in a final stock figure of 37.6 million tonnes for the period. With consumption growth at the same rate and the same level of production (considered to be realistic), final stocks at the end of the 1986/87 crop year would be reduced to 32.5 million tonnes or 31.9% of consumption, the lowest level since 1980/81.

International Sugar Organization

The Fourth Session of the International Sugar Council of the 1984 Agreement was held in London during November 18 - 22, 1985. Highlights of the agenda included the election of the new Executive Committee and the President and Vice-President of the Council; and the appointment of the new Executive

- 1 F. O. Licht, *Int. Sugar Rpt.*, 1985, 117, 585-590.
- 2 *Sugar Scene*, 1985, 3, (10), 2, 16.
- 3 C. Czarnikow Ltd., *Sugar Review*, 1985, (1743), 145-150.

Director to replace out-going director, Mr. William Miller. The Executive Committee is made up of Australia, Brazil, Cuba, the Dominican Republic, the EEC, Philippines, Argentina, Jamaica, India and Mauritius, as exporters. The importers elected Canada, Egypt, Finland, German Democratic Republic, Japan, Republic of Korea, Norway, the USSR, the USA and Sweden. This new Executive Committee will elect a new chairman, expected to be Mr. Jorge Ruiz of Argentina, at its first session in 1986.

Mr. Bruce McMullen of the United States and Mr. Alfredo Ricart of the Dominican Republic were elected president and vice-president, respectively, of the Council. No agreement was reached in the election to replace Mr. Miller. There were five candidates: Percy Eastman of Canada; David Fisher, current Fund administrator, and Bruce Dowling, both of Australia; Lenhart Alvin of Sweden and Leonid Lokshin of the USSR.

The secretariat has drawn up estimates of world production, consumption and foreign trade in 1986. The first two of these are given below.

	1985	1986
	---- tonnes, raw value ----	
Production	99,200,000	99,600,000
Consumption	97,700,000	98,900,000

The Sugar Consumption Committee met on November 19. One of the items on the agenda was a talk by scientist-researcher Dr. Riaz Khan of Tate & Lyle on the importance of alternate uses of sugar. The Council of the 1977 Agreement met on November 20 to discuss the liquidation of the Stock Financing Fund.

During the session, the four major exporters - Australia, Brazil, Cuba and the EEC - held talks to analyse the current world market situation and depressed prices, despite the recovery of the past few months. The "big four", as they are called, also discussed possibilities for negotiating a new agreement with economic clauses. When Mr. Miller, who attended the meeting, was interviewed he said he felt more optimistic than before the meeting, but he refused to give any more details. This was the first time the big four

have met since the Conference failed in June 1984.

At one of the Council sessions several countries expressed their support for working toward a new agreement. The big four were expected to meet again in January and later they will meet with the other six countries that make up the ten largest exporters.

EEC sugar quotas extension

At the meeting of the Agriculture Ministers of the European Community on December 9 - 10, it was agreed in principle, subject to the opinion of the European Parliament, to extend the quota system for sugar for the five years 1986/87 to 1990/91. For the first two years the A- and B- quotas will also remain at their existing levels, and the Council will take a further decision by the end of 1987 on quotas for the remaining three years. The maximum rates of levy on A- and B- quota sugar will remain unchanged for the first two years except for the additional levy designed to recoup, over the coming five years, the deficit that has accumulated on the levy account. The additional levy will be shared between member states so that those who produce most quota sugar will pay the most; as a result the rate of levy will average 1.31% of the present intervention price for the Community as a whole while individual countries' levies will be 1.63% for France and West Germany, 1.43% for Denmark, 1.39% for Holland, 1.32% for Belgium, 0.8% for the UK, 0.74% for Greece and Ireland and 0.32% for the French Overseas Departments. Spain and Portugal, not having contributed to the deficit, will have no additional levy. By delaying its decision on quotas for 1988/89 - 1990/91, the Council will be able to take account of developments, particularly in the use of sugar for the industrial products. Further detailed discussion of proposals on sugar for the chemical industry and for a revised starch program were also postponed.

C. Czarnikow Ltd. comment⁴: "The scheme falls short of perfection in several respects. It does nothing to prevent the creation of fresh deficits and provide no fresh disincentives to over-production such

as would have arisen from the application of a higher levy on B-quota sugar production, as originally proposed. ...Because it will spread the repayment of the deficit certainly over two and probably five years, it will be less of a financial burden on the largest producers and so reductions in sowings may now be less significant than they would otherwise have been. Finally, the intractable issue of the production quotas, if they are indeed to be frozen at their present levels, will have been sidestepped and thus a golden opportunity to rationalize EEC production will have been needlessly wasted."

US Farm Bill

The joint House-Senate Conference Committee negotiated a new Farm Bill on the basis of the versions passed by their respective chambers and unanimously approved their version on December 14. This was approved by both chambers separately on December 18 and sent to the President, who signed it into law on December 23. While providing comfort for domestic sugar producers it was not a welcome Christmas gift for the developing countries who have been suppliers to the United States.

The loan rate is frozen at 18 cents/lb for the 5-year life of the bill but a provision to allow, but not require, annual increases based on upward movements in production costs was included⁵. The intent of Congress is declared for operation of the sugar program at no cost to the Treasury beginning with 1986/87 but the bill also requires either an extension of the 1985/86 quota year for a minimum of three months (to December 31, 1986) or an "unspecified" action on the part of the government to minimize forfeitures.

The passage of the Bill through Congress has been a long-term bearish factor for the market, and an extension of the quota year is thought likely. E. D. & F. Man comment⁶: "It remains to be seen whether the administration will be able to rescue some credibility in the eyes of quota holding countries by other conciliatory measures."

⁴ *Sugar Review*, (1985), (1744), 166.

⁵ *Dyergram*, December 16, 1985.

⁶ *The Sugar Situation*, 1986, (416).

Analysis of sugar boiling and its technical consequences

Part II. Heat transfer during sugar boiling

By K. E. Austmeyer

(Institut für landwirtschaftliche Technologie und Zuckerindustrie an der TU Braunschweig, Germany)

Introduction

The boiling process is determined by mass transport of sucrose from the solution into the crystal lattice and by heat transfer at the calandria. Criteria for the calculation of the mass transport and the resultant numerical results have been described by us in detail in earlier publications^{1,2,3}. The following deals extensively with the analysis of heat transfer at the heating surface and with conclusions resulting from practical experience.

The relationships between the three heat transfer resistances can be seen for the course of discontinuous white sugar boiling by evaporation in Figure 2.

It is evident that during the process the resistance to heat transfer on the inside the tube wall will become more and more dominant by comparison with the resistance in the tube wall and in the condensate film. At the end of boiling, when the resistance within the tube amounts to more than 90% of the total resistance

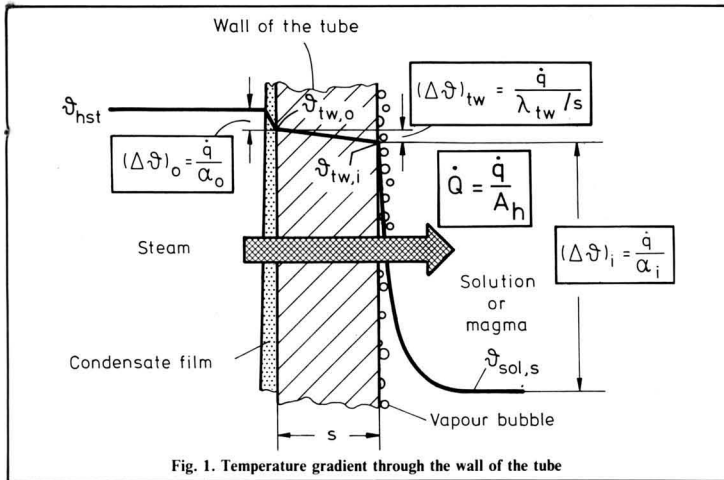


Fig. 1. Temperature gradient through the wall of the tube

Heat transfer

As illustrated in Figure 1, the heat transfer through the heating surface is inhibited by three resistances which are reflected by three ranges of the temperature gradient: The temperature ϑ_{hst} of the heating steam will first be reduced within the condensate film, then within the wall of the tube and, finally, on the inside of the tube covered with solution or magma and vapour bubbles. The total resistance can be determined by series summation of the individual resistances:

$$R_{tot} = \frac{1}{k} = R_o + R_{tw} + R_i = \frac{1}{\alpha_o} + \frac{1}{\lambda_{tw}/s} + \frac{1}{\alpha_i} \quad (1a)$$

It follows that the heat flux \dot{q} is given by:

$$\dot{q} = \frac{Q}{A} = \frac{\Delta\vartheta_{tot}}{R_{tot}} = \alpha_o \cdot (\Delta\vartheta)_o = \alpha_{tw} \cdot (\Delta\vartheta)_{tw} = \alpha_i \cdot (\Delta\vartheta)_i \quad (1b)$$

the k value is nearly equal to the value of α_i at the magma side.

While the calculation of the heat transfer in the condensate film and within the tube wall is comparatively simple^{4,5}, a uniform description of the heat transfer coefficient on the inside of the tube does not seem possible, owing to the considerable changes in microconvection at the wall caused by bubbles as well as to the difference in the magma flow within the tubes^{5,6}.

The thickening step, in which a distinct bubble boiling is evident, was submitted to mathematical analysis on the basis of dimensionless criteria^{7,8}. With the help of several representative criteria equations for bubble boiling it may be demonstrated that heat transfer in fluids which are highly superheated

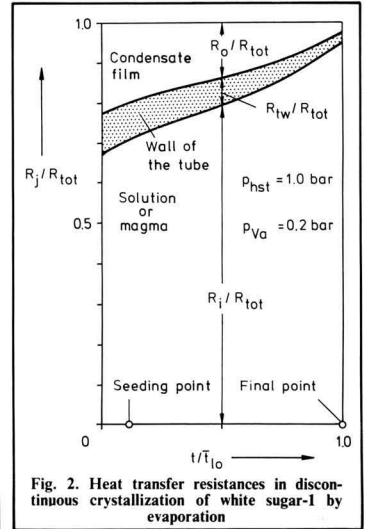


Fig. 2. Heat transfer resistances in discontinuous crystallization of white sugar-I by evaporation

at the heating surface, and in which boiling is thus mainly local, can only be described by an equation which is valid for temporary changing of bubble size as a function of superheating or under-cooling. Such an equation has been developed by Forster & Zuber⁹:

$$Nu = C Re^{0.62} Pr^{0.3} \quad ; \quad C = 0.0015 \quad (2)$$

Figure 3, which also contains the definition of the (dimensionless) numbers, shows an illustration of Equation (2) as an unbroken line in the field experimentally checked by the authors.

The following fact should be pointed out: in evaporation of sugar solutions, for example during thickening, it has been proved that the heat flux transferred at the heating surface is

- Schliephake & Austmeyer: *Zucker*, 1976, 29, 293.
- Orlowski & Schliephake: *ibid.*, 1972, 25, 619.
- Schliephake & Austmeyer: *Fortschr. Ber. VDI-Z.*, 1982, Series 3, (71), 39.
- Gregor: "Wärmeaustausch und Wärmeaustauscher", 2nd Edn. (Sauerländer, Aarau/Frankfurt), 1973.
- Austmeyer: "Untersuchungen zum Wärme- und Stoffübergang im Anfangsstadium der Verdampfungskristallisation der Saccharose", (Diss. TU Braunschweig), 1980.
- Idem: Paper presented to the 27th Tech. Conf., British Sugar plc, 1984.
- Brauer: *Chem.-Ing.-Techn.*, 1963, 35, 764.
- Stephan: *ibid.*, 775.
- J. Appl. Phys., 1954, 25, 474.

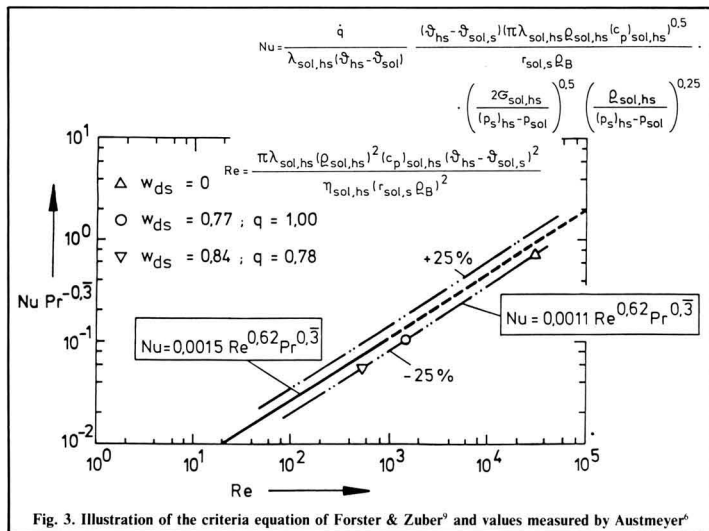


Fig. 3. Illustration of the criteria equation of Forster & Zuber⁹ and values measured by Austmeyer⁶

independent of the mean velocity of the solution entering the boiling tube when varied by a circulation device if the temperature gradient is high enough. This result, which applies to heat transfer during characteristic bubble boiling and which is not valid for convective heat transfer in low-bubble or bubble-free flow, has been confirmed in numerous publications. The influence of free or forced convection, therefore, is smaller than the effects of micropulsations caused by vapour bubbles.

These results lead to the following practical statement: during the first stage of boiling, when the temperature gradient is normally high, the stirrer installed inside the vacuum pan is not able to increase the heat transfer. In this first stage of the process, the primary function of the stirrer is to transmit shearing forces on the suspension with the still relatively small crystals.

Up to now it has not been possible to obtain a satisfactory analysis of heat transfer within the suspension for the second stage of processing, especially during Brixing-up. There are only empirical data available concerning the

efficiency of mechanical circulation.

Types of stirrers

Figure 4 shows the calandria/stirrer combinations currently in use in vacuum pans in West Germany. The following types may be differentiated:

(a) *Inward circulation (stirrer within calandria)*

The suspension is sucked axially into the central downtake and pushed under the heating surface. In order to improve the flow below the calandria a conical-bottom profile may be installed.

(b) *Outward circulation (stirrer above calandria)*

The suspension is moved above the

calandria and led into the annular downtake.

(c) *Outward circulation (stirrer below calandria)*

The suspension is sucked in from the bottom of the apparatus and driven through the calandria. The calandria must be raised in this type of installation.

In types (b) and (c) the stirrer is not equipped with a distinct guiding tube. From a wealth of empirically-gained data it has been shown that the best circulation effect is obtained with type (a).

Power demand of stirrers

The power demand of a stirrer is calculated according to the known relation¹⁰:

$$P_{st} = Ne \rho n^3 d_{st}^5 \tag{3}$$

The characteristic power value Ne (Newton number) for every stirrer is mainly dependent on the Reynolds number, defined as:

$$Re = \frac{n \cdot d_{st}^2 \cdot \rho}{\eta} \tag{4}$$

In Figure 5 the dependence of Ne on Re is illustrated for Kaplan-type 5-bladed propellers, inclined at 21° and 25° and made by Ekato. It can be seen that in the turbulent range (Re > 10⁴) Ne is constant (independent of Re) while in the range of slow Stokes motion (Re < 10) a hyperbolic dependence is evident.

The lines for Stokes and turbulent flow are connected by a curved section

¹⁰ Austmeyer & Kipke: *Zuckerind.*, 1979, 104, 395.

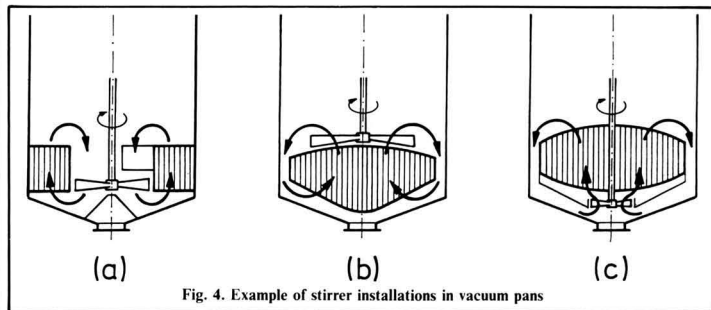


Fig. 4. Example of stirrer installations in vacuum pans

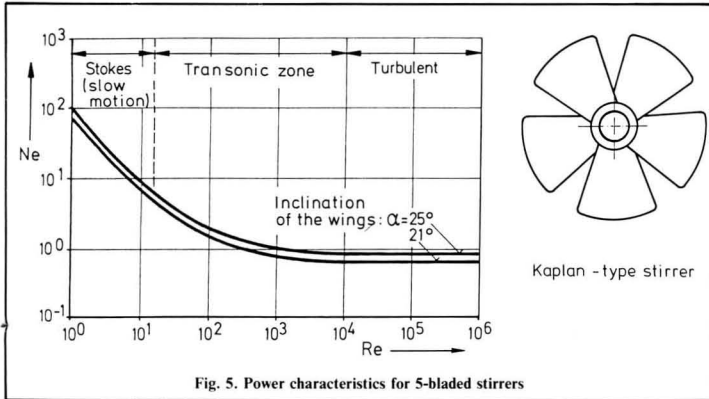


Fig. 5. Power characteristics for 5-bladed stirrers

in the transonic zone. In the Stokes range only forces of viscosity are of importance:

$$Ne = \frac{const.}{Re} : P_{st} = const. \times (\eta n^2 d_{st}^3) \quad (5)$$

Consequently, in the Stokes range, the density of the solution is not required for the calculation of stirrer power (Equation 5). In the turbulent field, however, only forces of inertia play a part, as expressed in Equation (3) with the density ρ included.

stirrer motor being utilized to the full or even with a 50% overload for a short time. If the speed of rotation is reduced from 67 to 45 rpm in the final step of Brixing-up by pole-changing, the required power demand of the stirrer decreases to 38 kW. The boiling process may thereby be extended for a short time Δt (see Fig. 6).

It should be pointed out that the power peak in the first stage of the

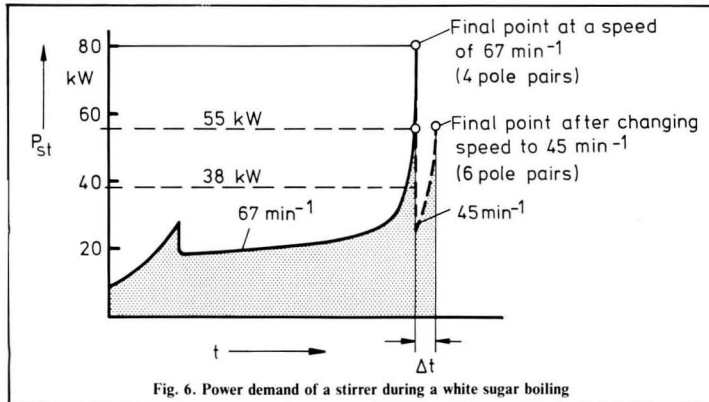


Fig. 6. Power demand of a stirrer during a white sugar boiling

Figure 6 shows the development of power absorbed by the stirrer during the white sugar boiling process.

It is obvious that a 55 kW motor with a stirrer speed of 67 rpm is being run at low load during almost the whole process, while only at the end of the white sugar boiling process is the

process is only dependent on the level of solution or suspension.

Balancing of boiling apparatus

Figure 7 shows the balance of energy flows for the boiling apparatus.

The steam side balance (a) applies to:

$$\dot{H}_{hst} = \dot{H}_{hsc0} + Q \quad (6)$$

Furthermore,

$$\dot{m}_{hst} = \dot{m}_{hsc0} \quad (7)$$

For the magma balance (b) can be written:

$$\dot{H}_{fs} + \dot{Q} + P_{st} = \dot{H}_{va} + \dot{H}_{Ma} + \dot{Q}_{lo} \quad (8)$$

As the effective temperature difference $(\Delta \vartheta)_{eff}$ in the calandria is not known, an apparent temperature difference $(\Delta \vartheta)^* = (\Delta \vartheta)_{hst} - (\Delta \vartheta)_{va}$ and a corresponding apparent heat transfer coefficient have been introduced. The heat-flux \dot{Q} transmitted at the heating surface A_h can be calculated from:

$$\dot{Q} = k_{eff} A_h (\Delta \vartheta)_{eff} = k^* A_h (\Delta \vartheta)^* \quad (9)$$

For the k^* -value at the steam side (balance a) it follows that:

$$k^* = \frac{\dot{m}_{hsc0} (h_{hst} - h_{hsc0})}{A_h (\Delta \vartheta)^*} \quad (10)$$

The more complicated equation of the k^* -value for the magma side has been published elsewhere⁶.

