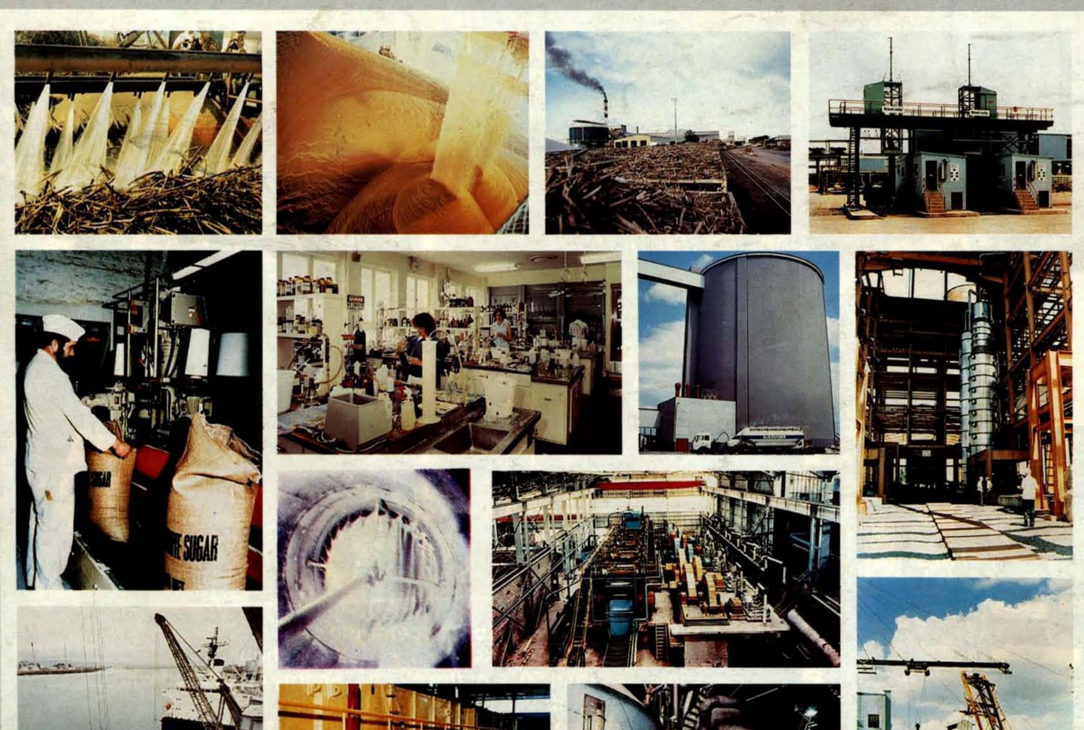
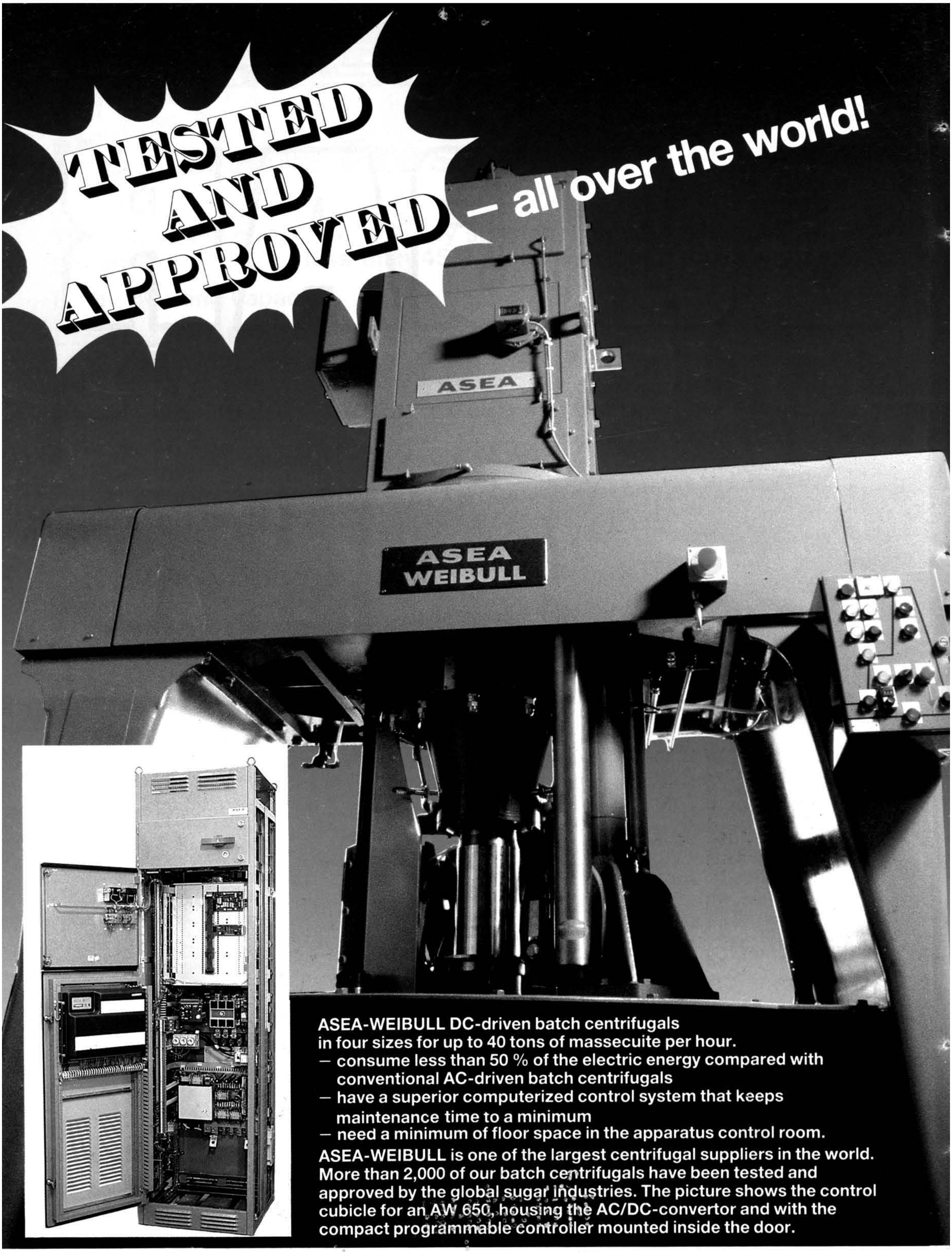
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXIX/ISSUE No. 1059