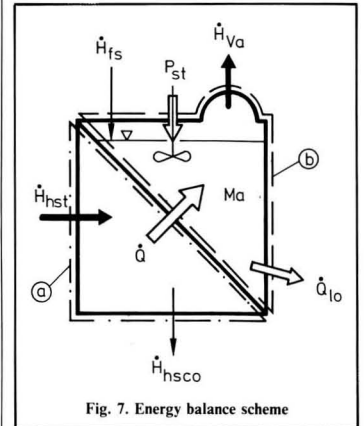


Fig. 7. Energy balance scheme

Representative sampling necessary for the solution of the magma side balance is difficult, especially during Brixing-up, so that the steam side balance should be given preference. For measurement of condensate yield the measuring arrangement shown in Figure 8 was chosen.

The condensate flow is detected by an inductive flowmeter whose integral can be checked by the aid of a stand-pipe at the condensate reservoir. It is important that this reservoir is provided with a pressure-balancing

tube connected to the steam system so that movement of the condensate column resulting from fluctuations of pressure in the heating system will be avoided. The condensate level is observed by means of a sight glass.

Development of the k*-value

As already mentioned, the magnitude of the k-value during the boiling process is, for constant conditions of steam pressure, vapour pressure and stirrer rotational speed, a function of each process state, especially of the

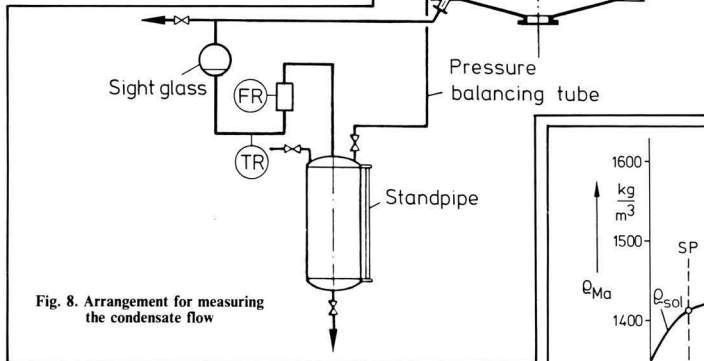


Fig. 8. Arrangement for measuring the condensate flow

time-dependent values of viscosity and level of suspension. Concerning the viscosity of magma, the after-product strikes handle more easily because the magma shows Newtonian behaviour during the whole process.

After-product boiling process

Figure 9 illustrates the changing

values of the physical units of density and viscosity, and the increase in crystal content w_c , during the boiling

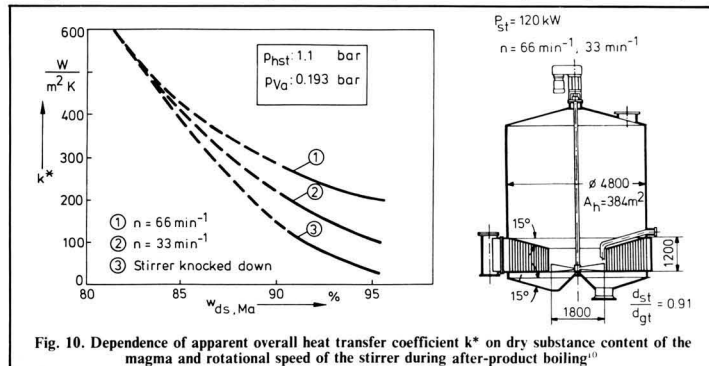


Fig. 10. Dependence of apparent overall heat transfer coefficient k^* on dry substance content of the magma and rotational speed of the stirrer during after-product boiling⁹⁾

cycle of a stirred after-product pan.

The units η and ρ are dependent at first on the supersaturation value y of the solution and, after the seeding point, on the properties of the magma of crystals and mother liquor. The viscosity of such solutions has been measured by several authors and has been mathematically expressed.

The viscosity of the magma in a crystal content range of 0.3 to 0.5 can be calculated from an equation of Gromkovskii & Fursov¹¹.

$$\frac{\eta_{Ma}}{\eta_{sol}} = \left[1 - w_c \cdot \frac{\rho_{Ma}}{\rho_c} (3.4 d_c^{-0.0525} - w_c \cdot \frac{\rho_{Ma}}{\rho_c} 3.01 d_c^{-0.0965}) \right]^{-1} \quad (11)$$

Up to the highest value of this range ($w_c = 0.5$), below which the after-

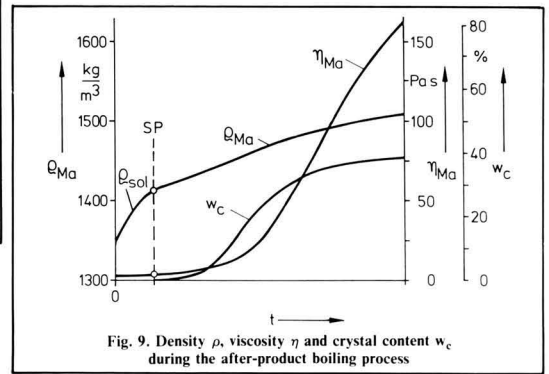


Fig. 9. Density ρ , viscosity η and crystal content w_c during the after-product boiling process

product magma is principally situated, all suspensions behave as Newtonian fluids.

For the density of the magma the following relationship can be derived with the help of material and dry substance balances:

$$\rho_{Ma} = \frac{\rho_{sol} \cdot w_{ds, sol}}{w_{ds, Ma} - w_c (w_{ds, c} - w_{ds, sol} \rho_{sol} / \rho_c)} \quad (12)$$

as well as with the aid of material and volume balances:

$$\rho_{Ma} = \frac{\rho_{sol} \cdot \rho_c}{\rho_c - w_c (\rho_c - \rho_{sol})} \quad (13)$$

The values of ρ and η are used to determine the stirrer power, too, according to Equations (3) and (5).

Figure 10 shows the dependence of

11 Izv. Vuzov, Pishch. Tekhnol., 1977, (4), 157.

observed k^* -values, obtained in the vacuum pan illustrated on the right-hand side, on the refractometric dry substance content of the solution or suspension as well as on the rotational speed of the stirrer. As we are convinced that construction and layout of the vessel are also important for the heat transfer, the measured data in this paper are combined with a drawing of each vessel involved.

The experiments which were the basis of this Figure were carried out with constant steam and vapour pressures and with virtually identical operating procedures. It becomes clear that the increased circulation velocity caused by the higher stirrer rotation speed has a considerable influence on the evaporating capacity of the vacuum pan. At the end of the boiling process the k^* -value could be increased from $25 \text{ W/m}^2/\text{K}$ (stirrer inoperative) to about $200 \text{ W/m}^2/\text{K}$ at $n = 66 \text{ rpm}$ when $P_{st} > 150 \text{ kW}$.

The aim of further investigations was to find out the dependence, under unchanged conditions, of the apparent heat transfer coefficient k^* on the level of the suspension in the vacuum pan. To achieve a consistent level at the stage of Brixing-up, each strike was first grown normally, then any surplus discharged before Brixing-up the remainder. Figure 11 shows the dependence of the k^* -values on the magma level under variable steam pressures p_{hst} ; the vapour pressure was approximately constant during each experiment at 0.27 bar. The refractometric dry substance content of the magma¹² amounted to $w_{ds} = 0.97$. A drawing of the vacuum pan used is given on the right-hand side of Figure 11.

The k^* -values show a distinct maximum at $L_{afc} \approx 0.8 \text{ m}$. Thus, a minimum level is necessary for magma circulation; when the optimum level is passed, as in the second stage of processing during a conventional boiling process, the apparent heat transfer coefficient becomes lower.

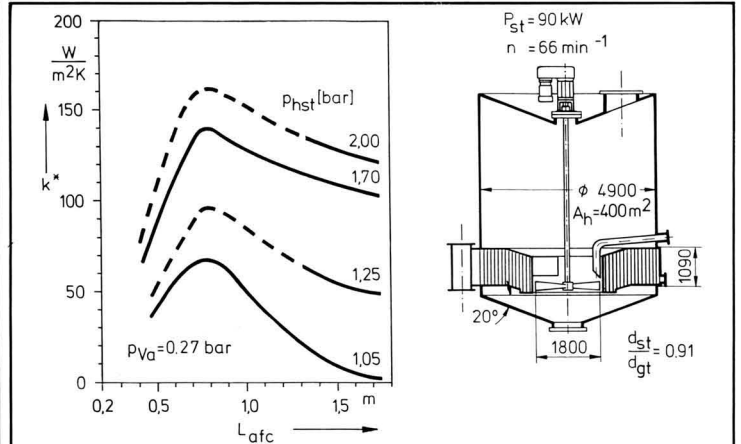


Fig. 11. Variation of the apparent heat transfer coefficient k^* for different steam pressures p_{hst} with level L_{afc} of the massecurite above the calandria (after-product boiling; final point of process)

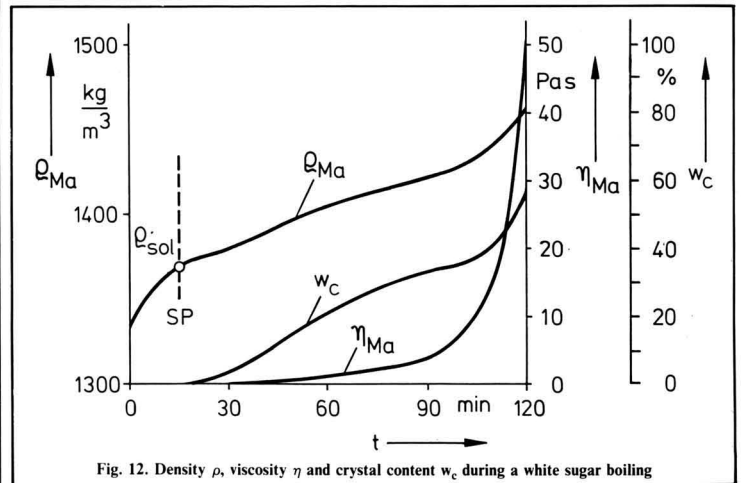


Fig. 12. Density ρ , viscosity η and crystal content w_c during a white sugar boiling

In order to operate at an optimum level during the whole boiling process, it is necessary to transfer from discontinuous to continuous work. This system of processing, carried out since 1981 in the sugar factory at Lage, Germany, is described later in this series.

White sugar boiling process

The development of density ρ , viscosity η and crystal content w_c of the magma for a typical first white

sugar strike can be seen in Figure 12 and compared with the analogous Figure 8 (after product strike). At the end of boiling there is a remarkable abrupt increase in viscosity; this can be attributed to the high final crystal content of the magma by comparison with that in the after-product boiling process. It is also known that suspensions with a high crystal content do not show Newtonian behaviour ($w_c > 0.5$). It is currently being

¹² Reinfeld: *Zuckerind.*, 1983, 108, 307.

investigated in detail as to whether structural viscosity or only slipping effects are the reason for this phenomenon.

Figure 13 shows the dependence of a special α -value, calculated for the middle height of the tube, here called $\tilde{\alpha}$, for the course of white sugar boiling (represented by the Prandtl number) obtained in practice, with the pressure conditions written down together with values calculated for two special cases: undercooled bubble boiling with respect to the previously mentioned Forster & Zuber equation and laminar pipe flow of solution or suspension with respect to the equation of Sieder & Tate. The criteria equation for the two mentioned special cases are written down in the Figure. The more complicated definition of the dimensionless numbers for undercooled bubble boiling according to Forster & Zuber are to be found in Figure 3.

It is obvious that the curves calculated for laminar flow and the velocity as parameter, here 0.001, 0.01 and 0.1 m/sec, are also situated low compared with the field including the experimental results. The curves for bubble boiling, on the other hand, cannot give the slope of the experimental curves in the last phase of the process. It is astonishing that the measured values in the last part of the process increase and lie above those calculated from the equation of Forster & Zuber, while the situation is reversed in the first part of the process. This phenomenon observed in the final stage can be explained by the increasing effect of the stirrer on magma circulation and, furthermore, the changing rheological properties of the magma towards the final point.

The progressive slope of the curves for laminar flow results from the structural behaviour. The laminar flow was calculated with a Reynolds number for non-Newtonian flow respecting the power law with the exponent "m" derived from the Newtonian shear stress equation¹³. In the last phase of

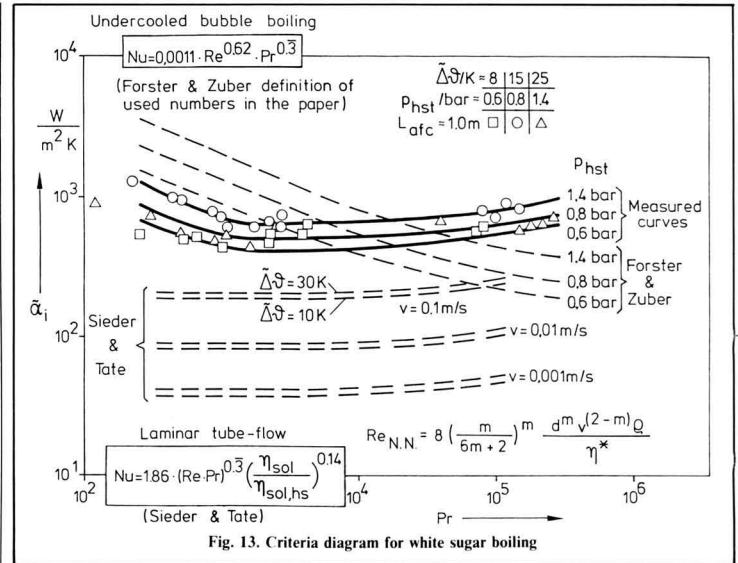


Fig. 13. Criteria diagram for white sugar boiling

the process the heat transfer calculated for the laminar flow increases progressively and reaches the same slope as the experimental results. On the other hand, the distance between these curves and the field given by experimental results shows that the problem is more complicated and cannot be described by laminar flow only.

For heat transfer with respect to bubble boiling it has generally to be acknowledged that in the final part of the process, it is the thin layer of solution containing crystals that is important for heat transfer (at the wall) and not the rheological properties of the bulk of the magma. Further investigations with the aim of improving calandria construction and obtaining better stirrer effects are planned.

Results for heat transfer at the final point of the white sugar boiling process in stirred vacuum pans, empirically obtained during the last campaign, are summarized in Fig. 14.

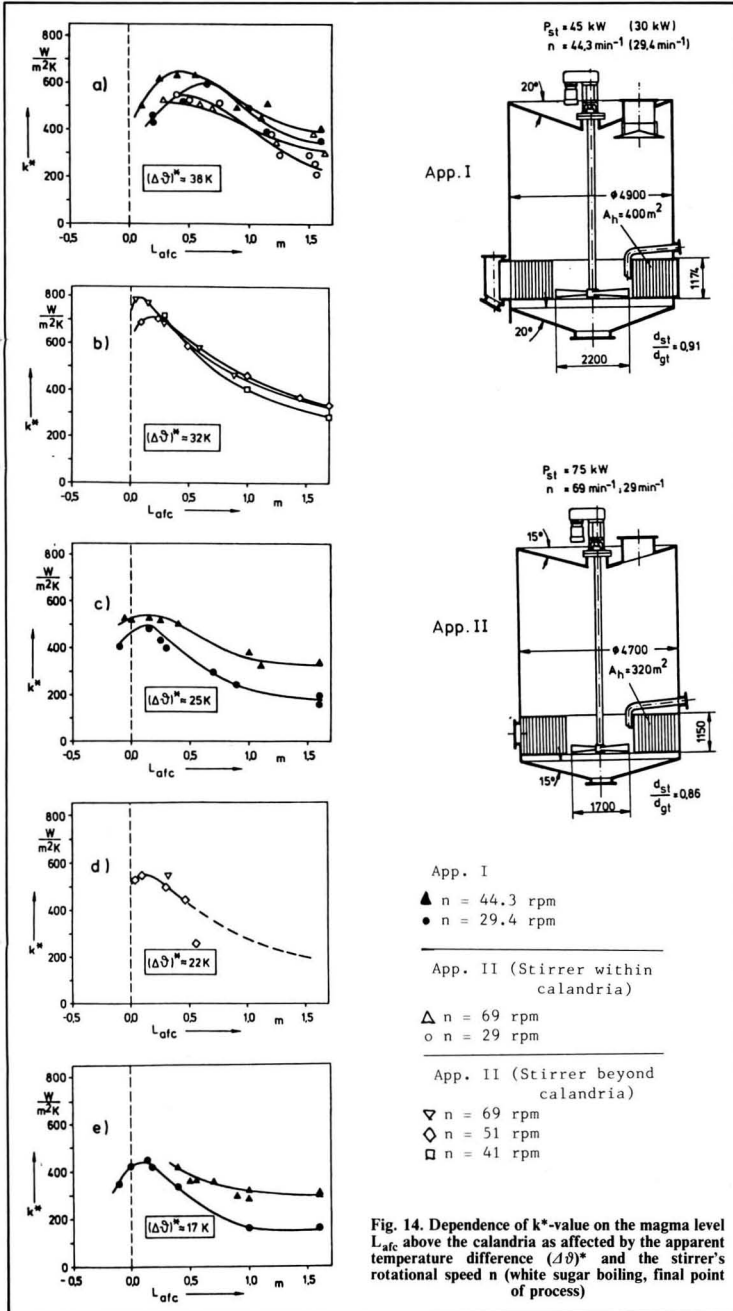
These investigations also show clearly that there is an optimum level for the suspension above the calandria;

at the final point of the process (w_c about 0.57) this lies in the range of 0.15-0.65 m. The underlying measurements were carried out with two differently designed crystallizers; their dimensions are indicated in Figure 14. From the heat economy point of view of special interest are those k^* -values which were obtained at low heating steam pressure [0.6 bar ; $(\Delta \vartheta)^* = 17k$] shown in Fig 14e. The diagram shows that the k^* -value achieved by maintaining the optimum level ($L_{afc} = 0.15 \text{ m}$) can be more than double that with the normal level ($L_{afc} = 1.6 \text{ m}$) at the end of boiling in the case of conventional operation at $n = 29.4 \text{ rpm}$.

Furthermore, it becomes clear that locating the stirrer beneath the floating calandria is advantageous for continuous operation. The change of direction of the magma takes place in the stirrer zone itself; the stirrer drives the magma out radially. The achieved improvement in the k^* -value at low magma level by continuous operation is considerable.

Maintenance of the constant

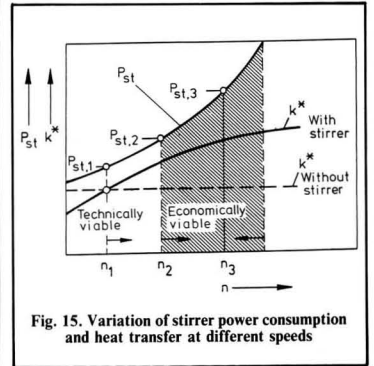
¹³ Shelland: "Non-Newtonian flow and heat transfer" (Wiley, New York), 1967.



optimum level naturally requires continuous operation. A development of continuous crystallization by evaporation elaborated in the Braunschweig Institute is presented in the next part of this series.

Considerations of stirrer economy

A trend seen over recent years with respect to mechanical stirring of massecuite in vacuum pans has been the reduction in speed of rotation with a reduced power demand. Figure 15 shows that if the influence of the stirrer on massecuite-side heat transfer (k^*) towards the end of the boiling is considered, then the installation of a pan stirrer is only of practical value if the minimum speed n_1 (power requirement $P_{st,1}$) is achieved. At lower speeds the stirrer forms a resistance to flow which has the result that the k^* -value is lower than in a pan without a stirrer.



However, the installation of a pan stirrer will begin to be financially viable if a speed n_2 (power $P_{st,2}$) is planned, above which the stirrer achieves financial benefits which justify the investment, maintenance and running costs. Further increasing speed increases the power demand with the square of the speed.