MARCH 1987



ASEA-WEIBULL DC-driven batch centrifugals in four sizes for up to 40 tons of massecuite per hour.

- consume less than 50 % of the electric energy compared with conventional AC-driven batch centrifugals
- have a superior computerized control system that keeps maintenance time to a minimum
- need a minimum of floor space in the apparatus control room.

ASEA-WEIBULL is one of the largest centrifugal suppliers in the world. More than 2,000 of our batch centrifugals have been tested and approved by the global sugar industries. The picture shows the control cubicle for an AW 650, housing the AC/DC-convertor and with the compact programmable controller mounted inside the door.

For further information, please contact
ASEA INDUSTRY AND ELECTRONICS,
Dept. IDF, S-721 67 VÄSTERÅS,
Sweden, or nearest local ASEA office.

Nils Weibull AB

ASEA

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

Printed by Adams & Sons (Printers) Ltd.,
Blueschool Street, Hereford.
Telephone: 0432 54123

INTERNATIONAL SUGAR JOURNAL

Volume 89
Issue No. 1059

CONTENTS March 1987

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: 2790 Foster Avenue, Corning, CA 96021
Inquiries regarding advertising should be addressed to the above offices or the appropriate representative:

UK and Continental Europe, other than France and Holland	Robert Baker, P.O. Box 107, Camberley, Surrey GU17 9HN, England. *Tel:* 0276-32842. *Telex:* 858893 Fletel G.
France:	MaG-Watt International, 6 rue des Acacias, Vert-le-Grand, 91810 Essonne. *Tel:* (6) 456.00.15.
Holland:	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
Korea:	Ace Korea Company, C.P.O. Box 9315, Seoul. *Tel:* (02) 273-7011/2 *Telex:* 23231 Mocndm Ext. 4023.

News and views

World sugar prices

The new year started quietly with the London Daily Price for raw sugar sliding gently from its opening level of $145 per tonne on January 2 to $139.50 on January 7. Rumours began of purchases by the USSR; these were confirmed and, with growing evidence of tightness of supplies in Brazil, the LDP rose quickly to a minor peak of $164.50 on January 15, and then to $195 by January 29 before ending the month at $183. The Soviet Union, absent from the world market for much of the last quarter of 1986, bought between 500,000 and 750,000 tonnes in January and is thought to need a total of up to 1,000,000 tonnes, partly because of lower production in Cuba and partly because of a boom in soft drinks consumption in the USSR following tight restrictions on alcohol sales.

The Brazilian Sugar and Alcohol Institute has sought the rolling forward of some of its export contracts and is thought to be seeking cancellation of some of these in face of reduced production because of drought and higher domestic demand for both sugar and fuel alcohol. The Cuban crop has also been hit by drought and this is also a possibility with Australia which is suffering in the same way.

The demand and shortfall being concerned with raw sugar, the LDP(W) or white sugar price was not affected as much as that for raw sugar. In general, it rose with the LDP but not to the same extent so that the premium, which started the month at around $30, had halved near the end of the month. Thus, the LDP(W), which was $174.50 on January 2, rose to a peak of $211.50 on January 26 and ended the month at $204.50.

Iran cane sugar expansion[1]

The Iranian government recently decided on a 7-year development program to increase cane sugar production in the Khuzestan province. The costs of the program are estimated to total 400,000 million rials, half of which is for an improvement in the infrastructure. Some 35% of the total sum to be invested will have to be spent in foreign currency, corresponding to some $1200 million. Beginning with the second year of the development program, $200 million will be available annually, according to the Deputy Minister of Agriculture. The project provides for annual production of 700,000 tonnes of cane sugar from an area of 70,000 hectares in Khuzestan (1985/86 cane sugar output was 233,000 tonnes, raw value.) By the application of efficient agricultural methods,the average crop yield per hectare is to be raised. Along with the planned increased harvest, several new sugar factories as well as production plants for by-products such as animal feed, paper, etc., are to be built.

Total sugar production in the Iranian year 1364 (March 21, 1985 - March 20, 1986) amounted to 700,000 tonnes, white value, and this is to be raised in the current year to 800,000 tonnes. Iran has 36 beet sugar factories and 2 cane sugar factories. Owing to difficulties in raw material supplies, utilization of production capacity is comparatively low and Iran has to import sugar in order to cover domestic requirements.

Problems but higher prices forecast

In its annual survey, "World commodity outlook, 1987", the Economist Intelligence Unit considers that the free market for sugar will remain subject to malign political influences. Globally, sugar should again be in deficit by about 1.5 million tonnes, despite a 3% rebound in production, but imports are likely to fall sharply by over 9%. An important factor will be the contraction of US imports. Squeezed between rising US domestic production, the competition of corn syrups and the obligation of the CCC to operate the loan program at nil cost to the Treasury, exporters to the USA face disaster unless sugar policy is changed in the interests of the US foreign policy. India, too, is pushing closer to self-sufficiency while subsidized EEC exports will remain heavy. The free market price is expected to average under 7 cents/lb in 1986/87, rising to 8-9 cents/lb towards the end of the season in expectation of a bigger supply deficit in 1987/88.