By suitable investigation, the position of a possible "optimum point" (speed n_3 ; power $P_{st,3}$) for the particular case in question may be found.

The use of the impurity balance to study historical change in sugar refining

By C. W. Davis*

This paper discusses an aspect of a recent historical study of the Pymont refinery of CSR Limited in Sydney Australia¹. This refinery has produced New South Wales' supply of refined sugar products since February 16, 1878.

For this study the thesis was advanced that an organizing concept for centralized sugar refining, and so for this factory site as a refinery, is that of an urban system for receiving raw sugar made remotely in the cane-growing areas, and for separating its impurities into various streams according to contemporary values, while retaining the pure sugar content. The aim was to present the pattern of change in such a way that it would be readily comprehensible, and would show a continuity through the more than one hundred years of Pymont refinery's existence.

This paper introduces the use of the impurity balance for studying historical change. The change observed is in relationships among the various streams of impurities in the refinery system. The pattern of change at Pymont is displayed graphically in Figures 1 and 2. It divides into phases marked by characteristic innovations: Start: 1880: Syrupy sugars.

Phase 1: 1880-1890: Golden syrup and char.

Phase 2: 1890-1920: Affination and boil-out (recovery boiling).

Phase 3: 1920-1940: Bone char.

Phase 4: 1940-1950: Golden syrup and boil-out.

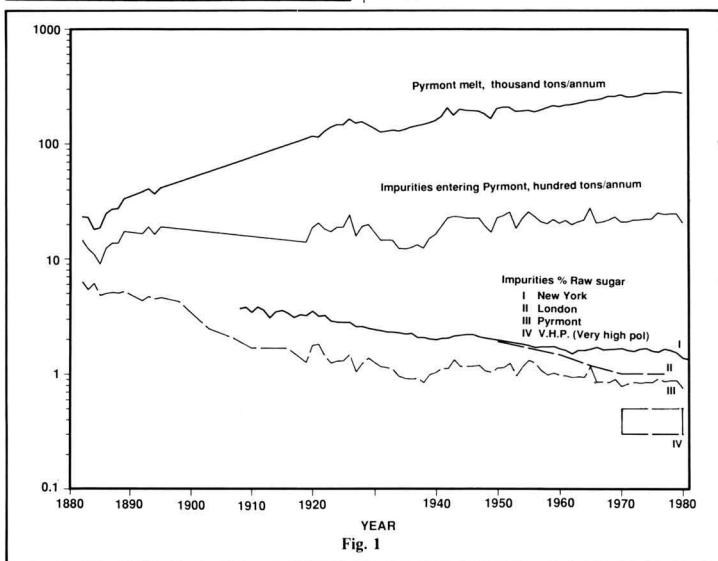
Phase 5: 1950-1970's: Boil-out and liquid sugar.

The phases can readily be traced in Figure 2. The pattern commenced with most of the impurities in the refined sugar and some removed by char as waste. In successive phases increasing amounts of impurity were extracted, instead, as golden syrup, then as by-product molasses, then to the drain as waste washed from char, then partly back to golden syrup, and finally as by-product molasses, aided by liquid



C. W. Davis

the V.H.P. (very high pol) figures for South Africa 1970-1980 are from Alexander⁶. The CSR figures were usable, either directly as presented, or after addition of the individual impurity figures. Other figures (except for V.H.P. sugar) were available as Pol only, with no indication of water



sugar in place of golden syrup.

As an introduction to discussion of impurity distribution within a refinery, some consideration was given to historical change in the first element of the impurity balance: the impurities introduced with raw sugar. The gross amount of impurity in a raw sugar is expressed as the sum of its constituents other than pure sucrose and water.

The reducing trend in impurity content of raws over the past hundred years is evident from the graphs presented in Figure 1. The Pymont figures were obtained from the Refinery Reports of CSR². The New York figures are from the Annual Reports of the New York Sugar Trade Laboratory Inc.³, and from extracts of these quoted in Willett and Gray's weekly *Journal*⁴. The English figures for 1950 to 1977 are from Bennett⁵, and

content. In these cases, Pol was subtracted from 100, and the result (impurities + water) divided by 1.4, a factor derived from inspection of full analyses available in the CSR Refinery Reports.

The Pymont graph shows a reduction in impurity content of raws from over 6% at the beginning to less than 1% today. The American graph exhibits a similar trend, although

*ex-General Manager — Technology, CSR Limited, Sydney, Australia.

1 Davis: "Pymont sugar refinery with particular reference to char". *Ph.D. Thesis* (University of Sydney), 1984.

2 *CSR Refinery Reports*, 1882-1910, 1919-80; also Powell: *Report*, 1923.

3 *Annual Reports to the Directors* (New York Sugar Trade Laboratory Inc.).

4 *Weekly Statistical Sugar Trade Journal* (New York, 1842 to approx. 1978).

5 *Proc. Meeting Sugar Industry Tech.*, 1978, 37, 386-395.

6 *ibid.*, 1981, 40, 130-143.

Cane sugar manufacture

Cane quality — potential and realized

D. I. T. Walker. *Proc. 1982 Meeting West Indies Sugar Tech.*, 74-93.

While results of varietal trials in both plant and ratoon crops in Barbados over a number of years have indicated average increases in cane pol resulting from newer varieties in the B series, factory results have fallen short of expectation. Even allowing for trial results in which the sampled cane was in an ideal condition and despite a high correlation between cane juice sucrose content and factory sugar recovery, the gap between factory and experimental results has widened. Examination of the situation has shown that increasing levels of extraneous matter, particularly in regard to fibre content, account for some two-thirds of the discrepancy, while the remaining third may be due to low-purity stale cane (although this requires further investigation).

The drying characteristics of bagasse

A. C. Pilgrim and D. R. McGaw. *Proc. 1982 Meeting West Indies Sugar Tech.*, 266-280.

Drying experiments were conducted in a chamber having a diameter of 6 in and a length of 6 in; heated air was evenly distributed over the entire cross-section of the tube by means of a series of perforated plates at the base of the chamber. The bagasse was spread out in a single layer over the base of a suspended flat-bottomed wire mesh basket constructed so as to fit as close as possible to the walls of the chamber without touching them. The drying air had a temperature in the range of 130-212°C and flowed at 8.1-13.9 ft/sec; the bagasse was of four particle sizes. The results showed that the rate of drying in the initial period was externally controlled by the rate of heat transfer to the bagasse and could be increased by raising the air temperature and flow velocity and

reducing the bagasse size. A period of constant drying rate may occur but lasts for only a short period of time. Most of the drying takes place during a period of falling rate, where the rate of internal moisture transfer is the governing factor. The standard semi-log drying equation was found to be valid for this region, showing that the drying rate may be increased merely by raising the temperature and reducing the bagasse particle size.

Improved preparation and utilization of bagasse as a fuel

G. Kroeker. *Proc. 1982 Meeting West Indies Sugar Tech.*, 290-299.

Means of increasing utilization of the energy potential of bagasse are examined, including pre-drying, which is shown to have a number of advantages by comparison with wet bagasse combustion. The merits of rotary drum dryers with centre fill are indicated. Controlled zone drying is an innovation in which an integrated system of flights maintains the wet fuel in specific zones in the dryer and controls the distance the particles fall; at the inlet, where the fuel is wettest and has the highest specific gravity, it is allowed to fall the greatest distance. As the moisture content falls, the distance the bagasse is conveyed horizontally as it falls increases. In single-pass dryers, it is important to establish a high humidity in the high-temperature area (initial zone) by recycling the exhaust gases and mixing them with the newly introduced hot gases.

Bagasse drying and densification

A. E. Kennett. *Proc. 1982 Meeting West Indies Sugar Tech.*, 300-313, 319. Details are given of the bagasse drying plant at Pepekeo sugar factory in Hawaii, and mention is made of densification studies from which it was concluded that a cubing plant would be economically better than a pelleting

plant, despite advantages of pellets over cubes. Information is also provided on the Babcock & Wilcox boiler and on bagasse storage equipment.

A review of some of the fundamentals of milling practices

S. Balkaran, B. Radhakishun and K. Khan. *Proc. 1982 Meeting West Indies Sugar Tech.*, 334-361.

The objectives of cane preparation are outlined and equipment and systems for achieving the aims are described. The major factors governing mill extraction are indicated, and the importance of mill settings demonstrated. Different methods of applying hydraulic pressure are described, and the interrelationships between mill hydraulics, roller grooving and imbibition discussed. Mill sanitation is also considered.

Barometric condensers

M. C. Hudson. *Proc. 1982 Meeting West Indies Sugar Tech.*, 362-372.

See *I.S.J.*, 1985, 87, 90A.

Trials with inserts in mill coupling boxes

C. A. Sylvester. *Proc. 1982 Meeting West Indies Sugar Tech.*, 373-383.

Trials at two factories owned by the Guyana Sugar Corporation are reported in which various materials were used as inserts in cast iron boxes serving to couple the final gear shafts, tail bars and top roller shafts in cane mills; the aim was to find the most suitable material to extend the useful life of the boxes. The materials tested were Lamigamid B (a polyamide material widely used for the shoes of couplings in steel rolling mills), Laminex (a moulded compound of cotton and man-made fibre which has greater strength properties than Lamigamid B and is primarily intended for roll neck bearings), brass, mild steel, Perplas (a nylon material) and

Nylacast Oilon (an oil-impregnated nylon-based material). Results from seven crops during which nearly 1.2 million tonnes of cane were crushed in 11,800 hours showed that the last-named material was the most suitable, and it was planned to extend its use to other sugar factories operated by the Corporation, although further trials with Lamigamid B were also recommended in view of its similarity in performance to Nylacast Oilon.

A brevity on dextran

E. Shah and J. Abdool. *Proc. 1982 Meeting West Indies Sugar Tech.*, 384-391.

Aspects of dextran briefly discussed include: its chemical nature; formation in the cane and during factory processing; its effects on syrup viscosity, sugar crystallization and process control; its balance in the sugar factory; and the prevention of dextran formation.

Trash processing and its effects on recovery at HCPC

E. A. Kennett. *Proc. 1982 Meeting West Indies Sugar Tech.*, 392-403.

Trash washing and milling at the Pepekeo factory of HCPC in Hawaii are discussed. Modifications to the washing plant are described, and the economics of trash processing analysed. It is shown that trash processing can increase the overall sugar output while also providing extra fuel, but in the short term the crushing rate of the factory was adversely affected by the additional fibre to be milled, the water adhering to the trash, the additional imbibition water involved and the lower purity juices. However, on balance, trash milling is favoured, and in a discussion of the paper, the author mentions adoption by some factories of trash milling together with cane, as against separate trash and cane milling.

Application of ion exchange to the sugar industry (review)

W. A. Mellowes. *Proc. 1982 Meeting West Indies Sugar Tech.*, 451-466.

After a brief review of ion exchange as decolorizing and deliming means, experiments on clear juice treatments are reported. Despite the high performance achieved, attention is drawn to the risk of inversion and to the costs of regeneration with brine. Invert syrup manufacture by ion exchange was also investigated, and the possibility of producing a 53°Bx syrup by treatment with 11 bed volumes indicated. Decolorization of the product varied with the bed volume. Tabulated results show removal of up to 98.9% of the Ca⁺⁺ ions using a series of exchange columns. The costs of a plant for invert syrup manufacture are briefly calculated.

Combustion characteristics of dried and pelletized bagasse

J. F. Stubington and H. Fenton. *Combustion Sci. Technol.*, 1984, 37, (5/6), 285-299; through *S.I.A.*, 1985, 47, Abs. 85-603.

The combustion of dried bagasse in the forms of loose fibre, densely packed fibre (to simulate the condition after baling), small (8 mm diameter) pellets and large (90 mm diameter) pellets was studied. Tests were carried out in a laboratory-scale pot furnace to simulate underfeed combustion, as on a travelling-grate stoker. The large pellets ignited rapidly on the surface, and each pellet burned slowly as an individual lump; a bed depth >700 mm would be necessary to reduce primary air to the stoichiometric rate. The other three forms exhibited the characteristic ignition and burn-out stages at low air rates. Their maximum combustion rates were ignition-limited and decreased as the bulk density increased. Since the corresponding primary air flow rates were less than or equal to stoichiometric, their combustion at the maximum rate would be practicable. The ash from the small pellets fused into clinker, so that in existing bagasse boilers they should be fired only as a

supplement to wet bagasse at temperatures below the ash fusion temperature.

Conceptual design of a solar cogeneration facility at Pioneer Mill Co. Ltd.

Anon. *Rpt. US Dept. Energy*, 1981, (DOE/SF/11432-TI), 159 pp; through *S.I.A.*, 1985, 47, 85-608.

A detailed description is given of an investigation carried out by Bechtel Group Inc. with the aim of demonstrating that a solar central receiver system could be integrated with the existing system for cogeneration of steam and power at this Hawaiian sugar factory. The factory operates 40 weeks/year, and during the off-season power is required for irrigation. Bagasse currently supplies 76% of the fuel requirements, and oil the remainder. A conceptual design is presented of a system which would enable the use of oil to be almost eliminated. It would comprise essentially a collector field containing 785 heliostats each with a reflective area of 52.8 m², a tower-mounted receiver with output of about 26 MW, and a pipeline connecting the receiver to existing plant and controls; the working fluid of the receiver would be water-steam.

Suspension-type bagasse dryer at Central Azucarera Don Pedro

P. Morales. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 102-109.

Although the installation of a diffuser in 1970 to operate in conjunction with the 17-roller tandem increased the cane milling capacity and extraction, it also caused an increase in bagasse moisture content and hence in supplementary fuel consumption, so that it was decided to install two suspension-type bagasse dryers, each of 17.5 tonnes/hr throughput and designed to reduce the moisture content from 56% to 35%; boiler flue gas was to be used as heating medium. A new boiler was also

installed. Details are given of the dryers and of test runs, together with teething problems. Tabulated data for one of the dryers showed a reduction in moisture content from 50.7-55.8% to 14.5-24.4% at an hourly throughput of 23.16-26.79 tonnes. The fuel consumption was reduced to 1.23 litres oil per tonne of cane compared with 6.36 litres/tonne as the average for 1970/78 and a peak of 7.88 litres/tonne in 1978/79.

Experiences in cane handling and gantry operation in UPSUMCO

E. G. Burgos. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 110-117.

Details are given of modifications to the cane handling system, which includes a gantry station, at United Planters' Sugar Milling Co. Inc. after a number of problems had been encountered with the previous system. The innovations have resulted in more stable feeding of the cane to the mills, with a consequent rise in milling capacity and considerable reduction in losses.

Cane feeding and cane preparation experiences in UPSUMCO

E. G. Burgos and N. M. Posadas. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 118-124.

Problems in cane feeding and preparation at UPSUMCO included frequent choking of the cane equalizer and of the shredder chute, bending of feed carrier slats, failure of feed carrier runner beams cause by chain derailment, and overloading of the equalizer drive and of the cane cutters. Remedial measures are described and their positive effects indicated.

Five-roll milling

G. Carr and B. Krummel. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 125-130.

A detailed description is given of the two-roller continuous pressure feeder developed in Queensland for use in conjunction with a three-roller mill. Advice is offered on installation of the feeder on an existing mill and on operation of the resultant five-roller unit.

Gravity chamber-wet scrubber air pollution control device

G. N. Flordeliz. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 131-134.

The system used at the Santa Catalina factory of Tolong Sugar Milling Co. for removal of solid particles from boiler flue gas includes a collector with gravity chamber, which is an integral part of the boiler, and a wet inertial scrubber. Advantages and disadvantages of the system are indicated.

Liming system — experiences at UPSUMCO

A. N. Racal. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 136-138.

Because of fluctuations in the nature and behaviour of juice from cane supplied by some 2000 farmers using varying field practices and growing different varieties, the UPSUMCO factory has to use flexibility in its liming. Problems encountered included overliming as a result of uncontrolled lime application in the mixed juice tank, frequent clogging of lime piping, and inaccurate control of heated, limed juice pH. The improvements that followed remedial measures are described.

Clarification experiences at SONEDCO

R. M. Gicana. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 139-147.

After failure of the single continuous clarifier at the Kabankalan factory of Southern Negros Development Corp. to provide a brilliant, high-clarity juice

during periods of a high crushing rate and/or muddy cane supply, it was decided to install a second clarifier of identical dimensions. Tests showed that a longer retention time than recommended (e.g. about 5 hours) contributed to higher juice clarity, the favourable effects of which on subsequent processing offset the losses caused by the longer retention.

Experiences in clarification and filtration at UPSUMCO

J. E. N. Villaluz. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 148-151.

The system at UPSUMCO includes removal of suspended impurities followed by fractional cold and hot liming of mixed juice (to pH 6.4-6.6 and 7.8-8.0, respectively), or one-stage hot liming to pH 7-8, heating to 102-104°C, clarification and vacuum filtration of the mud; the filtrate (not suitable for evaporation because a fine mud suspension is still present) is recycled to the liming tank to be mixed with incoming juice. The benefits provided by the scheme are listed.

BISCOM's caustic soda-hydrochloric acid cleaning of evaporator sets

R. R. Maalat. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 152-155.

A brief description is given of the NaOH-HCl evaporator cleaning procedure used at Binalbagan-Isabela Sugar Milling Co. Inc. The positive results of the cleaning are indicated and the economics calculated.

Cane Purchase System (CPS) — an overview

C. T. Cabanilla. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 243-251.

The cane payment system intended for introduction in the Philippines is discussed, and methods of cane analysis are described.

Beet sugar manufacture

A new continuous evapo-crystallization tower for white sugar and low-raw products

E. D. Bosse. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 16 pp.

Descriptions are given of the BMA continuous evapo-crystallization gravity-flow tower and of a pump specifically designed to transfer the massecuite from the bottom chamber to a mixer¹. The design parameters of a crystallization tower for an hourly throughput of 100 tonnes of white sugar massecuite are given as an example. The crystal size distribution in a low-grade massecuite boiled in a 3-, 4- and 6-chamber tower is shown in the form of a histogram, which demonstrates that there is only slight improvement in uniformity with increase in the number of chambers, so that 3- or 4-chamber operation will be adequate for most cases. Adjustment to the quantity and size of the seed crystals will provide for changes in the final crystal size requirements. A low massecuite level above the calandria in each chamber permits a temperature difference between the massecuite and steam to be lower than in a batch pan, so that a steam pressure as low as 0.7 bar (equivalent to a temperature of 90°C) can be used; measurements during two campaigns showed heat transfer coefficients of 300 and 450 W/m²/°K in the top and bottom chambers of a 4-chamber unit. Steam consumption at the sugar factory in question was 5% lower than with batch boiling because of the absence of need for steaming-out after every cycle, the use of high raw product as seed for white sugar, replacement of large quantities of wash water with wash syrup in the centrifugals, and the possibility of using a feed syrup of high Brix. Details are given of: the seeding technique used; the automatic controls for such parameters as massecuite level, Brix and power consumption of the massecuite stirrer in each chamber

(used instead of Brix as reference input so as to protect the stirrer drives); materials flow and valve apertures; boiling-out (which may be carried out in individual chambers without having to stop operation of the entire unit); and crystal size distribution with 3- and 4-chamber operation (showing only slight difference) when one chamber is being cleaned. Performance data are given for an evapo-crystallizer boiling 50-60 tonnes/hr of white sugar massecuite, showing an average Brix at dropping of 92.5-93.5°, a crystal content of 58% and a mean crystal size of 0.7-1.2 mm, with ≤0.5% of crystals measuring <0.2 mm, and ≤3% of crystals measuring >2.0 mm.

A technological-microbiological examination of sugar manufacture

L. Kerekes. *Cukoripar*, 1985, 38, 29-34 (*Hungarian*).

After a brief survey of the literature on sugar factory microbiology, the author reports investigations conducted in 1978/81 in which samples of juices, *A*-massecuite and white sugar were incubated at 55° and 62°C. Results, statistically analysed, showed that the average count of acid spore-forming bacteria was higher at 62° than at 55°C with the exception of thin juice; the counts were very much higher in raw juice and *A*-massecuite (taken from the pan and mingler) than in the other products, while those in white sugar were higher than in the juices and massecuite sampled after the centrifugal. While yeasts and moulds were absent from white sugar, they did occur (but only at relatively low levels) at some stages in the sugar house, whereas aerobic mesophiles dominated at all stages (including white sugar); aerobic thermophiles also occurred at all the stages studied, but at a lower level, while the ratio of acid spore-forming to total thermophiles rose in the *A*-massecuite centrifugal and in the

white sugar. It is concluded that a secondary bacterial infection occurs at the sugar end that is unconnected with the micro-organisms in the juices at the beet end, and statistical analysis of further investigations of this re-infection yielded a regression equation relating log increase in white sugar aerobic mesophiles to the number of days since the sugar was manufactured ($r=0.775$).

Some thoughts on the classical method of juice purification

H. Schiweck, T. Cronewitz and G. Witte. *Sugar J.*, 1985, 47, (11), 18-22.

The aims of juice purification are set out, and process parameters having a major effect on performance are indicated. The question of residence time distribution in liming is examined, and residence time curves plotted for various systems. Heat loss in carbonatation is discussed and a flow scheme given of a juice purification system used in factories of Süddeutsche Zucker-AG. It incorporates cold preliming plus main liming at 62.5°C, hot liming at 85°C and a second liming at 96°C before 2nd carbonatation. Filter-thickeners are used to give a thickening factor of 1.5-1.6 and a juice CaO content of 100-140 g/litre. In five out of seven factories, Hoesch automatic filter presses have replaced rotary filters to remove the mud at a filter cake dry solids content of >70% and a sugar loss of <0.2% on beet. Sweetening-off water consumption is only 80% on mud dry solids. The filter cake may be spread over the land as a fertilizer without the need for further drying. Pumping tanks for transfer of carbonatation juice to the filters are provided with juice "chutes" down which the incoming juice flows gently to come to rest on the surface of the juice already present in the vessel; this ensures that the first juice in is the first juice out.

1 *I.S.J.*, 1985, 87, 80.

Starch based sweeteners

Performance of a zigzag fluidized bed as an immobilized enzyme reactor

K. Nakamura, H. Kumagai and T. Yano. *Agr. Biol. Chem.*, 1984, **48**, (5), 1131-1137; through *Food Sci. Tech. Abs.*, 1985, **17**, (3), Abs. 3 L 16.

Glucose isomerization, catalysed by immobilized glucose isomerase, was analysed with a first-order rate equation. The overall reaction was measured in a batch reaction, and the effectiveness factor could be separated by use of the effective diffusion coefficient which had been measured. The immobilized glucose isomerase was used in a reactor consisting of zigzag inclined channels. The particles of the immobilized enzyme were fluidized stably at flow velocities of up to one-tenth of the particle terminal velocity. The performance of the fluidized bed reactor was well described by the model of axial dispersion at an intermediate flow velocity, and the attainable degree of isomerization was >50%. Conversion, however, became worse at a liquid velocity <0.5 cm/min.

Conversion of liquefied starch into glucose using a novel glucoamylase system

J. J. M. Labout. *Starch/Stärke*, 1985, **37**, 157-161.

Alpha-amylases liquefy starch to dextrins which are then saccharified by means of glucoamylase to yield high-glucose syrups. However, laboratory experiments on a number of commercial and non-commercial glucoamylase preparations showed considerable fluctuations in performance in terms of maximum glucose yield and saccharification times, and possible causes are suggested, including the presence in some preparations of amylolytic enzymes other than glucoamylase which contribute to the saccharification process. The kinetic theory of solubilized starch hydrolysis by

glucoamylase is discussed, and HPLC of glucoamylase preparations reported. The experiments revealed one commercial preparation, Amigase GM (manufactured by Gist-Brocades N.V.), that contained no transglucosidase, an enzyme known to contribute to formation of isomaltose and other α -1,6-linked saccharides during starch saccharification and thus lead to a lower glucose yield. The α -mylase isolated from Amigase GM was incubated using soluble starch as substrate, and maximum activity found to occur at pH 3.5-5.0, indicating that it is a true acid amylase (AA); the optimum temperature was 65-70°C. When added to glucoamylase in varying quantities, the AA increased the maximum glucose yield and the rate of glucose production; the saccharification time fell with increase in the amount of AA added. Increasing the glucoamylase dosage also increased the rate of hydrolysis, but the glucose peak remained unaffected; however, a higher AA concentration can be used to compensate for a reduction in the glucoamylase dosage, which is of benefit in reducing the amount of isomaltose formed. Moreover, use of glucoamylase in conjunction with substantial amounts of AA raises the dry solids content and thus reduces evaporation costs while giving maximum glucose yields comparable to those obtained under normal condition.

Determination of glucoamylase in culture filtrates containing other amylolytic enzymes

C. Kuek and D. K. Kidby. *Starch/Stärke*, 1985, **37**, 161-162.

An improved method is proposed for the determination of glucoamylase in the presence of other amylolytic enzymes. The method uses low molecular weight dextran as specific substrate, while the glucose-producing activity of the enzyme used for starch hydrolysis is quantified on the basis of a glucose oxidase-peroxidase-

chromogen reaction. Linearity was established between enzyme concentration and optical density in a range that more than covers the concentration at which glucoamylase is likely to occur in culture filtrates. The method is of advantage in not requiring purification of the culture.

Purification of starch hydrolysates by ion exchange chromatography

E. Berghofer, W. Tauber, H. Klaushofer and W. Steyrer. *Starch/Stärke*, 1985, **37**, 163-172 (German).

Experiments on ion exchange chromatographic treatment of starch hydrolysates are reported in which Lewatit TSW 40 was used in three forms (Na^+ , Ca^{++} and H^+), of which the Na^+ form proved the most suitable. Important properties of the resin determined included the pore volume, interstitial volume and distribution coefficients of glucose, maltose and NaCl . Since ion exchange chromatography suffers from the disadvantage of yielding highly dilute fractions, attempts were made to obtain fractions of the highest possible dry solids content by recycling the eluate. A procedure was developed which permitted glucose fractions of 23-25% dry solids to be obtained at a purity of approx. 93-95% and 88.7% yield.

Heat transfer plate speeds tank car unloading

R. F. Ellis. *Food Processing* (Chicago), 1985, **46**, (1), 170-171; through *S.I.A.*, 1985, **47**, Abs. 85-690.

Uni-Temp tank cars have been purchased by Archer Daniels Midland for shipment of HFS and other corn syrups in the USA. They incorporate a sloping heat exchange plate in the floor of the car, which enables HFS (a solid at low temperatures) to be rapidly liquefied for unloading, while avoiding non-uniform heating which would lead to degradation.

Laboratory studies

The refractive index of aqueous solutions of sucrose-invert sugar mixtures

A. Emmerich and K. J. Rosenbruch. *Zuckerind.*, 1985, 110, 285-291 (German).

Details are given of the procedure used in the preparation of sucrose-invert sugar mixtures and in measurement of their refractive indices at 589.3 nm and 20°C; tabulated values are given for mixture dry solids contents of 20-70% and an invert component of 25, 50 and 75%, and comparison made with values found for pure sucrose and invert sugar^{1,2}. At a dry solids content of 50%, the new measured values deviate from the earlier values by only $\pm 2 \times 10^{-6}$, which corresponds to an error of only $\pm 0.001\%$ in dry solids determination. With the sucrose-invert sugar mixtures there was a distinct deviation of the refractive index from the linear mean of the indices for pure sucrose and pure invert sugar which increased with concentration; at 20°C and 70% total dry solids of a 1:1 mixture, the deviation was $+42 \times 10^{-6}$, corresponding to an apparent increase in dry solids of approx. 0.018%. Sensitive instruments, such as dipping refractometers, can measure this difference, but not Abbé-type refractometers or other instruments having an accuracy of only $\pm 1 \times 10^{-4}$. On the other hand, correction formulae have been derived which are relatively easy to use, while a table of corrections has also been calculated for refractometric dry solids of 20-85%. Tabulated corrections are also given for temperatures of 15°, 25° and 30°C in air where the invert sugar component is 25, 50 and 75% of the mixture and the total dry solids concentration is 20-70%.

Questions on the principle of viscometry of sugar massecuites, particularly of low-grade massecuites

T. Szekrényesy, L. Parádi, K. Hangyál

and K. Liktör. *Zuckerind.*, 1985, 110, 296-302 (German).

The concepts of dynamic (differential) and apparent viscosity are explained and the effect of dispersed phase concentration on viscosity noted. Of the various means of measuring viscosity, the most suitable is considered to be the rotary viscometer, and the theory of rotary shear and torsion on which it is based is expounded. Sources of error in rotary viscometry are discussed in turn, namely (1) the additional braking moment that occurs on the end-faces of the rotating cylinder, (2) the film of massecuite adhering to the wall of the cylinder and thereby altering its effective radius, (3) variations in the rate of shear at different points in the viscometer, (4) a reduction in the crystal content in the vicinity of the inner cylinder, probably resulting from centrifugal effects and increasing with the initial crystal content, and (5) effect of axial linear flow on the observed moment and hence on the calculated viscosity. Of these sources of error, only (1) and (3) gave errors of such magnitude in the investigations that allowance had to be made for them. To allow for the end-face effect, the cylinders were calibrated at several points using standards of varying viscosity; since errors caused by variation in the shear rate could not be completely eliminated, data were based on measurements obtained with one and the same pair of cylinders. Details are given of the calibration procedure and of the dimensions of the cylinders used in the Rheotest Type 2 instrument. Other factors affecting viscosity measurements include preparation and storage of the massecuite sample, the formation of bubbles, evaporation of water from the sample during viscosity measurement (of trivial importance), sedimentation of the crystals, the measuring gap between the two cylinders (hence the relative radii of the cylinders), the rate of shear chosen (which is governed by the speed of rotation of the inner

cylinder), the occurrence of stationary shear after a given time and (in the case of massecuites of high crystal content) lasting 20-30 minutes, the wall effect (whereby the moment observed in the vicinity of the inner cylinder and hence the calculated viscosity are smaller than would be the case with a uniformly distributed massecuite because of reduction in the crystal content caused by alignment of the crystals or by the centrifugal force acting on them), variation in the instrument factor, and the pattern of flow of the massecuite.

Control of export sugar (analytical and statistical control)

J. Jaddoo. *Proc. 1982 Meeting West Indies Sugar Tech.*, 320-333.

The Sugar Industry Research Institute central laboratory in Jamaica was established in 1981 to monitor sugar quality and to pay manufacturers on the basis of its results. Whereas in 1980, there had been a discrepancy of about 900 tonnes of 96° sugar between SIRI laboratory analyses and those of factory laboratories, the difference in 1981 was only 8 tonnes. The procedure used in analysis of sugar samples is described, and the question of measuring accuracy is discussed, particularly in regard to polarimetry.

Phosphate analysis

A. C. Pilgrim. *Proc. 1982 Meeting West Indies Sugar Tech.*, 441-450.

Details are given of a method for determining the phosphate content in cane juice in which molybdophosphoric acid formed by reaction between the inorganic phosphates and ammonium molybdate (added as an acid solution) is reduced to molybdenum blue by ascorbic acid (which gives a more stable blue colour that is less subject to interference than when stannous chloride is used as reducing agent).

1 Rosenbruch: *Proc. 16th Session ICUMSA*, 1974, 144-156.

2 Idem: *Proc. 18th Session ICUMSA*, 1982, 191-203.

By-products

A new process of xylose production from bagasse for ethanol fermentation

W. F. Yee, L. H. Wang, M. C. Hsie and S. L. Sang. *Taiwan Sugar*, 1985, 32, 12-17.

A new process developed for continuous preparation of bagasse hydrolysate containing approx. 17% xylose (as against 2-5% obtained by conventional means) is described, in which the hemicellulose was prehydrolysed at 100°C with pure HCl at 1.5% on bagasse dry weight and at a low liquor ratio of 0.8, and the prehydrolysate extracted with water at 100°C in a special counter-current diffuser. The residual acid content in the hydrolysate was 2-3% compared with 18-19% normally. HPLC revealed that 82.5% of the sugars was xylose, 10% was arabinose and 7.5% glucose.

Diversification of the sugar industry for maximum utilization of sugar cane

K. C. Rao. *Maharashtra Sugar*, 1985, 10, (3), 71-73, 75.

Utilization of factory waste products and of cane trash is reviewed.

The use of counter-diffusion technology for desalting molasses

D. W. Scott. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 13 pp.

The process described for desalting molasses to be used as animal fodder involves a membrane element containing a large number of hollow fibres (in the example cited, an element of 1.8 m² surface area contains 15,000 fibres, each 1 ft long with an internal diameter of 200 µm). As the molasses flows through the fibres, its salts (e.g. sodium, potassium and chloride) selectively pass through the membrane into "stripping" water flowing around the outside of the fibre counter-current to the molasses flow. So as to prevent

fouling of the membrane and gel polarization, the membrane is such that water passes through the walls of the fibre to the inside (the lumen) and thus continuously washes the inner surface. Since the flow of salts takes place against the incoming flow of water, the process is termed "counter-diffusion", and the hollow fibres function as support material for the immobilized crystalline lattice. The continuous washing permits molasses of 50°Bx to be pumped through the fibre bundle. The operation of a desalting plant embodying the technique is described with the aid of a diagram, and important parameters are indicated, based on cane molasses from Australia. The benefits of molasses desalting are indicated.

Developments in fuel alcohol technology

D. R. McGraw and L. A. Shah. *Proc. 1982 Meeting West Indies Sugar Tech.*, 417-423.

The literature on developments in alcohol manufacture by fermentation is reviewed. The possible use of substrates other than cane juice and molasses is examined, covering whole cane, bagasse and cane tops. A two-stage process being developed in Guatemala involves loading the fermenter with cane chips, water and inoculum; an expansion of the system includes pith as separated by the Tilby type of equipment. Results have shown ethanol levels of 12.9-40.0 g/litres after the 1st cycle and 42.0-53.0 g/litres after the second, depending on the strain of yeast used. Sugar consumption is generally >98%, and neither the presence of a solid phase nor particle size appeared to affect fermentation. Since extraction and fermentation are carried out simultaneously, there is no need for mills, although the fermentation equipment will need to be larger than with the conventional process. Developments in bagasse fermentation have been largely concerned with the hydrolysis stage,

and some of the processes under investigation are mentioned. While distillation techniques for the removal of water from the fermenter product are well established, efforts have concentrated on optimization of the initial atmospheric concentration stage and on minimization of energy consumption, for which vapour recompression is particularly suitable. For high-analysis alcohol (of approx. 99.5% concentration by weight), azeotropic distillation using pentane and extractive distillation using gasoline were comparable in terms of dehydration and gave lowest operating costs, although a number of process options have proved more favourable in regard to energy consumption than the conventional method; solvent extraction and adsorption showed significantly reduced energy costs, but the technology has not yet reached a commercial stage. The ATPAL low-energy system developed by W. S. Atkins Group integrates the fermentation and separation stages to a certain degree by introducing an intermediate flash stage which provides liquid recycle to the fermenter, and vapour feed to a distillation stage at approx. 30% ethanol by weight. Since tests had shown that alcohol containing up to 3% water by volume will blend satisfactorily with gasoline, so that it is not necessary to produce 99.5% ethanol, the process includes only a single vacuum distillation stage, with vapour recompression suggested to reduce energy costs. Mention is also made of the micro-distillery developed in Brazil, and of vinasse treatment and disposal.

Cane tops as a source of ethanol

W. A. Mellowes. *Proc. 1982 Meeting West Indies Sugar Tech.*, 424-428.

Laboratory studies are reported on alcohol manufacture from cane leaves and tops. Since hydrolysis with dilute acid at 100°C gave a relatively low yield of reducing sugars, a method was

used involving prehydrolysis with sulphuric acid at 5% concentration and hydrolysis with an 8% acid concentration; this gave a reducing sugars yield of 23.8 g/litre.

Fermentation of the hydrolysate yielded an ethanol concentration of 1.55% at an estimated yield of 176 litres of 95% alcohol per tonne of cane leaves. The economics of a plant to produce 3.2×10^7 litres of ethanol per year from 187,000 tonnes of cane leaves are discussed.

Vinegar production from clarifier mud

W. A. Mellowes. *Proc. 1982 Meeting West Indies Sugar Tech.*, 429-440.

Experimental manufacture of vinegar from clarification mud is reported. The stages included separation of the sugar extract from the mud by decanting, followed by sterilisation by boiling; the cooled solution was then inoculated with yeast and fermented, after which distillation was used to remove any alcohol that formed. A second fermentation using a column packed with bagasse or with sweet potato made use of *Acetobacter* sp. Details are given of vinegar yield, quality and purification, and the capital and production costs are briefly calculated for a plant processing 3300 tonnes of mud annually and yielding 175 ml of vinegar per kg.

Kinetic study of nitrite inhibition during alcoholic fermentation of beet molasses

A. Glacet, F. Letourneau, P. Leveque and P. Villa. *Biotechnology Letters*, 1985, 7, (1), 47-52; through *S.I.A.*, 1985, 47, Abs. 85-759.

Beet molasses wort containing 140 g sucrose/litre was fermented with *Saccharomyces cerevisiae*, either without added nitrite or after addition of 200-400 ppm nitrite. The latent period of fermentation became longer

with increasing nitrite concentration; after this period, the biomass and ethanol outputs increased linearly, the rates of increase being independent of initial nitrite concentration. It was shown that nitrite ions were oxidized to nitrate during the latent period; this was due to the action of yeast, and not to any chemical reactions between nitrite ions and molasses components.

Effect of protein source and sex on the digestibility indices of pigs fed final molasses

J. Ly and R. Díaz. *Cuban J. Agric. Sci.*, 1984, 18, 277-281.

Experiments showed that final molasses digestibility was independent of the sex of the pigs studied, but was greatly influenced by the source of protein in the ration.

Production of protein and fatty acids in the anaerobic fermentation of molasses by *E. ruminantium*

K. I. Mehta and C. D. Callihan. *J. Amer. Oil Chemists' Soc.*, 1984, 61, (11), 1728-1734; through *S.I.A.*, 1985, 47, Abs. 85-768.

An anaerobic fermentation process for the production of single-cell protein was investigated. Cane molasses was pretreated by centrifuging and diluting to 2.85% total sugars by weight, and supplemented with 1.5 g yeast extract and 3 g $(\text{NH}_4)_2\text{HPO}_4$ /litre; it was fermented by *Eubacterium ruminantium* at 37°C. The maximum rate of protein production, 0.326 g/litre/hr, occurred when the pH was 6.2 and retention time 5-7 hr. Biomass yield (on sugars consumed) was 10.7% after 5 hr and 13.9% after 15.5 hr. Carbohydrate conversion was 82-99%. Volatile fatty acids were also formed, mainly acetic and *n*-butyric acids. Two kinetic models were used to fit the experimental data. The amino-acid composition of the cell protein is shown.

Factors in acid-treated bagasse inhibiting ethanol production from D-xylose by *Pachysolen tannophilus*

N. E. Watson, B. A. Prior and P. M. Lategan. *Enzyme & Microbial Technol.*, 1984, 6, (10) 451-456; through *S.I.A.*, 1985, 47, Abs. 85-761.

The fermentation of D-xylose, the major component of bagasse hemicellulose, to ethanol by the yeast *P. tannophilus* was inhibited by various substances produced or released during acid hydrolysis of the bagasse or during fermentation. These included Fe, Cr, Cu, Ni, acetic acid, furfural and ethanol; concentrations which caused inhibition were measured. Removal of the metals by treatment with ion exchange resin enabled the sugars to be fermented to ethanol; however, D-xylose utilization was slow and incomplete (unlike that of D-glucose). Ethanol concentrations up to 4.1 g/litre and ethanol yields up to 32% (based on D-xylose + D-glucose utilization) were obtained.

Molecular sieve carbons from agricultural wastes

A. M. Youssef. *Surface Technol.*, 1981, 13, (1), 83-89; through *S.I.A.*, 1985, 47, Abs. 85-793.

Activated carbons were prepared from bagasse by impregnation with solutions containing 10, 25 and 50% ZnCl_2 , heating at 200°C for 6 hr, then carbonizing at 600°C. Alternatively, the bagasse was gasified at 900°C with steam to burn-outs of 12, 25 and 52%. Non-activated carbons exhibited molecular sieve properties but had very low capacities. Activation with ZnCl_2 or with steam to low burn-outs improved the adsorption capacity, and the molecular sieve action was retained. Steam gasification to high burn-outs resulted in loss of the molecular sieve property; the pore structure became accessible to adsorbates of various sizes.