Poor prospects for a new ISA

At the start of 1986 there were hopes of improvement in sugar prices owing to expected cutbacks in sugar production by exporters, both by deliberate action and as a consequence of bad weather, etc. A premature rise in prices following the nuclear power station accident in Chernobyl gave rise to optimism and output was not reduced. While individual countries react in this way, the road to a recovery in world sugar prices is likely to be longer than necessary and prospects for an eventual surge in prices following a supply shortfall more probable. A new International Sugar Agreement which could regulate the supply of sugar to the world market would be of benefit to all exporters if they could act together.

It is accepted that exclusion of the EEC from the previous ISA was a major cause of its failure, and that agreement among the Big Four exporters (Australia, Brazil, Cuba and the EEC) must be the cornerstone of a new agreement. For this reason, it is disappointing that there was no progress during talks between their delegates to the ISO meeting in London last November and that plans for further talks in February were cancelled.

An outline of the problems facing the Big Four was recently published[2]:

"The EEC delegation had come (to the November meeting) without any kind of mandate to negotiate, but one might have expected to see some concrete discussion taking place on the Brazilian proposal to allocate market shares in percentages of actual imports needs, not in fixed tonnages. The situation was almost immediately blocked by Australia's insistence on having at least a minimum export entitlement in tonnage, which comes against the very principle of the

1 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 620.
2 *Amerop-Westway Newsletter*, 1986, (157), 7.

"automatic adjustment" idea. This is all the more important since import demand is dropping; according to figures released by the ISO secretariat, net import demand on the free market (which includes the USA) will drop from 18.1 million tonnes, raw value, in 1985 to 17.6 million in 1986 and to 16.3 million tonnes in 1987.

"Australia's situation explains much of this attitude; Australia is a producer almost totally lacking flexibility. Cuba has the socialist countries' outlets (although Australia would like to cut this avenue sharply), Brazil can switch to alcohol, and the EEC has the advantages of both an annual sugar crop and "carry-over" mechanisms for export sugar. Australia only knows how to produce, without having even the capacity to store much sugar from one crop period to another. Also, Australia is in the process of reformulating its sugar policy and restructuring its industry — particularly the growing sector. Would it be safe to make international commitments without knowing whether the reshaped industry will be able to adapt to them? To this question, the Australian answer, at least for the time being: no."

Peru sugar industry dispute[3]

The cooperatives which produce sugar in Peru accuse the government of continuing the previous adminstration's policy of reversing gains made through agrarian reform and deliberately undermining the cooperatives by maintaining low prices and by not providing incentives. They are protesting at authorization of sugar imports totalling 200,000 tonnes. The cooperatives say the imports are excessive and demand that the government raise prices paid to producers to induce expansion of output. At present they receive 4.5 intis ($0.23) per pound for white sugar, well below their production cost.

The government is criticized for not announcing decisions on price policy, which could bring serious liquidity problems for the industry and result in a fall in production as in 1986 when outturn dropped to 620,000 tonnes from 757,000 tonnes the previous year.

Japanese refiners under pressure[4]

In 1976 30 refining companies in Japan operated 37 plants with a theoretical refining capacity of 3.81 million tonnes per annum. This was well in excess of requirements which were of the order of 2.8 million tonnes. The excess capacity, combined with unequal shares of high-priced import contracts, led to strong competition between the refiners for market share, causing the domestic price for refined sugar to fall far below the theoretical levels of the government's stabilization scheme. This had two consequences: first, refiners, supported by associated trade houses, suffered very heavy losses and, second, the cost of subsidizing domestic farmers increased for the government.

To solve the problem, legislation was introduced in early 1978 to fix the share of imported raw sugar for each refiner. With a reduction in competition, prices stabilized. The system of import quotas for refiners was incorporated in the sugar price stabilization law in 1982, along with measures to reduce the price advantages of HFS. With relatively stable prices and known market shares, refiners were able to rationalize their operations under the industrial restructuring law which was applied to the sugar industry in 1983.

By June 1986 refining capacity had been reduced to 2.85 million tonnes per annum with government figures showing 24 refining companies and 22 plants, some operated jointly. However, this traumatic shrinking of the industry, which involved scrapping existing facilities, moving large numbers of staff to other activities and refinancing the companies, has not really solved the refiners' problems. Because of the growth of domestic beet and the increase in HFS, refinery melt requirements have been reduced by about 750,000 tonnes during the same period. As a result, over-capacity remains of the same order as it was in 1978.

Over 600,000 tonnes of outlet has been lost to cheaper HFS which is only able to compete with sugar because of the Japanese government's pricing policy for domestic sugar. At present Japanese refiners face an even greater threat, however. Japanese industrial consumers require cheap raw materials and blends of sugar and confectionery mixes do not bear the import duty or surcharges that apply to sugar. In 1985/86 over 150,000 tonnes of such blends were imported and this is expected to rise over 200,000 tonnes in the current year. This will further undermine the position of the Japanese refiners and of their suppliers.

The government is examining the possibility of abolishing the consumption tax on refined sugar of 16,000 yen ($98) per tonne which has been imposed since 1901; this only accounts for one-sixth of the costs imposed by government, however. A reconsideration of the whole policy of paying uneconomical prices to domestic farmers to grow sugar which is already freely available at depressed prices on the world market would be much more helpful to Japanese sugar consumers, refiners and world market suppliers.