Patents

UNITED KINGDOM

Continuous separation system

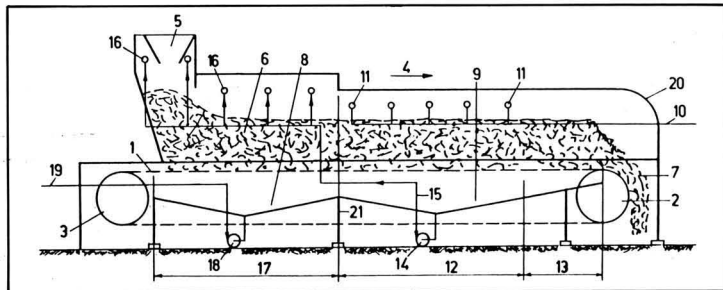
Unice Machine Co., of San Francisco, CA, USA. **2,085,746**. October 20, 1980; May 6, 1982.

See US Patent 4,256,581¹.

Prescalder

Extraction De Smet S.A., of Edegem, Belgium. **2,086,757**. November 6, 1981; May 19, 1982.

Before being fed to a diffuser, beet cossettes 6 on a conveyor 1 are treated with hot juice from the diffuser, introduced through pipe 10 and distributed by sprayers 11, passing to collector 9. The partly cooled juice is delivered by pump 14 and pipe 15 to the second set of sprayers 16 and distributed upon the cossettes, draining through into compartment 8 and thence through pipe 19. The juice flow rate, the cossette layer height and the conveyor speed are so adjusted that the juice temperature at the outlet 19 is at the most 40°C and preferably about 30°C. The cossette layer height on the conveyor 1 is at least 1.5 metres and preferably about 2 metres.



Purifying sugar juice

A/S De Danske Sukkerfabrikker, of Copenhagen, Denmark. **2,090,861**. January 14, 1982; July 21, 1982; March 21, 1984.

Raw juice is filtered before addition of 100 ppm FeCl₃ and 0.024% H₂O₂, whereby oxidation and complexing take place at 60-70°C and pH 6.8-7.2

to convert low molecular weight non-sugars (mainly phenolics such as 3,4-dihydroxy phenylalanine) into higher M.W. compounds and to solubilize high M.W. compounds such as pectins and proteins. The juice is then heated and treated by ultrafiltration at 80-90°C and pH 7 (6.5-6.7). Water is added continuously or batchwise to the concentrate after a major part of the juice has been removed as permeate, and the diluted concentrate is further concentrated by ultrafiltration. Addition of 0.05% CaO to the permeate to adjust the pH to 8.8 is followed by heating to 100°C, at which temperature the juice is maintained for 15 minutes; the resultant precipitate is then removed by filtration and 600 ppm Na₂SO₃ is added to the filtrate to form a thin juice.

Production of L-glutamic acid by fermentation using a *Brevibacterium* or *Corynebacterium* mutant

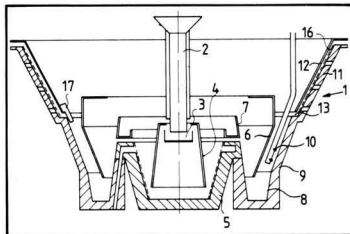
Ajinomoto Co. Inc., of Tokyo, Japan. **2,093,020**. December 22, 1981; August 25, 1982; July 18, 1984.

A mutant of the *Brevibacterium* or *Corynebacterium* genus (*B. lactofermentum*, *B. flavum*, *C. glutamicum* or *C. acetoacidophilum*) is aerobically cultured at pH 6-8 (6.5-8.0) and 30°C (30-38°C) for 20-80 (24) (30) hours on a medium containing, as carbon source, glucose, sucrose, molasses, etc.

Continuous centrifugal

Braunschweigische Maschinenbauanstalt AG, of Braunschweig, Germany. **2,093,364**. February 11, 1982; September 2, 1982; October 17, 1984.

During the washing operation in centrifugals, a large part of the wash liquid hitting the sugar layer is atomized mechanically and rebounds; this means that impurities dissolved by the liquid from the crystal surfaces are also atomized and rebound. In continuous centrifugals, this contaminated mist is caught by the violent air current that passes across the sugar surface from the narrow towards the wide end of the frusto-conical basket, and is carried to the drying zone where it recontaminates the sugar; the very short period of retention of the sugar in the individual zones of the basket is not sufficient to allow the recontaminating impurities to be eliminated.



To prevent a second contact between the wash liquid and the sugar, the inside of drying stage 11 is provided with a cover 12 which substantially conforms to the shape of the basket; at the same time, the diameter of drying stage 11 increases abruptly like a step. The bottom edge of cover 12 is aligned with the generating line of the inner surface of washing stage 9 or may slightly recede outwards. In order to get into drying stage 11, the sugar drops from the top edge of washing stage 9 and must pass through a slot 13 between the top edge of stage 9 and the bottom edge of cover 12. This slot is as narrow as possible to prevent any of the contaminated wash liquid mist from entering the interspace 16

¹ I.S.J., 1983, 85, 154.

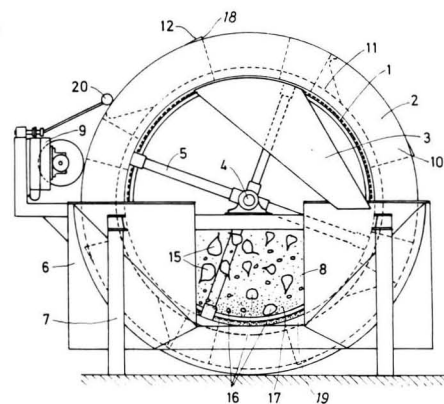
between cover 12 and the sugar in stage 11; the slot may be altered to suit conditions by means of an adjusting ring. Cover 12 separates the mist which, together with the wash liquid condensate and sugar lumps too big to pass through slot 13, passes up cover 12 and is discharged from the centrifugal, possibly by means of suction. The web-shaped supports 17 by means of which cover 12 rests on stage 9 may be in the form of fan blades which will produce a sufficiently strong air current to direct the mist past slot 13.

Recovery of purified monosodium glutamate

Ajinomoto Co. Inc., of Tokyo, Japan. 2,095,232. January 29, 1982; September 29, 1982; February 20, 1985.

A glutamic acid broth obtained by fermentation of cane molasses (high-test molasses) is concentrated and adjusted to pH 3.2 to crystallize the crude acid, which is then dissolved in NaOH or Na₂CO₃ and the solution decolorized with active carbon. After concentration to yield crystalline pure monosodium glutamate, the crystals are separated from the mother liquor. Further purification is carried out by ion exchange.

Beet-stones separation



SN-Engineering A/S, of Nykøbing, Denmark. 2,095,585. March 23, 1982; October 6, 1982; April 24, 1985.

Small stones and gravel are separated from beets by a rotating screening drum 1 located along the flume 8 and parallel with it so that its bottom is substantially level with the bottom of the flume. An annular hollow body 2, 22 carried by the drum at each end and rotating with it contains four channels 10 extending from openings 11 on the inside surface of the annular body to respective openings 18 on its outer surface. Each channel runs around the circumference of the body 2, 22, and those parts of the channels immediately adjoining the openings 11 act as elevator buckets for small stones; the end of each opening 18 facing the direction of rotation carries a cowl or scoop in the form of a tangential projection 12. A fin 13 describing a spiral path on the circumference of drum 1 has a portion extending from the drum as well as a portion on the interior of the drum.

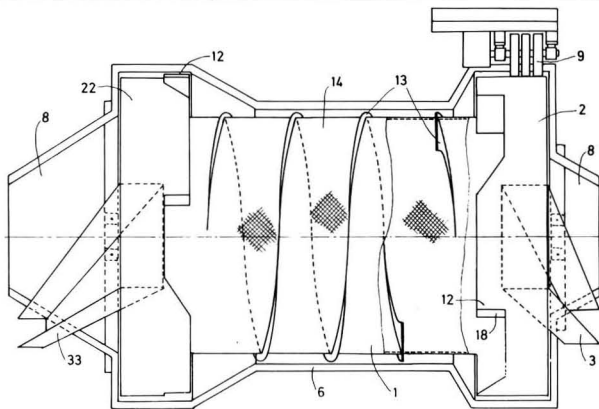
As beets plus foreign bodies pass the first annular body 2, some of the gravel and stones will fall down through the water towards the inner surface of the body, and will then roll/slide down the surface into openings 11; the beets will remain floating under the effect of the rotation of the drum, the flow rate of the water and upward streams of water

generated in the openings 11 as the drum rotates. When the openings 11 reach the upper part of the separator, the stones and gravel fall into discharge chute 3. A lip 19 produced by the difference between the inside diameter of the drum and the inside of body 2 prevents stones that have already settled on the inside of the body passing into the drum. Some of the stones passing into the drum with the beets will sink to the bottom and will be carried back to body 2 and discharged via openings 11 and chute 3. When the capacity of the apparatus is fully utilized, the pathway 14 will be filled with gravel, and stones will roll on this to be conveyed through the drum to body 22 and discharged via chute 33. An overload safety device stops the drum immediately an object gets jammed between bodies 2, 22 and discharge chutes 3, 33.

Process for producing L-glutamic acid by fermentation

Ajinomoto Co. Inc., of Tokyo, Japan. 2,096,992. February 16, 1982; October 27, 1982; February 13, 1985.

Brevibacterium flavum or *B. lactofermentum* is aerobically cultured on a medium containing, as carbon source, glucose, sucrose, molasses, etc. for 1-7 days at 20-40°C and pH 5-9.



Process for producing glucose/fructose syrups from unrefined starch hydrolysates

Nabisco Brands Inc., of New York, NY, USA. 2,097,400. April 27, 1982; November 3, 1982; April 3, 1985.

A glucose-fructose syrup is produced by heating a starch hydrolysate [containing >92% (>94%) glucose and <30 ppm (<100 ppm) Ca⁺⁺ ions on starch dry solids and having a ketose:hexose molar ratio of 1:50] to 50-70°C (60°C) for 20-60 (30) minutes and then treating it with an immobilized glucose isomerase, e.g. alpha-amylase derived from *Bacillus licheniformis*. The process involves two-stage liquefaction (with autoclaving between the two stages) at pH 5-6 (5.2-5.4) to a D.E. of approx. 16, and saccharification at 54-62°C (58°C) and pH 4-5 (4.6) for 30-80 (60) hours.

Treating molasses

Kyowa Hakko Kogyo K.K., of Tokyo, Japan. 2,100,749. May 28, 1982; January 6, 1983; August 1, 1984.

For recovery of sugar, molasses is diluted with water to 35-70°Bx (40-70°Bx) (60°Bx) and its pH adjusted to 3.5-5.2 (4.5). The solution is then heated to >50°C (50-100°C) (90°C) and subjected to ageing for >5 (>10)

(10-60) (30) (20) minutes, so as to effect a substantial reduction in scale formation and promote further growth of crystals of calcium salts (e.g. CaSO₄ and K₂SO₄,CaSO₄,H₂O). The calcium-containing solids are separated by e.g. centrifugation, diluted with water at 70-90°C and the resultant solution aged with agitation for >5 (>10) (10-60) (20) min before centrifugation as above. The sugar-containing solution obtained in the first separation may be used to dilute the initial molasses.

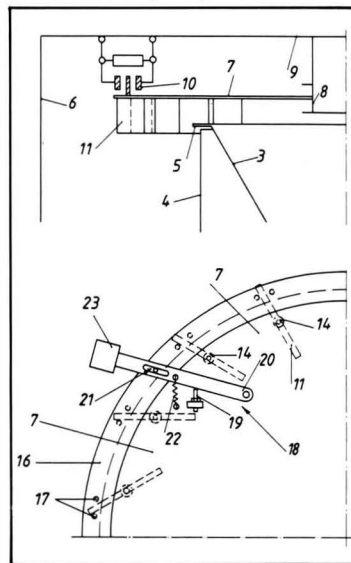
Continuous centrifugal

Braunschweigische Maschinenbauanstalt AG, of Braunschweig, Germany.

2,104,793. July 12, 1982; March 16, 1983.

Crystal damage by impact in a continuous centrifugal is prevented by means of plane, very thin, resilient metal plates 11 mounted on a rotatable ring or disc 7 located above the basket and retained by a bearing mounted on the lid of the sugar-collecting casing. The plates pivot about axes 14 which extend parallel with the axis of rotation of the basket so as to provide an optimum angle relative to the trajectory of the sugar crystals and ensure the requisite deceleration and hence reduction in

impact energy. This optimum angle (which is also of importance in regard to the cleansing effect of the sugar crystals acting as a sandblast, while the deflection of the plates is also enough to avoid encrustation) is obtained by means of an adjusting collar 16 on ring 7; the collar is provided with drivers 17 that act on the plates 11 (or on retainers carrying the plates) at a distance from adjusting axes 14.



An adjusting device 18 on ring 7, e.g. an adjusting screw 19 acting against a radius rod 20 (one end of which is supported by ring 7 while the other end acts on collar 16 via a slot-bolt connexion), produces relative angular displacement between the collar 16 and ring 7 as a result of which drivers 17 pivot the plates 11 about axes 14. The speed of rotation of ring 7 can be adjusted by a regulated braking system such as eddy current brake 10 comprising an induction ring fixed to ring 7 or collar 16 and fixed induction coils mounted on lid 9. The speed of ring 7 relative to that of the basket can be a function of the circumferential velocity of plates 11 and/or of the throughput of the centrifugal.

Abstracts of the following applications for UK patents have appeared in previous issues of this Journal and the applications have been granted subsequent to preparation of our abstracts. The *ISJ* reference to our abstract and the date of granting of the patent are listed below.

2,071,646	<i>I.S.J.</i> , 1984, 86, 62.	May 10, 1984
2,074,188	<i>I.S.J.</i> , 1984, 86, 62.	April 18, 1984
2,076,018	<i>I.S.J.</i> , 1984, 86, 159.	September 19, 1984
2,077,610	<i>I.S.J.</i> , 1984, 86, 159.	December 21, 1983
2,078,125	<i>I.S.J.</i> , 1984, 86, 159.	August 8, 1984
2,079,290	<i>I.S.J.</i> , 1984, 86, 54A.	May 16, 1984
2,084,184	<i>I.S.J.</i> , 1984, 86, 54A.	April 26, 1984
2,084,884	<i>I.S.J.</i> , 1984, 86, 55A.	June 6, 1984
2,085,026	<i>I.S.J.</i> , 1984, 86, 55A.	June 6, 1984
2,087,400	<i>I.S.J.</i> , 1984, 86, 55A.	May 31, 1984
2,089,640	<i>I.S.J.</i> , 1985, 87, 22A.	March 21, 1984

In addition, the following applications were withdrawn subsequent to preparation of our abstracts:

2,069,000	<i>I.S.J.</i> , 1984, 86, 61.
2,073,244	<i>I.S.J.</i> , 1984, 86, 62.
2,074,187	<i>I.S.J.</i> , 1984, 86, 159.
2,075,817	<i>I.S.J.</i> , 1984, 86, 159.

impurity levels in the twentieth century were twice those of Pymont. Bennett's figures, up to at least 1940, except for 1869, were also from the New York laboratory, and have therefore not been included in the graphs. His figures for 1950 to 1977, obtained from Tate & Lyle, have been plotted and are seen to range between the American and the Australian zones. The trends signify an increasing assumption of the refiner's impurity-removing function by the mill.

Over the period of Pymont Refinery's existence the rate of melting increased some twelve times, but the proportion of impurities in raws decreased to approximately one-sixth of the original. Thus the impurity loading merely doubled, from around 1200 to 2400 long tons per annum.

Within the total amount of impurities there may be certain unwanted substances that are present in only minor amounts, yet are important to the refiner. The research and review literature abounds in references to such impurities. Those at issue in each era appear in the four-yearly ICUMSA Referee's Reports and in the ICUMSA sugar analysis book edited by Schneider⁷. The history of these substances is not attempted in this present work.

In separating impurities, the refiner attempts to harmonize consumer preferences with factory economics and practicalities. He may be seen to build his system around four processes: affination, clarification, decolorization and crystallization.

Choices made among the four purification processes named above took Pymont through the various phases of its history.

First phase: 1880-1890, golden syrup and char

As shown in Figure 2, the first phase at Pymont was marked by transfer of impurities from the initial soft, syrupy refined sugars into golden syrup. This development is attributed to a change from the "in-and-in" to the "out-and-

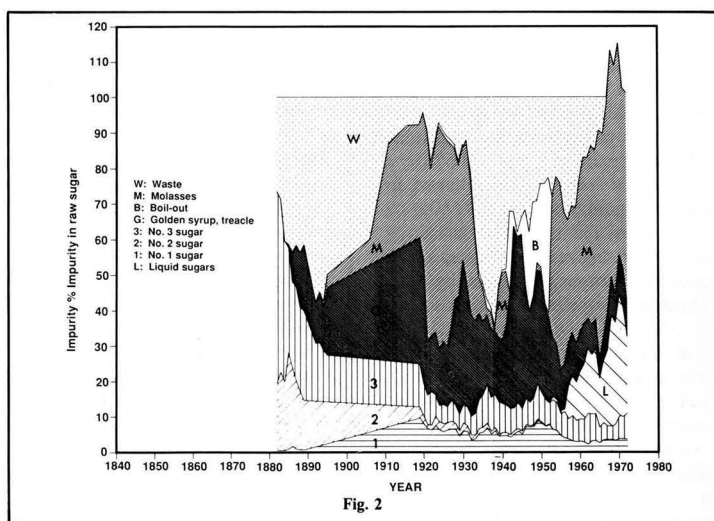


Fig. 2

out" boiling process, as described below.

The colours of the sugars of 1882 may be ascertained from their Dutch Standard numbers: the No. 1 sugar was white (DS 26), the No. 2 could be described as primrose (DS 23), and the No. 3 as dark brown (DS 14.4). The raw sugar, at DS 11.9, was even darker. The retention of impurity in the sugars suggests that Pymont commenced with the "Greenock system", described by Wallace in 1869⁸.

In the 1880's the Greenock system was, according to Eastick⁹, used also in the London refineries except for Tate's, and was known as the "Scotch 'in-and-in' method":

"... mixing the syrup as produced by adding fresh charges of raws, and turning out a sufficient quantity of low soft yellows to carry away the syrup, only occasionally boiling out treacle or molasses, when too great an accumulation had taken place."

In a paper delivered to the British Association in 1876 Patterson attributed the in-and-in or Greenock system to Duncan and Scott, around 1860¹⁰. He linked it to the introduction of centrifugals, whereby syrup from

one day's boiling could be returned rapidly, and so in an unfermented state, for the next day's boiling. Thus, all syrup could be included in the product massecuites. That the centrifugal enabled this process to be introduced is consistent with the 1879 description of Havemeyer & Elder's refinery in America, which used centrifugals for soft sugars and cones for hard sugars. The soft sugars could have retained considerable amounts of syrup, and the freely draining hard sugars in cones would have been washed¹¹.

The change to the out-and-out process by Abram Lyle and Sons occurred some time after 1881, as reported by Eastick:

"... the separation of the soft and syrupy yellow pieces (soft sugar) into a pure hard dry sugar and golden syrup was a commercial success, the latter soon replacing the old treacles

7 Keniry: *Proc. 17th Session ICUMSA*, 1978, 414-429; also Schneider: "Sugar Analysis - ICUMSA Methods" (International Commission for Uniform Methods of Sugar Analysis, Peterborough), 1979.
8 *Sugar Cane*, 1869, 1, 257-267; 1870, 2, 2-16, 259.
9 *J.S.J.*, 1914, 16, 353-354.
10 *Sugar Cane*, 1876, 8, 580-594.
11 Anon: *Scientific American*, Jan. 25, 1879, 48-49.

which disappeared with the soft pieces formerly so largely consumed.”

A similar change evidently occurred in Pymont in the 1880's. Over the period 1882 to 1889, the proportion of impurities going to all refined products decreased markedly, from 73.5% to 58.7%. The corresponding increase in the loss figure, from 26.5 to 41.3, without any record of boil-out molasses being made, indicates an increase in impurity removal by char. Figure 2 illustrates the change graphically.