World sugar production, 1986/87

F. O. Licht GmbH have recently produced their second estimate of world sugar production for the current season[5] which takes account of the larger than expected European beet sugar crop which, with a cane sugar forecast almost the same as the first, brings the total for world sugar output to 101,425,000 tonnes, raw value. The new forecast has the benefit of virtually final figures for most West European countries and also clearer indications of conditions in East Europe, although there are still uncertainties over the final outcome of cane sugar crops in Brazil, Cuba and India. With the forecast level of production, however, Licht does not believe that stocks can decline as much as predicted by some analysts.

3 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 655; 1987, **119**, 14.
4 *Czarnikow Sugar Review*, 1986, (1756), 180 - 181.
5 *Int. Sugar Rpt.*, 1987, **119**, 41 - 49.

Product news

BMA reduces crystal breakage

Shattering of sugar crystals is an inherent feature of conventional continuous centrifugalling, owing to the impact of discharged crystals on the housing. Now BMA have developed a device, known as the Crystal Rotor, which slows the stream of crystals, reducing the impact and enhancing crystal quality. The Crystal Rotor is essentially a spoked wheel, fitted with metal plates, which rotates within the centrifugal housing but at a lower speed than the basket. The stream of crystals leaving the basket is intercepted by the plates and substantially retarded before impacting with the housing. Results have demonstrated the effectiveness of the Crystal Rotor in the near elimination of crystal breakage. Crystal Rotors can be retro-fitted to existing continuous centrifugals.

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

No-cost filtering?

The use of fine or polish filtration is accepted for sugar liquors in refineries but has always been unpractical when applied to evaporator syrups in the raw sugar factory. However, the growing market for sparkling, low-turbidity sugars direct from the factory for industrial and retail sale is changing the picture. Existing filtration systems, relying on precoated cloths or screens and the inclusion of filter aid in the syrup, not only make them costly to run but also the high viscosity and fine particle size of the turbidity can give poor filtration performance.

Tate & Lyle's Process Technology Division has been working on this problem and they have come up with a modification of their Talo deep bed filter to do the job. In its existing application in refineries, the filter is used to protect char and carbon columns from premature fouling, to extend the life of ion exchange resins, and simply to give the liquor a polish prior to crystallization. In factory applications, the deep bed filter works in conjunction with the Talodura thick syrup clarification process, producing high-quality direct consumption sugars with very low turbidity. The syrup can be filtered without difficulty as the deep bed method is not affected by the high viscosity of the process stream.

But perhaps the real advantage lies in the fact that the method employs no filter aid whatsoever, either in refinery or factory applications, so there are virtually no operating costs associated with the process, either directly as bought-in filter aid or indirectly in having to sweeten-off spent filter cake.

Further details:
Tate & Lyle Process Technology,
55 Liddon Road,
Bromley, Kent BR1 2SR,
U.K.

ABAY sugar silo sales

ABAY has just signed a contract in Hungary for the design and licensing of an ABR patented sugar silo. ABAY will provide some of the equipment and technical assistance for its construction. The mechanized steel silo will hold 30,000 tonnes of sugar and will be commissioned in 1988. Recently, Yugoslavia ordered another 40,000 tonne silo, to be constructed in the Cuprija sugar factory. The two contracts bring the number of ABR silos constructed in a dozen different countries to 27; this represents a storage capacity of 864,000 tonnes of sugar.

A breakthrough from Saunders valves

With their new EC pneumatic actuator range, Saunders Valve Company Ltd. have added a new dimension to remote operation for diaphragm valves. Saunders claim the most competitive actuated valve package yet for process industries. Selecting the EC actuator, valve body and diaphragm gives a combination suited to many specific applications in the biotechnology, food processing, water treatment and other process industries.

The component parts of the new actuator – the housing, cap, indicator piston and retaining disc – are fabricated from a new material called polyethersulphone. This is a high-temperature engineering material with superior load bearing, thermal stability and chemical resistance properties. The material is suitable for sterilization by steam, dry heat and chemical techniques.

The resulting low cost is just one of the many benefits. The EC actuator is the smallest practical remote control packages for weir-type diaphragm valves. The first phase includes valve sizes up to 1 inch (DN25), but is to be extended. It is available in fail-safe closing, fail-safe opening and double-acting modes to suit specific process requirements, and provides 100% leaktight closure against recommended line pressures and industrial vacuum. It guarantees long life with extremely low maintenance and offers autoclave capability to meet requirements for external sterilization of process plant.

Further details:
Saunders Valve Co. Ltd.,
Grange Road,
Cwmbran, Gwent, UK.

A new high-performance hydrocyclone

The Larox twin vortex cyclone for water and effluent treatment gives very sharp cut and high separation performance and is easy to adjust to a wide particle size range. It consists of an upper cylindrical section into which material is fed; a washing section where wash water is introduced; and a hydrocyclone for re-treating primary underflow.

Feed is led into the twin vortex cyclone in the normal way. The primary overflow is discharged and led further in the process. The wash water carries coarse fractions into the secondary cyclone. Here the wash water together with a small amount of fines carried by coarser fractions are separated from sand and led to the process or back to the pump sump. In the latter case the wash water can be used for diluting of the cyclone feed. The underflow, free of fines, is returned to the mill or led to further process steps.

By regulating the quantity of wash water the cut size of the cyclone can be adjusted to a great extent. The flow rate of wash water is normally 20 to 40 % of the cyclone feed volume.

Compared with ordinary hydrocyclones or multi-stage cyclone systems Larox claim their twin vortex cyclone offers greater versatility, superior classification efficiency, ease of control and adjustment, and superior desliming or degritting performance.

Further details:
Larox Oy.,
P.O. Box 29,
SF-53101 Lappeenranta,
Finland.

The Pieralisi SCP-C5 continuous centrifugal

A new brochure describes the Pieralisi continuous centrifugal for magmas and high- and low-grade massecuites. It is now possible to prepare, within the machine, a magma or Brix-controlled syrup from the cured sugar, the input of syrup or water being regulated by a motor-driven valve controlled from the power absorbed by the centrifugal, which is related to sugar throughput. The separation of the feed massecuite occurs on the screen which is carried by a frustoconical basket; this is not perforated but has a series of slots at about half its height and another series near the top. Separate drainage of the mother liquor and washings is thus possible.

Further details:
Pieralisi Nuova M.A.I.P. S.p.A.,
Viale Cavallotti 30,
60035 Jesi,
Italy.

Increasing size of FCB sugar equipment

During the latest campaign, Société Fives-Cail Babcock commissioned two pieces of equipment, each in its own field being the largest unit ever built. At the sugar factory at Sainte Emilie, France, belonging to Société Vermandoise Industries, FCB commissioned in October 1986 an RT5-type continuous diffuser which has a nominal processing capacity of 12,000 tonnes of beet per day. This unit, the overall dimensions of which are 67 m by 9.8 m, weighs 1100 tonnes without load and 2300 tonnes when in operation.

At the sugar factory at Vierverlaten, Holland, belonging to CSM Suiker BV, FCB in September 1986 commissioned a 160 m^3/1650 m^2 continuous vacuum pan. This unit, comprising a cylindrical vessel 5.3 metres in diameter and 12 metres long (inside dimensions), is to produce 125 tonnes per hour of second strike massecuite, using heating steam at a low thermal level, with a temperature below 100°C.

Further details:
Fives-Cail Babcock,
7, rue Montalivet,
75383 Paris Cedex 08,
France.

Lucks sugar silo contracts

After having been recently entrusted with the complete design for the third white sugar silo of the Jesi sugar factory in Italy, Lucks & Co. GmbH received in November 1986 a contract for the turn-key erection of a fifth white sugar silo for the Tulln sugar factory in Austria which, like the four existing silos, will be built according to the Lucks silo system. The new unit, of reinforced concrete, will have a storage capacity of about 38,500 tonnes and will bring the total capacity world-wide of white sugar silos erected according to the Lucks system to 3,353,700 tonnes.

New generation digital viscometer

A new Brookfield digital viscometer has recently been launched. Known as the DV-II, this versatile instrument automatically calculates and displays, at a touch, viscosity (centipoises), shear stress (dynes/cm^2) and % scale (Brookfield). The DV-II offers a high degree of sophistication, including simultaneous output of all instrument parameters (limit indicators, %, cp, ss, rpm, model, spindle). It is user-programmable for calculation of any spindle boundary condition and has an 8-speed range giving it the capability of performing rheological studies. It has hard copy output capability for connexion to a recorder, printer or data logger and is computer-compatible for fast and flexible data processing. Other features include auto-zeroing, auto-ranging and display hold. It is compatible with standard Brookfield spindles and accessories and, as with all Brookfield viscometers, accuracy is guaranteed to be within 1% of the selected range with 0.2% reproducibility.

Further details:
Brookfield Engineering Laboratory,
Stoughton, MA 02072,
U.S.A.

Revolution in water filters

The Filtomat is a remarkable innovation in water filters with numerous advantages over alternative methods. It is an on-line full-flow filter with automatic self cleaning which requires no external power source. In addition, it is compact, easily installed in any position, and virtually maintenance-free. A range of meshes down to 15 microns is available with capacities up to 900 m^3/hr, with filtering unaffected by fluctuating water flow.

Raw water entering the filter under pressure passes through a perforated plastic cylinder which acts as coarse grid and strains large particles from the water. A steel ring seals the raw water compartment from the strained water interior. The water then enters the lower compartment which is enclosed by another perforated plastic cylinder, lined with a fine corrosion resistant screen, designed to the particular requirements of the user (screens are available between 50 and 1680 microns). The screen is rigidly attached to the plastic cylinder and is designed to withstand a water pressure of 10 kg/cm^2 (150 psi). No particles larger than the screen openings can pass through the screen and reach the outlet of the unit.

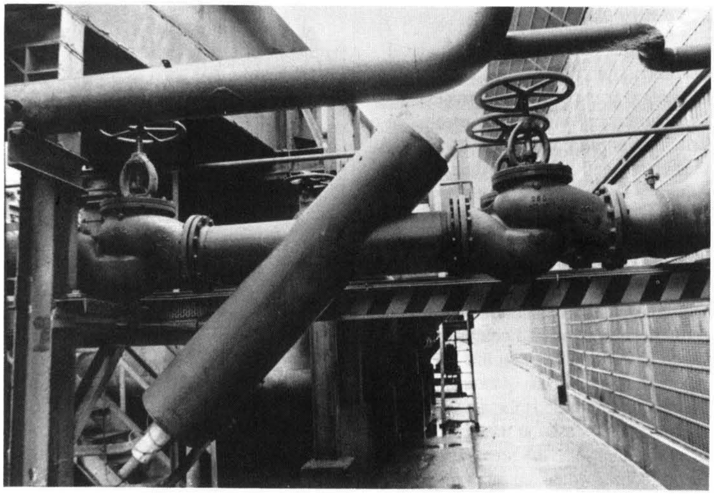
As the solids accumulate on the screen, they form a bed which increases the pressure difference between inlet and outlet water pressures. At a predetermined pressure difference, the cleaning mechanism is actuated. The hydraulic valve opens for a brief period of time, cleaning fins within the lower compartment rotate about their axis and wash off the build-up of solids on the screen. In the larger models the cleaning fins rotate and travel axially up and down simultaneously.