In the same period golden syrup appeared, taking 19% of the impurities, so that the proportion of impurities going to refined sugars decreased from 73.5 to 39.7%, or slightly over half. Correspondingly, the average impurity content of the refined sugars was 4.73% at the start of the period, and 2.23% at the end. The impurity content of raw sugar also decreased, from 6.23 to 5.16%, as shown in Figure 1.

A similar change to that from the in-and-in to the out-and-out process was reported for the French sugar refining industry in the same era¹². The author, Fierain, saw the introduction of the boiling of large, uniform crystals (“La cuite en grains”), towards the year 1860, as a revolution in sugar technology. Such crystals could easily be rendered dry, brilliant and free of molasses. The technique for producing large crystals was attributed to a sugar boiler in the French Antilles accidentally introducing fresh syrup into a vacuum pan containing supersaturated material, and then feeding the microscopic crystals so formed, by fresh additions of syrup.

Second phase: 1890-1920, affination and boil-out

In the second phase there was a distinct shift of impurities into molasses and golden syrup, and a corresponding reduction in impurities in refined sugars and in losses to drain. Boil-out, resulting in molasses, aided

by golden syrup and treacle manufacture, took over the impurity-removal function formerly performed by char and sugars. Among the sugars, the greatly increased proportion going to No. 1 is noteworthy. Its impurity percentage had halved, but its tonnage increased disproportionately. No. 2 and No. 3 sugars also became more pure. Presumably the market favoured higher-purity refined sugars.

Affination was introduced in 1900, in order to increase production by the use of boil-out. By 1919, 17.5% of the impurity introduced was being separated by affination. Some impurity was thus diverted from char to the black boil-out station, and some passed through char as melter liquor, then through the white boil-out to the black boil-out. Thus, the black- and the white boil-outs took a considerable load off the char, the former by going around it, the latter by allowing more impurities to pass through it.

Within the refined sugars, the considerable reduction in impurities borne by No. 2 and No. 3 sugars contrasted with the increase in that borne by No. 1 (Figure 2). This increase is explained by the great increase in production of No. 1, from 16.6% of refined products in 1889 to 84.44% in 1919. Production of No. 2 decreased from 58.8 to 9.75%, and of No. 3 from 19.6 to 2.81%. At the same time the impurity contents of the sugars decreased, as did the colour of No. 2 and No. 3 (from DS 24 and 15 respectively, to 26 and 21).

The greater use of boil-out in place of char, directly indicated by the molasses increase, marked this phase of Pymont's history in which affination was introduced.

Third phase: 1920-1940, bone char

The third phase was marked by a volte-face: the rise and fall of the boil-out function, and the transfer of the main impurity-removal function back to char.

Some 60% of impurities was

removed in the refined products in 1919, in molasses in 1921, and in the waste washed from char (the “loss” figure) in 1938.

In 1921 there was an excess of impurities. This resulted from an increase in impurities in the raws (Figure 1), accompanied by a falling-off in demand for golden syrup and treacle and for No. 2 sugars. It became necessary to remove more impurities at affination and increase molasses production. The interrelationship of these changes is depicted in Figure 2.

By the mid-1920's, with increases in both impurity load and white sugar production, a long-term decline in quality of the white sugar needed to be arrested. Attention focussed on char, and on the likelihood of considerable improvement to be gained from the process known as “degrading”. It had been used by CSR until the year 1900, when the introduction of affination reduced the variability of the raw sugar melted. By 1925 it was being reintroduced, with a difference. Before 1900 CSR had used freshly revived char for each grade of liquor regardless of its purity. The new process was designed to utilize the char more fully in each cycle. It did this by passing only the purest liquor over freshly regenerated char, to be followed successively by increasingly impure liquors.

The 1930 Report stated that:

“It is now our definite policy to wash as much of the sugar as possible to the highest possible standard . . . facilitate the maintenance of the highest possible degree of purity in the refined sugars but will assist materially in operating the refinery with a minimum of chemical loss (i.e. loss of sucrose).”

By 1933 char had commenced to take over:

“There was a marked fall in the amount of C.B.O. massecuite boiled at Pymont and this is in accordance

¹² Fierain: “Les raffineries de sucre des ports en France, XIXe — début du XXe siècles” (Arno Press, New York), 1977, pp. 39-40.

with our policy of using the char to the maximum possible extent for the elimination of impurities.” and by 1938, as shown dramatically in Figure 2:

“At Pymont this year no C.B.O. massecuites were boiled for elimination of impurities via C-syrup.”

Figure 2 shows that, in that year, 64.6% of the impurities entering the refinery were eliminated in waste, having been absorbed by char and washed to drain. This marked the completion of the transfer of the principal impurity-removal function from molasses to char, and the end of the third phase. It also marked the reversal of the falling-off in quality of white sugars that largely initiated the introduction of degrading over char.

Although boil-out and char, in their respective phases, had performed the principal impurity-removal function, a glance at Figure 2 will show that the syrups and sugars also had a significant effect. The marked decrease in demand for golden syrup and treacle in 1921 needed to be offset by a corresponding increase in molasses production, brought about through increased affination and boil-out. The decrease in demand for No. 2 and No. 3 sugars added to the need for boil-out.

Thereafter, the build up in demand for syrups during the great depression peaked in 1930 and necessitated a reduction in molasses production. The demand was so great that some of the raw washings filtered over char went to golden syrup instead of to boil-out.

The increase in total impurities in refined sugars, peaking in 1936, following on a declining trend from 1920 is, at first, puzzling (Figure 2). It is in fact evidence of success in the attempts to increase efficiency of char usage. The char had so decolorized the liquors that it became necessary to include more total impurities in No. 3 sugars for them to exhibit their customary colour.

As stated above, it is noteworthy

that by 1936 the purity of the white sugar was satisfactory. It will be recalled that dissatisfaction with the purity of white sugar had precipitated the decision to intensify the work of the char, commencing in the mid-1920's. The removal of other impurities than colour bodies, although striking, could be considered incidental.

Fourth phase: 1940-1950, golden syrup and boil-out

During this period, with char kilns at the limit of their capacity, and with increasing melts, char usage decreased from 30% on raw sugar to an inadequate 20%. This had followed on a strong re-affirmation, in 1940, of the policy of restricting char usage to that amount necessary to decolorize the main liquor courses. The “loss” figures, in Figure 2, fell from a high of 64.6% in 1938 to 24.4% in 1950.

A significant feature of the war years was the great increase in golden syrup sales, and also in syrups, such as BBO, sent to the Distillery to replace molasses imported from the mills. The removal of so much impurity in golden syrup and distillery syrups produced a striking result: from 1941 until the 1950's there was virtually no final boil-out for the removal of impurities as molasses.

Further evidence of inadequacy in the char department was the peak in refined sugar impurities in 1949 (Figure 2).

Fifth phase: 1950-1970's, boil-out and liquid sugar

During the fifth phase, commencing in the early 1950's, the main flow of impurities was increasingly into boil-out molasses and liquid sugars. Raw washings no longer passed over char, but proceeded directly to the pan station for boiling-out. The flow into golden syrup decreased to less than 10% of the total, and that into the refined sugars to a similar amount. Loss of impurities through removal by

char diminished considerably.

The continual decrease in the loss figure from 64.6% in 1938 to less than zero (this due to errors of measurement) in this phase, is manifest in Figure 2. The great reduction in work done by char was accompanied by a considerable reduction in char used (kilned), from more than 20% on raw sugar to 12%. This is consistent with the policy enunciated in the 1920's and referred to above of restricting char usage to that needed for colour removal. The need would have been considerably reduced by the diminution in demand for golden syrup and treacle. The reduction in char use may also have been influenced by its coming replacement with active carbons. Approximately half of Pymont's capacity had been substituted in this way by 1981.

The considerable increase in impurity removal by liquid sugars may be seen, from Figure 2, as a replacement for the role previously played by golden syrup and treacle.

Conclusions

Figure 2 demonstrates how the concept of an impurity balance governed by contemporary costs and preferences may serve as a connecting thread for making a history of the Pymont site. A century of change may be viewed at a glance. With the aid of this concept, otherwise puzzling and apparently unrelated changes in raw sugar, in products, and in the technology that links the two, can now be perceived as the operation of one organic whole. The concept could be expected to apply equally to the understanding and comparison of other sugar refineries.

The trend at Pymont was one of an increasing shift of impurities from sugars into liquids: golden syrup, treacle, liquid sugars, and, predominantly, boil-out molasses. In the early period much impurity was removed by char. After affination was introduced in 1900, boil-out aided by

golden syrup and treacle took over the major impurity-removal function. By 1938 this situation was reversed, and most of the impurities were removed by char. However, the superiority of char proved to be temporary. After 1938, with the continued policy of restricting char usage to that necessary for removal of colour bodies, the dominance of char was swamped by

increasing production rates. Boil-out took over again. In the 1980's the logic of the char policy was carried further with the introduction of activated carbon, which removes colour and little else.

A recent proposal by Meikle¹³ to include most of the impurities in soft sugars for consumption takes us back to the 1880's. It exemplifies the

usefulness of the impurity balance concept, guided as it is by contemporary values.

Acknowledgement

Grateful acknowledgement is made to CSR Limited for permission to use its archives in the preparation of this paper.

¹³ Proc. Meeting Sugar Industry Tech., 1982, 41, 140-148.

Instrument error in measuring sugar colour

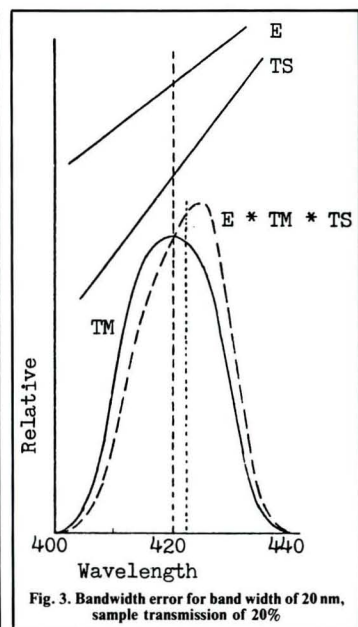
By Frank G. Carpenter

(Continued from page 17)

The energy reaching the photodetector at wavelengths slightly removed from 420 nm is the product of the relative source emission (E) times the relative transmission of the monochromator (TM) times the relative transmission of the sample (TS). This becomes a function of the slope of the emission curve (assumed always = 0.0153), bandwidth of the monochromator, and transmission level of the sample.

This energy was evaluated for bandwidths (Bw) of 2, 5, 10, 12, 15, 20, 25, 50 nm; sample transmission (ST) of 80, 60, 40, 20; and for 21 points (f's) on each of the curves.

A "worse" case is shown in Figure 3. It is seen that the effective peak has been shifted appreciably towards longer wavelengths. However, it is not the peak that counts; the detector has been assumed of uniform response, so it is the weighted average that is needed. This corresponds to the median of the peak, where there is as much area above as below. This is shown as the dotted line. The wavelength of the median is given in Table I. The percentage error in the sugar colour



measurement caused by this bandwidth error is given in Table II.

It may be seen that for bandwidths of less than 10 nm the error is less than 1%, which is within the announced

Bandwidth, nm	Sample transmission			
	20	40	60	80
2	420.02	420.02	420.01	420.01
5	420.14	420.11	420.08	420.07
10	420.56	420.41	420.33	420.26
12	420.80	420.59	420.47	420.38
15	421.24	420.92	420.73	420.59
20	422.1	421.6	421.3	421.0
25	423.3	422.5	421.9	421.6
50	431.0	428.8	427.3	426.1

Bandwidth, nm	Sample transmission %			
	20	40	60	80
2	0.04	0.03	0.02	0.02
5	0.23	0.17	0.13	0.11
10	0.91	0.67	0.53	0.43
12	1.31	0.97	0.76	0.62
15	2.0	1.5	1.2	0.95
20	3.5	2.6	2.1	1.7
25	5.3	4.0	3.2	2.6
50	18	14	12	10

goal. Bandwidths of over 20 nm produce too great an error and the writer considers that ICUMSA should adopt a bandwidth specification of 10 or 12 nm. Furthermore, for bandwidths of over 8 nm, the wavelength should be 419.4 ± 0.6 nm. For narrower

bandwidths the wavelength should remain 420 ± 0.6 nm.

How do these compare with real colorimeters? High priced precision spectrophotometers have typical minimum bandwidths of 0.5, 1, or 2 nm. Inexpensive spectrophotometers have typical bandwidths of 20 or 50 nm. However, in both the bandwidth depends upon the slit width. In the least expensive instruments the slits cannot be adjusted. In other instruments the slits are programmed and non-adjustable. In the best instruments the slits are adjusted by the operator, who may not choose to use the finest slits. Further, it is probable that two operators will not choose the same adjustment. Consequently, even with expensive spectrophotometers, although they are capable of accurate sugar colour measurement, it is not certain that they will be used in an accurate fashion, or even the same fashion.

Interference filters are available with a bandwidth of 10 nm. These are not adjustable, so the bandwidth will be known. This was the rationale behind the choice of interference filters for the Talameter^{6,7}. The stability of interference filters is stated to be excellent⁶, but we have no supporting data. In fact, evidence seems to show otherwise. Figure 4 shows the transmission curves for the interference filters from the two Talameters. They are both marked 421 nm with a bandwidth of 12 nm. The usual transmission for interference filters is about 35 to 40%. One meets the 35% T and 12 nm bandwidth specification, but badly misses the peak wavelength. The other comes closer on peak wavelength but has only 10% transmission, and 22 nm bandwidth. The sugar colour error caused by wavelength plus bandwidth errors is -10.7 and -5.4% respectively. If they were originally as marked, then they have shifted wavelength and lost transmission with the passage of about 10 years. If they are stable, then they were originally

mismarked. The writer believes that the former is probably the case.

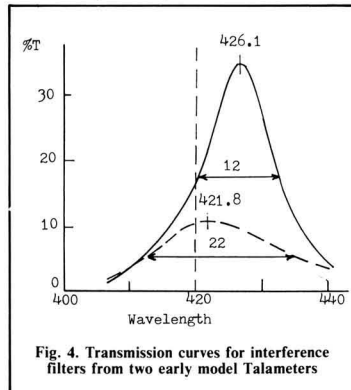


Fig. 4. Transmission curves for interference filters from two early model Talameters

Detector response

Many operators of colour measuring instruments get worried about the "calibration" or "linearity" of their instrument. This is one item that should present no problem. Photodetectors are noted for having a very long linear range—at least 6 powers of ten—and some are linear over 10^{14} . Most instruments actually cover a range of only 10^2 or 10^3 , and any designer should certainly get that within the linear range of his photodetector element. Electrical circuits can be designed to be very linear and very stable, so if they work at all, they are probably working right. The linearity and readability should be 0.2% or 0.5% or at most 1%.

The most sensitive part of the detector circuit is the "zero" (or 100% T) setting. This is most likely to drift, but all operators soon learn this and check it often because it affects their own reproducibility. In checking several instruments, they were found to vary no more than from 98 to 102% T in an hour. However, in actual practice, it would have been set back to precisely 100% several times in that hour. Some instruments do far better than this.

For those who wish to check their linearity, the same sample of fairly high transmission can be checked in various

parts of the scale. This is done by placing 2 samples in series. One sample which is say 80% T is placed in series with another sample and the combination should read 80% of the other sample alone. On the absorption scale, the readings are additive.

The same effect can be achieved on some instruments that have a wide zero adjustment range. The zero is set to various levels and the same sample should produce the same % change in transmission at all places on the scale.

Mixtures of coloured salts or dyes which can be made up to a certain concentration to give a certain % T, are usually not completely satisfactory because it is extremely difficult to get the concentration exactly right. In practice, the variation from one preparation to another is greater than expected. However, a dye or salt solution can be used with the Lambert-Beer Law,

$$a = -\log T/bc,$$

by changing b and c to see if $-\log T$ changes accordingly. Sugar solutions cannot be used because they also have light scattering and do not necessarily follow the Lambert-Beer Law.

Coloured glasses can be measured repeatedly over the years, and if the same curve is obtained this lends assurance that the instrument is still the same as it was. If a glass is chosen that has a peak, then this also serves as a wavelength check. If the glass is checked on several instruments, then it is reassuring that all instruments are responding the same. There is no continuing source of calibrated coloured glass for sugar colorimeters; you have to be farsighted and make your own.

Every instrument that has been checked has always proven to have a linear scale if it worked at all.

Cell compartment

The placing of the cells in the cell compartment can be a source of error.

6 Rich *et al.*: *Proc. Sugar Ind. Tech.*, 1972, 111-123.

7 Vanc: *Sucr. Belge*, 1973, 92, 379-385.

For those instruments that will accept only one size cell, the cells can be inserted in only one way and there is no chance for error. However, sugar colorimeters must accommodate 10 or 20 cm cells as well as 1 or ½ cm cells. There is therefore the possibility that the shorter cells can be placed in the cell compartment in more than one place. If the possibility exists, then surely someone will do it. The Beckman DU-7 can accept short cells at any location in the cell compartment. When a cell containing a perfectly clear non-turbid solution was put in various locations, the reading was always the same. The Beckman DU-7 has the monochromator before the sample compartment.

When the same was tried with the original "1000" series Talameter, the reading was different in different locations in the cell compartment. The reading was quite reproducible but changed by 0.015 absorbance units (3.5% T) from one end of the light path to the other. If both the reference cell and the sample cell were placed in the same location, the sugar colour reading obtained (which is the difference) was the same no matter where they were both placed. If the reference cell was placed in one location, and the sample cell in a different location then erroneous readings were obtained. In normal operation, most operators would probably place both the reference and the sample in the same place, but, since the possibility for error exists, it will some day occur.

The cause of this error was traced to the fact that the interference filter was placed after the cell compartment (before the photo detector) coupled with a slight imperfection in the collimation of the light beam. The optics of the Talameter are shown in Figure 5.

The diameter of the entrance aperture is 8 mm, and the beam is slightly convergent to about 5 mm at the centre of the cell compartment and

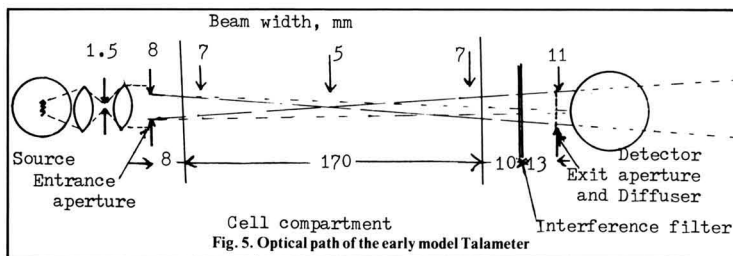


Fig. 5. Optical path of the early model Talameter

has diverged to about 7 mm at the exit of the cell compartment. This is exceedingly good and the main optics are excellent. However, an interference filter is primarily a mirror. About 70% of the light at the pass wavelength is not passed but is reflected back to the cell surface where 5% of the 70% (=3.5%) of the light is sent back to the interference filter for a second try. If both reference cell and sample cell are at the same location, this happens for both and the error cancels out. However, if one cell is placed at the exit end of the cell compartment and the other at the entrance end of the cell compartment, then the returning beam from the cell at the entrance end has travelled about twice the length of the cell compartment farther than the returning beam from the cell at the exit end. Since this extended beam is quite divergent, the detector aperture accepts only a small part of this beam. When the cell is at the exit end, all the secondary beam is accepted. This can cause either a positive or negative error depending upon the location of the sample relative to the reference. When the interference filter was placed at the entrance end, this error disappeared. However, by having the interference filter where it is, it is easier to align the beam of white light through the cell compartment, and the interference filter protects the photodetector from overloading when the cell compartment is opened.

This error can be avoided by always placing the sample and reference in the same place. If this is not done, an error of up to 0.015 absorbance units results. Since the lowest absorbance that is

usually read is about 0.100 (80% T) this could be as much as 15% error either plus or minus.

This error could also be avoided by a mechanical device that would restrict the placement of the short cells to only one location.

Light scattering

Whether the object of sugar colour measurement is to measure colour and not scattering, or whether both absorption and scattering should be measured together or separately, is a subject of great debate that will not be addressed further here. We assume that the object is just to measure colour and, for this purpose, part of the sample preparation for a sugar colour measurement is a filtration to remove "turbidity", meaning light scattering particles. The method implicitly assumes that this filtration completely eliminates the scattering and the total remaining optical effect is assigned to colour.