The dirty water enters suction slots in the fins, and is transferred to the hydraulic valve, from where it is discharged through the drain opening. The duration of the cleaning cycle is adjustable to suit the quality of water. A portion of the clean water is drawn for cleaning (which lasts between 4 - 8 secs) while the main flow is uninterrupted.

The whole cleaning operation is controlled automatically. When the filter screen has been cleaned, the cleaning cycle stops until the pressure difference between inlet and outlet again actuates the cleaning cycle. The unit requires a minimum of 2 bars pressure to operate.

Originally developed for irrigation water, Filtomats have been extensively tested in many other industries, including the beet sugar industry. Major applications have included cleaning of beet wash water (so protecting spray nozzles), screening of milk-of-lime, raw juice filtration to prevent clogging of heat exchangers and filtration of thin juice, thick juice and cooling water, with considerable savings in costs and labour.

Further details:
Filtration Ltd.,
8 Galgalei Haplada Street,
Herzliya 46722, Israel.



A 350 mh^3/hr Filtomat in use for removing particles above 9000 microns from thin juice

Refractometer update from Bellingham & Stanley

The RFM81 model of automatic digital refractometer hs been given updated electronics. The specification now provides four scales: Sugar and temperature compensated Sugar, Refractive Index and Zeiss, plus either Oechsle or Butyro.

Further details:
Bellingham & Stanley Ltd.,
Longfield Rd.,
Tunbridge Wells, Kent, U.K.

Temperature measurement made easy

Thermindex Chemicals and Coatings Ltd, manufacturers of stick-on thermometer strips and colour change paints, have extended their range of products for 1987. General purpose and specialized labels with up to eight high accuracy temperature increments are now available from stock. In addition to specially developed miniature thermometer strips for PCB and electrical applications, Thermindex enter a new market with a tell-tale device to monitor transport and storage conditions of chilled and frozen products. Traditional techniques using colour change or melt type crayons and temperature indicating paint complete the –17°C to 1130°C range. A brochure and sample are available on request.

Further details:
Thermindex Chemicals & Coatings Ltd.,
P.O. Box 191.
Mold CH7 3PS, UK.

"Uniform size" benefits from Bayer ion exchange resins

Bayer AG has introduced a new generation of ion exchange materials called Lewatit monodisperse resins. These are intended primarily for the production of ultra-pure water, for sugar chromatography and catalysis in the petroleum industry. The resins in this new range have beads of uniform diameter — believed to the the first time that macroporous cation and anion exchangers have been offered in this form.

Several advantages are claimed. Optimum rheological behaviour makes exacting processes simpler and more reliable. This leads to "perfect separation" of the cation and anion components, for example in mixed-bed units. The diffusion paths in the beads are similar, thus improving elution and rinse characteristics.

In chromatographic processes the separation effect is improved. In catalysis there is an increase in yield at optimum rates of reaction, as a result of a reduction in side reactions.

Further details:
Bayer AG,
D-5090 Leverkusen,
Germany.

A new sugar decolorization process*

By Dieter Frank, Lincoln D. Metcalfe and John Park
(Akzo Chemie America, Central Research Laboratory, McCook, Illinois, USA)

Basic steps in sugar refining

Phosphatation is the first chemical operation after affination and melting of raw sugar in the refining process. Phosphoric acid and lime co-precipitate certain impurities and colour bodies and thus clarify and decolorize the sugar solution. Typical colour removal is reported to be in the 25 to 35% range[1]. Effluents are solid phosphates to be dumped.

Talofloc, alone or in combination with phosphatation/Taloflote, adds further clarification and colour removal. Up to 75% decolorization has been reported. A long-chain quaternary ammonium chloride is the active chemical and is used at the 500 ppm level. Effluents are the precipitated colour bodies which are discharged together with phosphatation muds[2].

Bone char and activated charcoal have been used for decades as the stand-bys for the final polish, removing ash (in the case of bone char) and colour to below 100 ICU. Practically no waste streams are generated, but relatively large amounts of energy are consumed in the regeneration process. Losses of carbon and sugar are unavoidable. These losses may be as high as 4% of carbon per cycle. 2 - 6% of sugar value (on weight of carbon) cannot be washed out of the carbon beds[3].

Ion exchange has been introduced more recently to the refining industry. It brings today's chemistry into one of the oldest technologies mankind uses, and is mainly used for low-colour sugars, providing the final polish after carbon. Characteristics of ion exchange treatment are rather shallow beds and relatively low space velocities. Low costs of installation and labour are its main features.

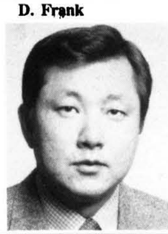
The mechanism of Talofloc

In the early stages our interest in sugar decolorization centred around Talofloc. From the numerous excellent papers on the subject one general principle can be arrived at[1]:

Water-soluble anionic colour bodies react with the cationic end of an otherwise hydrophobic molecule which

D. Frank

L. D. Metcalfe



J. Park

is water-dispersible but not water-soluble. The reaction product flocculates, floats to the top, and can then be skimmed away, thus removing colour from the sugar solution (Figure 1).

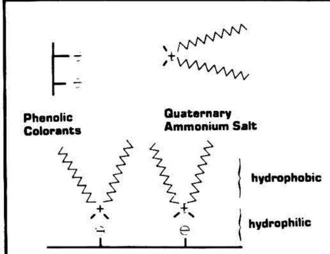


Fig. 1. Mechanism of Talofloc

Typical use level of Talofloc is around 500 ppm of which only minute amounts can be found in the process stream after the carbon bed.

The nature of the colour bodies

It may be learned from the papers of Clarke *et al.*[4] and Bardwell *et al.*[5] that the majority of colour bodies coming from the cane plant are phenolic in nature and belong to the flavonoid group (Figure 2). Amino nitrogen and iron, although also colour contributors, are present in much smaller amounts.

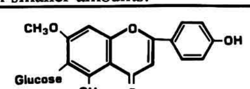


Fig. 2. Swertisin, MW 462

When we laid out our research strategy for developing a new decolorization system, we concentrated on the phenolics which are anionic in nature. These were logical targets for removal by cationics. The process we developed was originally called "Sugar decolorization through selective adsorption on micro porous polymers" but for convenience is now called SURE, short for Sugar Refining.

The basic phenomenon

Accurel as a sorbent

A unique microporous polymer had been developed in our laboratories in the late seventies. It was patented[6] in 1985 and is marketed under the tradename Accurel. This material can be made from polypropylene or polyethylene and, as may be seen from the electron micrograph (Fig. 3), has a very regular microporous structure of typically 75% void voloume. Its cells of 5 to 10 microns are connected by pores of 0.5 to 1 micron diameter.

It has the nature of millions of micro ping pong balls which have passageways wherever they touch each other. There is one characteristic however, that deviates from this analogy: the internal surface area of Accurel is typically 70 to 90 m²/gram. The ping pong ball model would have an area of only 3 or 4 m²/g.

Table 1. Structure of sorbents[3]

Type	Porosity, %	Pore size, µm	Surface m²/g
Accurel	75	0.5	90
Ion exchange resin	20	0.05	20
Bone char	0.	001-10	50-80
Activated carbon	38	0.01	1000

This fact and its hydrophobicity (polypropylene has surface tension of 29 dynes/cm) make it a unique adsorbent for all kinds of organic molecules. The high

* Paper presented to the 45th Meeting of Sugar Industry Technologists, 1986 (here partly abbreviated)

1 Clarke: *Sugar y Azúcar*, 1983, **78**, ( ).
2 Tate & Lyle Ltd.: US Patent 3,698,951 (1972).
3 "Cane Sugar Handbook", 11th Edn. (Wiley, New York), 1985, 578, 586, 592.
4 *Proc. 44th Meeting Sugar Ind. Tech.*, 1985, 53 - 87.
5 *ibid.*, 32 - 52.
6 Akzona Inc.: US Patent 4,519,909 (1985).

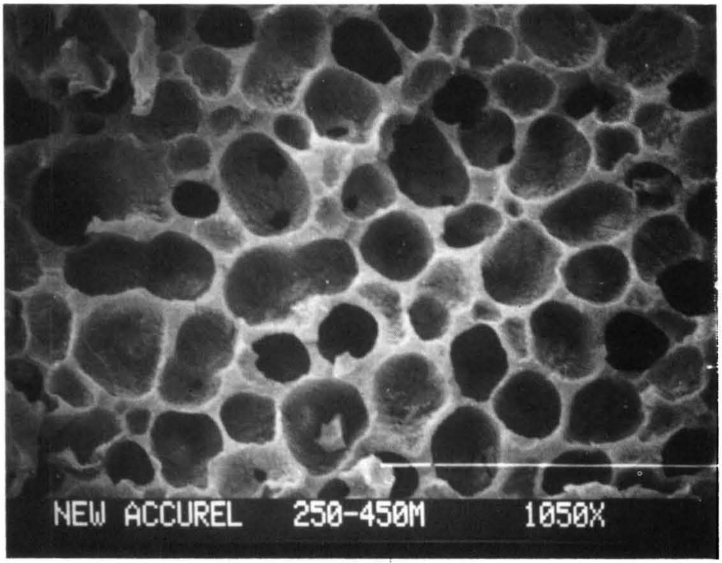


Fig. 3

internal surface cannot be seen in the electron micrograph and thus must be in the sub-micron range. Tremendous physical surface forces are available for any adsorption phenomenon. An Accurel powder of 250 to 500 microns particle size was treated with an alcoholic solution of a cationic surfactant, such as the well-known Arquad 2HT (as used in the Talofloc process). A large part becomes physically "anchored" to the Accurel internal surface and could not be rinsed out with water. We discovered this phenomenon in the context of our work on immobilizing enzymes by hydrophobic adsorption[7].

In order to "anchor" water-soluble enzymes like catalase or glucose oxidase to the hydrophobic Accurel surface, we examined a variety of cationic surfactants which we believe line up their hydrophobic tails along the polymer surface. They thus provide the right hydrophilic/hydrophobic environment at the polymer/water interface for the enzyme to be immobilized (Figure 4.)

The very same effect was used when we started to work on sugar decolorization. Originally we loaded cationic surfactants of various types onto Accurel from alcoholic solutions, rinsed out

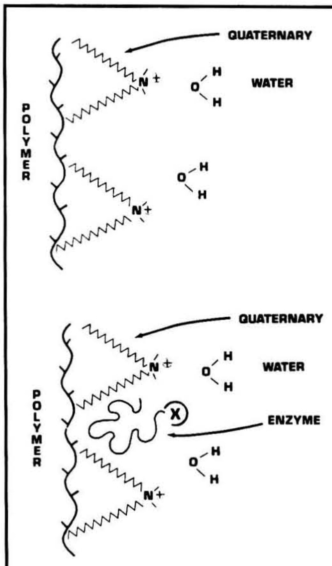


Fig. 4. Immobilization of enzymes

most (but never all) of the alcohol and used the bed to remove colour bodies from aqueous sugar solutions. Rather quickly we learned that the system was not very practical owing to the large amounts of circulating ethanol.