However, after any practical filtration, there remains some small amount of light scattering. Any transmission measurement measures the sum of both the light absorbed and the light scattered out of the beam. The definitive work on light scattering by sugar solutions, by Reiger & Carpenter⁴ in 1959, showed that light scattering from sugar solutions was primarily in the forward direction. It is important that this forward scattered light not be measured as part of the transmitted beam. ICUMSA specifies that the colorimeter should, in so far as possible, exclude forward scattered light. The argument is made^{6,7} that

some forward scattered light measured as transmitted is an automatic correction for the remaining turbidity. However, if this argument were carried to its logical conclusion, all scattered light should be measured with an integrating sphere photometer, which gives us an entirely different instrument and measurement.

Staying with the present ICUMSA method and excluding forward scattered light, means that the aperture in front of the photodetector should be only very slightly larger than the transmitted beam. It is necessary to be a little larger because when cells containing liquids of different refractive indices are used, the size of the beam shifts a little⁸. This is always the case for sugar because the reference is water and measurements are made in 50° Brix sugar solution.

Real spectrophotometers in general do not meet this requirement. Deep within their instruction booklets there is always the admonition that they should be used only on "optically clear" solutions. This is because the apertures in front of the detectors are very large. These apertures are made that way on purpose so that the entire transmitted beam would be measured. In very good spectrophotometers they have to be wide so that the entire beam will be measured at wide slit widths. In inexpensive spectrophotometers, the beam is little collimated so the aperture has to be wide to get the entire divergent beam. In either case, light that is scattered through only a small angle gets measured as if it were transmitted. Further, this small angle is larger than might be expected. The scattering optics of a typical colorimeter are shown in Figure 6.

For both the Beckman DU-7 and the Perkin Elmer 35, the angle in the worst case was 26°. For the Talameter, which was designed for sugar work, the worst case was 12°. For scattering centres at the other end of a long cell, or for a short cell at the far end of the cell compartment, the scattering angle is only 2° or 3°. For a long cell, the particles in the middle of the cell have scattering angles between these extremes.

Is there enough scattering in the real world for this to make any difference? This was determined by measuring coloured sugar solutions of differing degrees of turbidity at the two ends of a long cell compartment (Talameter) in a 1-cm cell. The sugars were of different colours, but that is beside the point. The degree of turbidity was subjectively estimated, by examining the solutions with a strong light against a dark background. The two designated "much scattering" were obviously turbid even to casual observation and were beyond the range that would normally occur in sugar colour measurements. The "faintest scattering" and "moderate scattering" were probably more nearly average samples. The "really clear" sample may occur in some instances.

Table III. Difference in absorbance for scattering samples measured at the two ends of the cell compartment

Much scattering	0.030
Much scattering	0.033
Moderate scattering	0.017
Faintest scattering	0.010
Really clear	0.000

The consistency of these results indicates that the scattering effect is real, and can be measured. Taking the "faintest scattering" as a realistic

average level, if in the worst case an absorption of only 0.100 were being measured, then this represents a 10% error. For a more typical case it would be a 3% error. For instruments with a wider aperture the errors could easily be twice these values. This is the amount of difference to be expected between instruments of different design.

These errors could be reduced very much by a simple but fundamental change in the design of the instrument whereby the detector aperture is simply moved farther away from the exit end of the cell. The aperture would then subtend a much smaller angle at the cell. The distance might be specified as at least equal to the length of the cell compartment. This requires a more careful collimation of the beam and a more careful optical alignment, but would effectively eliminate most of this error. This method has been tried⁵ and found effective.

Whatever the design used, there should most definitely be a specification on the amount of forward scattered light that is included with the transmitted beam. A small angle such as 5° might be a suitable specification. Further research is needed to define an instrument that excludes forward scattered light, is reproducible, and is practical.

Conclusions

The instrumental errors in making a sugar colour measurement are summarized in the following table.

Table IV. Instrumental errors in sugar colour measurement

	Typical %	Maximum %
Wavelength	5	15
Bandwidth	0.6	4
Scale	0.2	1
Cell placement	0	15
Scattering	3	10

It is quite evident that the largest source of error is the inability to achieve the specified wavelength of 420 nm. Light scattering can also cause significant error.

⁸ Idem: *I.S.J.*, 1972, 74, 35-36.

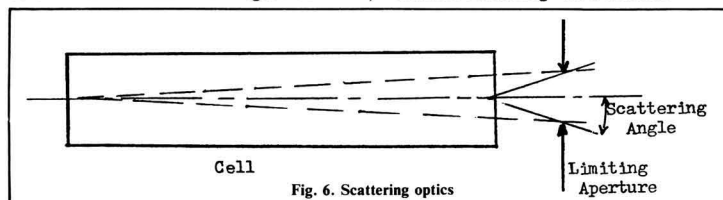


Fig. 6. Scattering optics

Variations between instruments of 5 to 8% are to be expected. Variations of 30 to 40% would not be surprising. This helps to explain part of the reported typically 100% error between laboratories. These errors could be reduced to an acceptable level by a tighter specification on wavelength and cell optics. The tightened specifications would be: Wavelength, ± 0.6 nm, with built-in calibration or check.

Bandwidth, <12 nm.

Scale linearity, <1%.

Cells, mechanically restricted to only one position.

Scattering angle, =5°.

A wavelength error of no more than 0.6 nm is required. This almost dictates a mercury arc line or laser. A laser would also improve cell optics and reduce scattering error. To use a mercury arc line, the wavelength would have to be changed, but any wavelength from about 400 to 450 nm should be satisfactory.

The mercury line at 436.833 seems the most suitable. Because of line broadening at high pressure, the type of source would have to be specified. Ramos⁹ and Urrutia *et al.*¹⁰ obtain good results at 436 nm and using 10° Brix concentration to speed filtration.

What sugar colorimetry really needs is a good, inexpensive, reliable, stable, and simple laser at somewhere between 400 and 450 nm.

Summary

The error in measuring sugar colour introduced by using different instruments was evaluated. Sources of error examined were: wavelength, bandwidth, detector response, cell placement and scattered light. The source of largest error was failure to achieve accurately the required wavelength of 420 nm, followed by variations in the handling of scattered light. Differences between instruments, even of the same make and model, of 5 to 8% are to be expected, and differences of 30 to 40% would not be surprising. In order to reduce the errors to a more acceptable level

tighter instrument specifications will be required. It appears that it may be necessary to use a mercury arc or laser for the light source. These instrumental errors account for only part of the observed error in the sugar colour measurement. The error associated with sample preparation can be much larger.

Erreur d'instrument lors de la mesure de la couleur du sucre

On a évalué l'erreur introduite lors de la mesure de la couleur du sucre et cela en utilisant différents instruments. Les sources d'erreurs examinées furent: la longueur d'onde, la largeur de bande, la réponse du détecteur, le placement de la cellule et la lumière dispersée. La source d'erreur la plus importante était le manque d'un réglage correct de la longueur d'onde à la valeur de 420 nm. Venaient ensuite des variations dans la façon du traitement de lumière dispersée. On peut s'attendre à des différences de 5 à 8% entre les instruments, même d'un constructeur et d'un modèle identique. Des différences atteignant 30-40% ne seraient pas surprenantes. Afin de réduire les erreurs jusqu'à un niveau plus acceptable, on devra établir des spécifications plus sévères pour les instruments. Il apparaît qu'un arc à mercure ou un laser devraient être utilisés comme source lumineuse. Ces erreurs instrumentales ne couvrent qu'une partie de l'erreur observée dans la mesure de la couleur du sucre. L'erreur associée à la préparation de l'échantillon peut être beaucoup plus importante.

Gerätefehler bei der Messung von Zuckerfarbe

Der Fehler bei der Messung der Zuckerfarbe, der durch die Verwendung von unterschiedlichen Geräte hervorgerufen wird, wurde bewertet. Untersuchte Fehlerquellen waren: Wellenlänge, Bandbreite, Detektorempfindlichkeit, Küvettenplatzierung und Streulicht. Die größte

Fehlerquelle war das Nicht-Erreichen der genauen Wellenlänge von 420 nm, gefolgt von Schwankungen im Verhalten gegenüber Streulicht. Unterschiede zwischen den Geräten, sogar bei gleichem Hersteller und Modell, von 5-8% sind zu erwarten und Unterschiede von 30-40% können nicht überraschen. Um den Meßfehler auf ein akzeptables Niveau zu reduzieren, sind genauere Spezifizierungen der Geräte notwendig. Es erscheint eventuell notwendig, Quecksilberlampen oder Laser als Lichtquelle zu verwenden. Diese Gerätefehler tragen aber nur zu einem Teil zu dem beobachteten Meßfehler bei Zuckerfarbe-Messung bei. Der Fehler durch die Probenvorbereitung kann noch viel größer sein.

Error instrumental en la medición del color de azúcar

Se ha evaluado el error en la medición del color de azúcar introducido por el uso de varios instrumentos. Los fuentes de error examinados fueron: longitud de onda, ancho de banda, respuesta del detector, colocación de la célula, y luz dispersado. El fuente de error más importante fué falta de realización precisa de la longitud de onda de 420 nm que se requiere; como segundo fuente fueron variaciones en el manejo de luz dispersado. Se pueden contar con diferencias de 5 a 8% entre instrumentos, aun de la misma marca y del mismo modelo; diferencias de 30 a 40% no serían sorprendentes. Para reducir los errores a un nivel más aceptable, se requieren especificaciones más estrictas para los instrumentos. Parece que puede ser necesario utilizar un arco a mercurio o un laser como fuente de luz. Estos errores instrumentales no forman que una parte del error observado en la medición. El error asociado con la preparación de la muestra puede estar mucho más importante.

⁹ Cuba Azúcar, 1982, (Oct./Dec.), 21-28.
¹⁰ ATAC, 1981, 40, (2), 45-55; through I.S.J., 1983, 85, 348.

Brevities

International Sweetener Colloquium, 1986

The 1986 colloquium, organized as before by the Sugar Users Group in the USA, is to be held at Fort Lauderdale, Florida, during February 9 - 12. A number of sessions have been organized during which papers will be presented on "The sweetened products market", "New sweeteners and new products", "Worldwide sweetener dynamics - sugar, HFCS and ethanol", "Foreign exchange rates and their effects on commodity prices", "The sweetener industry and ethanol", "The US sugar program", and "Putting sugar on the trade table".

New Brazilian autonomous distillery¹

Cooperativa Agro-Industrial São Francisco Ltda. opened a new distillery in São Francisco, Goias, in August with an initial capacity of 120,000 litres of alcohol per day, intended to be increased by 30% after its third season. The planting of cane land to provide raw material for the autonomous distillery was made possible by use of resources made available to the cooperative by the Federal government.

Indonesia sugar production and consumption²

Indonesia sugar output is expected to rise slightly to 1.85 million tonnes in 1985 from 1.83 million

ISSCT 19th Congress, 1986

The latest newsletter (No. 6) issued by the organizing committee of the 19th Congress of the International Society of Sugar Cane Technologists, to be held in Indonesia during August 21 - 31, 1986, announces that John L. Clayton, an Honorary Life Member of the society, has been appointed Editor of the Congress *Proceedings*. Mr. Clayton has many years of experience of both sugar technology and the editing of publications serving the industry. He will bring both to bear on a formidable task - the production in a printed form of the technical papers, to be produced as Volume I of the *Proceedings* for supply to delegates on registration at the Congress.

A three-day pre-Congress program (August 22 - 24) will include an agricultural tour of the Gunung Madu plantations, the Indonesian Institute of Sugar Research at Pasuruan and an inspection of the Reynoso system, while factory tours will be provided of the National Centre for Research, Science & Technology, and the Kedawang and Gondang Baru sugar factories. The

tonnes in 1984 and 1.76 million tonnes in 1983. Consumption fell significantly during 1984 and end-year stocks rose from 362,000 tonnes in 1983 to 897,000 tonnes at the end of 1984 but these are expected to fall again to around 375,000 tonnes by the end of 1985. There were no imports or exports in 1984 and it is forecast that this will be unchanged in 1985.

Panama sugar exports, 1984³

Exports of sugar from Panama in 1984 were all to the US and fell to 82,429 tonnes, raw value, from 136,898 tonnes exported in 1983, also to the US. In 1982, exports amounted to 111,580 tonnes, most to the US but including 13,691 tonnes to Tunisia.

Mozambique sugar factories rehabilitation⁴

South Africa has granted a R 8 million (\$3.1 million) credit for initial rehabilitation costs for five of Mozambique's six sugar factories, while additional funds are expected from the UK and the World Bank early in 1986. A study by the South African consultants Techserve (Pty.) Ltd. says that a R 11 million interim rehabilitation could put the country's sugar industry back on a solid footing. 1985 production is estimated at 50,000 tonnes, up on the 38,000 tonnes of 1984 but substantially below the pre-independence peak of 350,000 tonnes. Techserve was retained

technical papers will be presented during August 25 - 30. A keynote address is to be given on the international impact of competitive sweeteners on the cane sugar industry, followed by a panel discussion on the outlook for sugar consumption in the next ten years. Two parallel symposia will feature biotechnology, microprocessors, by-product development and the transfer of sugar technology.

On account of unfavourable climatic conditions in early September, the Thailand Society of Sugar Cane Technologists has suggested an alternative to the 1986 Post-Congress tour. A program designed to attract delegates, scheduled for August 17 - 21, covers all aspects of the Thai sugar industry from cane planting, through harvesting, to processing. There will also be a seminar on recent Thailand government regulations to control sugar production, and cultural visits will also be included. Details on the Thailand visit may be obtained from Dr. Kasem Sooksathan, TSSCT, 129 Luang Road, Vorack, Bangkok 10100, Thailand, while information on the main Congress is available from Ir. Moeljono Hadipoero, General Secretary-Treasurer, P.O. Box 86 JKWB, Jakarta 10270, Indonesia.

by Mozambique's Instituto Nacional do Açúcar and estimates that the country has an attainable capacity of between 80,000 and 90,000 tonnes in the short term. Years of neglect since 1974 and the deteriorating security situation have debilitated the industry to such an extent that it would need a major capital investment to bring it back to previous levels.

Yugoslavia self-sufficiency in sugar⁵

Yugoslavia will produce 840,000 tonnes of sugar this year, enough to meet domestic needs, according to officials of the sugar industry. Sugar beet was sown on 150,000 hectares and was expected to yield 6.5 million tonnes.

Hawaii sugar industry stabilization⁶

Hawaii has been scaling back its acreage and production for the past few years but any further cuts after the 1985/86 season are expected to be minimal, owing to Hawaii's economic dependence on sugar. Estimates of the 1985/86 crop range between 950,000 and 1 million short tons, against the 1984/85 level of 1,060,000 tonnes, raw value, the drop being due to the early harvesting of part of the 1985/86 crop at the beginning of 1985 to avert further damage caused by drought at that time. Sugar is the largest private employment sector in Hawaii outside of tourism. Switching out of sugar into another crop or land use is only marginally feasible; cane acreage has been diverted to macadamia nuts to the extent that the latter crop faces the threat of oversupply, while alternative vegetable crops account for only a few acres. Additional tourism development will not only destroy the intrinsic value of the resort industry but cannot be supported by the limited infrastructure (water, sewage, energy, etc.).

Drought damage to cane in Maharashtra⁷

Of the 87 sugar factories in Maharashtra, 50 may face early closure in the season which started in October, owing to lack of cane. Rainfall has been scanty and the water from dams has been cut by 50%. In Ahmednagar district closing-down of a majority of the factories is possible while in Shrirampur and Kopergaon only 10% of the cane is expected to survive the drought.

Sugar usage in the UK⁸

Use of sugar by the UK chemical industry has more than doubled since 1981/82, from 12,641 tonnes to 27,724 tonnes in 1984/85. At the same time, total UK consumption of sugar has been declining, from 2,322,000 tonnes in 1982/83 to 2,302,000 tonnes in 1984/85, according to figures revealed by the Minister of Agriculture.

- 1 *Revista do Alcool*, 1985, 4, (3), 47.
- 2 *Reuter Sugar Newsletter*, September 17, 1985.
- 3 *I.S.O. Stat. Bull.*, 1985, 44, (9), 31.
- 4 F. O. Licht, *Int. Sugar Rpt.*, 1985, 117, 668-669.
- 5 *Reuter Sugar Newsletter*, October 24, 1985.
- 6 "The US sweetener situation" (B. W. Dyer & Co., New York), Nov. 1985, p. 6.
- 7 *Sugar Scene*, 1985, 3, (10), 12.
- 8 *Chemistry & Industry*, December 2, 1985.

Argentina sugar crop limitation⁹

It was announced earlier that production of sugar in Argentina in 1985/86 would be limited to 1.1 million tonnes with the only permitted exports being a small quantity needed to meet the US supply quota. The quota for the 10 months December 1985-September 1986 has been set at just under 67,000 tonnes. There have been rumours that this original plan might be exceeded, especially since the recent devaluation of the peso which has made world market prices more attractive. However, subsequent frosts in the Province of Tucumán, normally producing 60% of the country's output, are reported to have reduced the average sugar content of the cane from the normal 10% to below 8%. Although it is thought that domestic needs and the US quota remain assured, it is unlikely that any sugar will be available for shipment to other countries.

USSR sugar plan targets¹⁰

The Soviet Union plans to raise beet production during the 12th Five-Year Plan period (1986-1990) to 92.0-95.0 million tonnes, which compares with 74.8 million tonnes during the first four years of the 11th Plan. The target for sugar beet differs significantly from the target of 102-105 million tonnes set in 1982. The target for beet sugar production has been set at 10-11 million tonnes, white value, compared with an average of 7.15 million tonnes in the first four years of the 11th Plan.

New Brazilian sugar factory-distillery¹¹

Linhães Agro-Industrial S.A. is to invest 60,000 million cruzeiros in the enlargement of its alcohol production capacity by 300,000 litres per day and in construction of a sugar factory, integrated with its distillery, for manufacture of 36,000 tonnes of sugar per season. The facilities will be at Fazenda Córrego das Pedras, 15 km from Linhares, where the company has a distillery producing currently 160,000 litres of alcohol per day.

Andhra Pradesh sugar industry expansion¹²

During the 1984/85 season, ended in September last, the 30 sugar factories of this Indian state which were operating crushed a total of 3,751,000 tonnes of cane and produced 354,000 tonnes of sugar. In the previous season 31 factories crushed 3,054,000 tonnes of cane to produce 294,000 tonnes of sugar, so that the latest output represented an increase of around 22% above that of 1983/84. It is planned that in 1985/86, 32 factories will crush 5,000,000 tonnes of cane to produce around 475,000 tonnes of sugar.

Jamaica project for electricity from cane¹³

Construction of a facility for production of electricity from sugar cane is slated for July 1986 after a feasibility study under the direction of the US Agency for International Development. The project calls for some 20,000 acres of land to be planted with high-yielding high-fibre cane. It will be possible at any time to include alcohol among

the products of the facility by fermenting extracted sugars while the cane trash and bagasse will be used to generate 45 MW of electricity. The cogeneration of CO₂ and heat for hydroponic gardening are to be included in the project.

CITS 18th General Assembly

Following an invitation by the Italian sugar industry, the 18th General Assembly of the Commission Internationale Technique de Sucrerie will be held in Ferrara during June 8 - 12, 1987. The scientific committee has selected as priority themes the following: (1) Sugar degradation, (2) Colour, and (3) Pulp. Papers on other subjects may also be presented. Scientists and technologists of the sugar industry who wish to present a paper to this General Assembly should communicate the title and a brief summary, before October 1, 1986, to the following address:

Dr. R. Pieck, General Secretary, CITS,
Aandorenstraat 1, B-3300 Tienen,
Belgium.

All additional information regarding this meeting can be obtained from the same address.

Mexican factory closure proposals¹⁴

The Mexican state-owned sugar agency, Azúcar S.A., has proposed closure of six or seven of the country's sugar factories which are said to be unprofitable. This could lead to 15,000 workers losing their jobs and the leader of the Mexican Sugar Workers Union has urged reconsideration of the proposal; he suggests that the state should think not just of sugar production but also of fuel alcohol manufacture.

An "Unrefined Sugarmark"

Some years ago, the industry introduced the "Sugarmark", a drawing in the form of a heaped teaspoonful of sugar which is featured on stationery and packaging and intended to convey the idea of purity as a selling point for high-grade white sugar. Now, a sugar importing company, Edward Billington (Sugar) Ltd., of Liverpool, is introducing into the UK market its own sign which identifies their sugar as unrefined cane sugar from Mauritius but will undoubtedly be sold at a premium price on the grounds that it is nutritionally superior to both white sugar and to brown sugars made by coating white sugar with cane molasses. The company relies on the opinions of Professor John Yudkin whose claims that refined sugar was "pure, white and deadly" caught the headlines some years ago (but have been largely ignored by the consumer). On the Barnum hypothesis that "there's one born every

minute", Billington's will undoubtedly make money on their sales; refutation of the health scares of the food-faddists is much less newsworthy than the original stories and it is the latter which are remembered by the unthinking (and probably overweight) man or woman in the street.

ICUMSA 19th Session

The 19th Session of the International Commission for Uniform Methods of Sugar Analysis is to be held in Cannes, France, during May 25 - 30, 1986, and intending participants are asked to send provisional notifications to the organizing committee who will then send registration documents. The address is: Comité National Français de l'ICUMSA, c/o I.R.I.S., 360 rue Jules Guesde, B.P. 39, 59651 Villeneuve d'Ascq Cedex, France.

Cane molasses desalting in Australia¹⁵

Bundaberg Sugar Co. Ltd. and Syrnix Research Pty. Ltd. are working in association with Molasses Products Corporation Ltd. on a unique desalting membrane technology. This major research program is aimed at desalting molasses to make it more palatable and more beneficial as a stock feed. Trial work at Millaquin mill has involved full-scale production runs using a 240-tube membrane plant for separation of excessive potassium which affects taste and digestibility.

Bagasse depithing in South Africa¹⁶

A new depithing plant has been installed at the Felixton sugar factory of Tongaat-Hulett Sugar; it separates fibre for supply to Mondi for paper manufacture while the pith and residual fibre is used to supply the factory's boilers. The new plant comprises three structural steel towers, five large rubber-lined cyclones, two belt conveyors and a slat conveyor able to handle 110 tonnes of coarse fibre per hour. The contract also included rebuilding of five 110 kW fans, assembling associated rotary valves and ducting and complete refurbishing of two mechanical depithers as well as redesign and rebuilding of two depither feeders.

Alcohol manufacture in Hawaii¹⁷

Tropicana Petroleum plans to construct a sugar-fed fermentation/distillation ethanol plant in Hawaii as a part of the company's commitment to the state governor for allowing non-Hawaii-produced ethanol to qualify for a 4 cents/gallon state tax break. Tropicana is to make its final decision on the plant before May 1987.

9 C. Czarnikow Ltd., *Sugar Review*, 1985, (1943), 156.

10 F. O. Licht, *Int. Sugar Rpt.*, 1985, 117, 667.

11 *Revista do Alcool*, 1985, 4, (4), 39.

12 *Sugar Scene*, 1985, 3, (9), 17.

13 *Amerop Westway Newsletter*, 1985, (144), 17.

14 F. O. Licht, *Int. Sugar Rpt.*, 1985, 117, 615.

15 *Australian Sugar J.*, 1985, 77, 292.

16 *S. African Sugar J.*, 1985, 69, 412.

17 *Alcohol Week*, 1985, 87, 12.



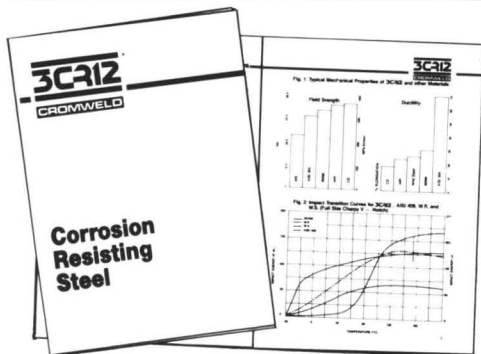
**the
material
answer to
CORROSION
and
ABRASION
in beet sugar
extraction**

Few applications can be as tough on steel as sugar beet processing.

Typically, carbon steel and abrasion resisting steel beet troughs which have to withstand 2000 tonnes of water per hour with 20% solids can fail within one campaign.

Cromwell 3CR12, in the same application, is still going strong three campaigns later.

An 11.5% chromium steel which combines corrosion and abrasion resistance with good weldability and ductility, Cromwell 3CR12 is the ideal, cost-effective solution to the toughest bulk handling problem.



If you would like to find out more, contact:
Cromwell Steels Ltd, Cornwall House, Sandy Lane
Newcastle-under-Lyme Staffs ST5 0LZ.
Telephone (0782) 636451. Telex 36359.

JOHN H. PAYNE INC.

International Sugar Consultants and Engineers

Cane Preparation

William Searby Developed
the Shredder in 1914

in
Hawaii

1164 Bishop Street
Suite 1510
Honolulu, Hawaii
U.S.A. 96813

Tel: (808) 536-7031
Telex: 633173
Cable: PAYNEHAWAI

REALTY INTERNATIONAL

**Real Estate Consultants
Brokers and Managers**

Confidential real estate appraisal,
search and acquisition throughout
the United States. Multi-lingual
consultants available for acting on
behalf of foreign principals

REALTY INTERNATIONAL

2915 Monroe Street
Columbia, SC 29205
U.S.A.

Tel: (803) 254-5555

Realty International is a subsidiary of Kuhne International Holdings

Rockware International

RELIABILITY THROUGH REMANUFACTURING

TIME PROVEN TECHNOLOGY AND DEPENDABILITY

BOILERS

225,000 PPH, 477 PSI/575° F, RILEY, BAGASSE, STOKER COAL
180,000 PPH, 425 PSI SATURATED, RILEY, BAGASSE, STOKER COAL
180,000 PPH, 280 PSI SATURATED, RILEY, BAGASSE, STOKER COAL
135,000 PPH, 675 PSI SATURATED, SPRINGFIELD BAGASSE, STOKER COAL
112,000 PPH, 475 PSI/725° F, WICKES, BAGASSE, STOKER COAL
112,000 PPH, 475 PSI/725° F, B & W, BAGASSE, STOKER COAL
85,000 PPH, 675 PSI/750° F, B & W, BAGASSE, GAS, OIL

SPEED REDUCERS

2,250 HP FALK, 4.4 RATIO, 1.5 S.F., INPUT 720 RPM, OUTPUT 163 RPM
1,700 HP PACIFIC WESTERN, 10.946 RATIO, INPUT 3600 RPM, OUTPUT 329 RPM
1,375 HP FARRELL, 13.01 RATIO, 1.5 S.F., INPUT 3600 RPM, OUTPUT 277 RPM
1,000 HP LUFKIN, 13.36 RATIO, 2.47 S.F., INPUT 3600 RPM, OUTPUT 270 RPM
1,000 HP WESTINGHOUSE, 3.364 RATIO, 2.54 S.F., INPUT 300 RPM, OUTPUT 89 RPM
300 HP FALK, 110.06 RATIO, 3.75 S.F., INPUT 1200 RPM, OUTPUT 11 RPM

TURBINE GENERATORS

7,500 KW G.E., NON-CONDENSING, 435 PSI/750° F, 100 PSI EXT, 15 PSI EXH
7,500 KW G.E., NON-CONDENSING, 410 PSI/650° F, 250 PSI EXT, 45/60 PSI EXH
5,000 KW G.E., NON-CONDENSING, 400 PSI/650° F, 150 PSI EXT, 60 PSI EXH
4,000 KW WESTINGHOUSE, NON-CONDENSING, 215 PSI/525° F, 60/10 PSI EXT
3,500 KW G.E., NON-CONDENSING, 400 PSI/545° F, 50 PSI EXT, 5 PSI EXH
2,500 KW G.E., CONDENSING, 450 PSI/700° F, 50 PSI EXT
2,500 KW G.E., NON-CONDENSING, 450 PSI/750° F, 50 PSI EXH
1,500 KW G.E., NON-CONDENSING, 200 PSI/D & S, 10 PSI EXH
1,500 KW WESTINGHOUSE, NON-CONDENSING, 225 PSI/580° F, 18 PSI EXH
1,250 KW ALLIS CHALMERS, NON-CONDENSING, 175 PSI/D & S, 18 PSI EXH
300 KW TERRY, NON-CONDENSING, 200 PSI/500° F, 20 PSI EXH

CORLISS ENGINES

1,000 KW CORLISS, 125 PSI/D & S, 5 PSI EXH

Complete Power Plant Systems for sale, lease or joint venture on a Turnkey Basis
Remanufactured to your specific requirements



ROCKWARE INTERNATIONAL

P. O. Box 95833 • Oklahoma City, OK 73143 • U.S.A.

(405) 670-6686

TLX No. 796342

ROTATOOLS (U.K.) LTD.

TUBE CLEANING EQUIPMENT SPECIALISTS

支管清刷配備

電力及氣件操作的清刷配備能快
速有效的清潔蒸發器和熱汽鍋水
的管及支管。

Nettoyeurs pneumatiques et électriques. Transmissions flexibles et brosses pour évaporateurs, etc., pour une nettoyage rapide et efficace.

Rohrreinigungsgeräte mit elektrischem- oder pneumatischem Antrieb. Werkzeuge und Bürsten für Verdampfer, usw., für schnelle und wirksame Reinigung.

لوله پاک کننده برقی و بادی با ابزار و اتصالات قابل انعطاف

دوس برای بدنه های تخییر و غیره باروش سریع موز

Represented throughout the World

★ Fast & effective tube cleaners (air & electric) for all sugar mill tubular plant.

Hand and mechanical tube brushes of all designs and types.

FLEXIBLE SHAFTS · TOOLS · CUTTERS · WIRE BRUSHES etc.

ROTATOOLS (U.K.) LTD.

BROOKFIELD DRIVE, LIVERPOOL L9 7EG, ENGLAND

Phone: 051-525 8611

Grams: SCALEWELL, LIVERPOOL

Telex: 667325 - COMCAB - G. ROTATOOLS

SUGAR BOOKS

Prices given below include insurance, packing and surface mail postage. They are approximate and subject to alteration without notice owing to fluctuations in currency exchange rates. Air mail postage extra will be quoted on request. Terms are strictly cash in advance.

Check your personal library against the list of basic books given below:

GEOGRAPHY OF SUGAR CANE: <i>Blume</i>	(1985)	£51.50
WSJ DIRECTORY OF THE WORLD SUGAR INDUSTRY	(1984)	£230.00
ELSEVIER'S SUGAR DICTIONARY: <i>Chaballe</i>	(1984)	£55.40
AUSTRALIAN SUGAR YEARBOOK 1984	(1984)	£22.15
F. O. LICHT'S INTERNATIONAL SUGAR YEARBOOK AND DIRECTORY	(1985)	£44.70
NOEL DEERR: CLASSIC PAPERS OF A SUGAR CANE TECHNOLOGIST: <i>Ed. Payne</i>	(1983)	£83.25
BEEF SUGAR TECHNOLOGY (3rd ed.): <i>McGinnis</i>	(1982)	£40.50
UNIT OPERATIONS IN CANE SUGAR PRODUCTIONS: <i>Payne</i>	(1982)	£34.00
MANUFACTURE AND REFINING OF RAW CANE SUGAR (2nd ed.): <i>Baikow</i>	(1982)	£98.30
BY-PRODUCTS OF THE CANE SUGAR INDUSTRY (3rd ed.): <i>Paturau</i>	(1981)	£48.80
STANDARD FABRICATION PRACTICES FOR CANE SUGAR MILLS: <i>Delden</i>	(1981)	£38.85
THE EFFICIENT USE OF STEAM: <i>Ed. Goodall</i>	(1980)	£53.65
SUGAR ANALYSIS: ICUMSA METHODS: <i>Schneider</i>	(1979)	£13.75
CANE SUGAR HANDBOOK (11th ed.): <i>Meade-Chen</i>	(1977)	£116.65
PHYSICS AND CHEMISTRY OF SUGAR BEET IN SUGAR MANUFACTURE: <i>Vukov</i>	(1977)	£68.00
SUGAR BEET NUTRITION: <i>Draycott</i>	(1972)	£27.25
HANDBOOK OF CANE SUGAR ENGINEERING: <i>Hugot, transl. Jenkins</i>	(1972)	£144.00
PROCEEDINGS 16th (1974) SESSION ICUMSA	(1975)	£8.50
" 17th (1978) " "	(1979)	£23.65
" 18th (1982) " "	(1983)	£18.50
ANALYTICAL METHODS USED IN SUGAR REFINING: <i>Plews</i>	(1970)	£25.25
SUCROSE CHEMICALS: <i>Kollonitsch</i>	(1970)	£8.50
INTRODUCTION TO CANE SUGAR TECHNOLOGY: <i>Jenkins</i>	(1966)	£57.50
TECHNOLOGY FOR SUGAR REFINERY WORKERS (3rd ed.): <i>Lyle</i>	(1957)	£20.00

SUGAR BOOK DEPARTMENT

International Sugar Journal Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.

Index to Advertisers

Australian Sugar Journal	ii
Contra-Shear Developments Ltd.	iv
Cromwell Steels Ltd.	v
International Business Associates	ii
Maguin.....	Cover II
M.E.S. International Ltd.	viii
John H. Payne Inc.	v
H. Putsch GmbH & Co.	Cover IV
Realty International	v
Renold Conveyor	iv
Rockware International	vi
Rotatools (U.K.) Ltd.	vi
Sugar Manufacturers Supply Co. Ltd.	iii
Taiwan Sugar.....	viii
Western States Machine Co.....	Cover III

We have a large amount of Stork Generator/
Turbine spares for the following:

Manufacture by Stork Heemaf

Date 1953

RPM Turbine 6000

RPM Generator 1000

OUTPUT 600 KW

Major parts include — Complete Rotor, Reduction
Gear etc. Please enquire for any parts or complete
list.

Please contact:

M.E.S. INTERNATIONAL LTD

11-13 COPDALE ROAD

LEICESTER LE5 4FG

ENGLAND

Tel: (0) 533 734311

Telex: 342293

For immediate attention

TAIWAN SUGAR

A bi-monthly journal published by
Taiwan Sugar Corporation deals
not only with the cane agriculture
and sugar manufacturing but also
areas of interest to the worldwide
sugar industries as well.

ANNUAL SUBSCRIPTION:

Seamail: Asian & Other Areas: US\$13.00

Airmail: Asian Area: US\$14.50

Other Areas: US\$16.50

Free specimen copy and advertising
rates on request.

TAIWAN SUGAR

25 Pao Ching Road
Taipei, Taiwan 100
Republic of China

Sugar Cane

The International Journal of Cane Agriculture

This new journal is published every two months.
It includes the abstracts on cane agriculture which
have previously been published as part of *International
Sugar Journal* and also incorporates an expanded
number of articles on sugar cane agriculture. Sub-
scriptions cost £20 or \$32 per year for copies supplied
by seamail, and £32 or \$52 for copies supplied by
air.

Advertising rates are modest and attractive in view
of the complete coverage of the world's sugar cane
industry which it provides.

Readers of this Guide are urged to ensure that they
receive a regular supply of *Sugar Cane* by sending a
cheque in the appropriate amount to the address
below. Companies supplying agricultural equipment
and materials to sugar cane growers are also recom-
mended to write for details of advertising rates, distrib-
ution, etc.

Sugar Cane

P.O. Box 26, Port Talbot

West Glamorgan SA13 1NX

United Kingdom

Tel.: 0639-887498

Telex: 21792 REF 869

“Are your profits in critical condition because of an aging centrifuge?”

Perform “CPR” Centrifuge Performance Revitalization



Six reasons why it makes sense to revitalize your centrifuge.

- 1. OVERALL ECONOMY**—save up to 60% of the cost of new equipment or, in cases where exotic alloys were originally utilized, savings may be even higher.
- 2. IMPROVE PERFORMANCE**—install the latest features, change metallurgy or replace surface coverings. Install more efficient drive systems and improve feed and unloading capabilities.
- 3. UPGRADE CONTROLS**—utilize the latest in manual or programmable control technology for more efficient operation.
- 4. REDUCE MAINTENANCE**—a revitalized centrifuge reduces downtime . . . less downtime means more profits!
- 5. INCREASE SAFETY**—upgrade point-of-operation safeguarding to the latest state-of-the-art design.
- 6. ONE YEAR WARRANTY**—Western States will issue a full year warranty on any work performed during “CPR.”

If your aging centrifuge is in a “CRITICAL” stage in your process and requires “INTENSIVE CARE,” let The Western States Machine Company specialists perform “CPR” on your equipment.

Our experienced process professionals will evaluate your equipment and provide valuable assistance during design review and start-up to revitalize your machines performance.

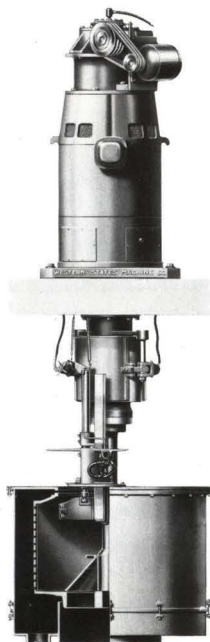
Western States is a recognized leader in the design and manufacture of Basket Centrifuges for the chemical, pharmaceutical and sugar industries. Whether you need to upgrade your equipment or just bring it back to specs, Western States can help solve your processing challenges. Write or call for more information on how we can make your aging centrifuge perform LIKE NEW.

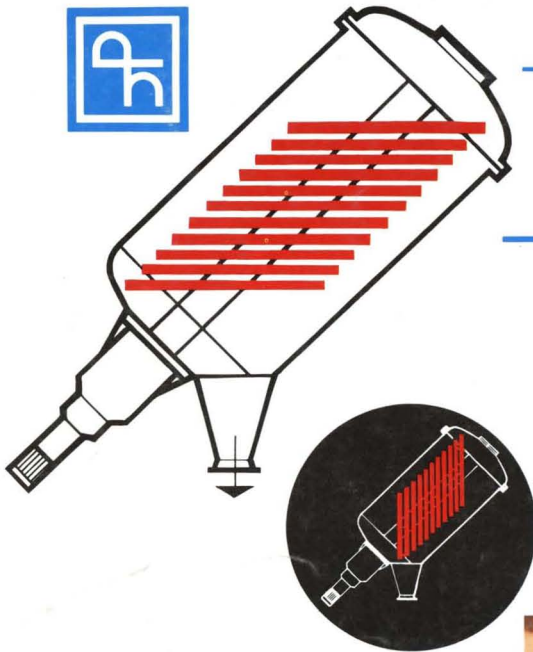
PUT OUR EXPERIENCE AND FACILITIES TO WORK FOR YOU!

**COME TO THE
CENTRIFUGE
SPECIALISTS
WESTERN STATES**



The Western States Machine Company
1770 Fairgrove Avenue
Hamilton, Ohio 45012
Telephone (513) 863-4758





Performance proves

Putsch Quality.

Putsch **Plate Filter**

The Darlings of the plant

Schematic drawings show filter in operation with plates in horizontal position and during cake removal in vertical position.

An unorthodox design: Filter is mounted at an angle of about 45°.
In operation: Filter plates stay in a horizontal position.
For cake removal: Central shaft is turned slowly.

Therefore:

- Safe filtration
- Easy cake removal
- Filtering surface completely clean after each cycle
- High capacity
- Fully automated
- Easily serviced
- Operation preferably with precoat, also with active carbon
- Ideal device for polishing sugar juices, such as thick juice, clairce, standard liquor etc.



After all - it's performance that counts.

Please ask for our offer and literature.



H. Putsch GmbH & Comp. · P.O. Box 4221 · 5800 Hagen 1/W.-Germany · Tel. (23 31) 3 10 31 · Telex: 8 23 795
In the USA: H. Putsch & Company, Inc. · P.O. Box 5128 · Asheville, N.C. 28803 · Tel. (704) 6 84-06 71 · Telex: 577 443
In Italy: Putsch-Meniconi: Loc. Bellavista, 48 · 53036 Poggibonsi (Siena) · 0577/979146 (3 Linee) · Telex: 571 169
In Spain: Putsch-Nerva. SA. · Apartado 406 · Valladolid 8 · Tel. (83) 272208-12-16 · Telex 26383