Water soluble quaternaries

Improving the original concept, we then directed our attention to water soluble quaternaries. Our hope was that some of them might still have enough attraction to the hydrophobic Accurel while also acting as wetting agents.

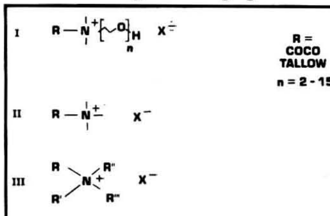


Fig. 5. Water-soluble quaternaries

From Figure 5 it may be seen that the choice of long chain alkyl water soluble quaternaries is rather limited, mainly mono-alkyl ethoxylated and mono-alkyl trimethyl ammonium salts. The third type shown is a new group of proprietary quaternary ammonium compounds. All three types are completely water miscible over almost the whole concentration range[8].

The wetting phenomenon

Owing to their water miscibility all three types can be loaded onto Accurel from an aqueous solution which certainly offers great advantages. Surprisingly, only the type III quaternary ammonium salts show good colour removal from sugar solutions. We have to conclude that water solubility alone is not a criterion for the ability of the quaternary compound to remove colour.

Table II. Water solubility and colour removal

Type	R	Water solubility, %	Colour removal, %
I	Coco	100	16
II	Tallow	60	20
III	a	100	80
	b	100	75

We then developed a film wetting test which provided us with a tool to predict the performance of the various

7 Idem: US Patent 4,539,294 (1985).

8 For a complete list of chemical and trade names of quaternary ammonium salts used see Armak Chemicals, Chicago, IL, Bulletin 84 - 48.

quaternaries. Using Accurel film, we measured wetting rates for the various cationics by applying a known amount of quaternary to a known area and measuring the time it took for the solution to be completely soaked into the film (to dryness). Some very interesting observations were made; Figure 6 shows plots of wetting rate versus surfactant units applied. The three types of quaternaries showed completely different wetting behaviour.

- A sharp maximum exists for the two quaternaries that showed good colour removal (IIIa and IIIb).
- Only a small maximum can be found for the marginal performer Arquad T.
- A flat wetting rate without any maximum over the whole concentration range appeared for the non-performers of the Ethoquad type.
- The wetting rates of the type III quaternaries are about one hundred times greater than the rates of the standard commercial compounds.

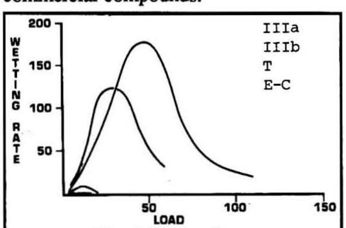


Fig. 6. Film wetting

The SURE process

Solution batch mixing

It is known that, in the Talofloc process, the quaternary ammonium salt Arquad 2HT (an Akzo product) is used at a level of few hundred ppm. In order to get some insight into the stoichiometry of our SURE system and also its efficacy or "yield" we simply batch-mixed Arquad IIIb in 100 ppm increments with sugar solutions of four different colour levels (1,800 to 7,000 ICU). As the quaternary compound is completely water-soluble, one would not expect any visible precipitate formation and, in fact, only a slight haziness and darkening of the colour could be observed. After filtering the mixture through a 0.45 micron Millipore filter, the resulting colours were measured and are shown in Figure 7 as colour removal *vs.* amount of quaternary used.

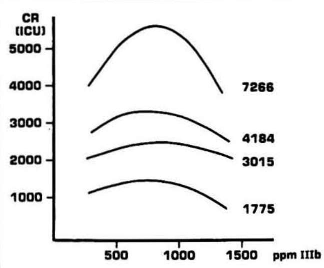


Fig. 7. Solution mixing

In view of the experimental work of Bennett[2] on the Talofloc process, these results were not too surprising. Maximum colour is attained between 500 and 700 ppm and re-solution of the colour salt complex starts beyond the point of stoichiometric equivalence. Such levels correspond well with Bennett's numbers.

Three-stage batch simulation with Accurel

In a similar manner, we mixed sugar solutions of three different colour levels with Accurel that had been impregnated with IIIb. The amount of colour removed was plotted against time of mixing. The results in Figure 8 show the maximum colour removal was achieved in less than 30 minutes. This would correspond to a column space velocity of approximately 2 BV/hr, certainly not too impressive a number. As will be shown later, however, column space velocities are much higher.

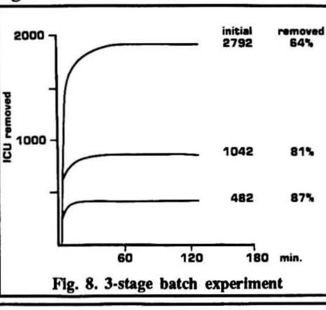


Fig. 8. 3-stage batch experiment

In spite of the fact that the same amount of quaternary salt and Accurel was used for the three experiments, the absolute amount of colour bodies removed decreases from 1800 to 850 and to 420 ICU (for feed colours of 2700, 1040 and 480, respectively). Owing to the lower feed colours in stages II and III, there is, of course, a lower driving force for the precipitation reaction. This would suggest kinetic control of the reaction. We have reason to believe, however, that the colour removal reaction is not primarily under kinetic control.

If one assumes that the mechanism is basically a precipitation, then the well-known solubility product provides a reasonable explanation. The solubility product is simply the product of the concentrations of the insoluble precipitate.

$S = (Q)\ (P) = \text{constant}$

where Q stands for the quaternary ammonium cation and P stands for the phenolate anion.

Without going into all the details of the calculations, a qualitative analysis (as shown) may be more appropriate.

The concentration of	Q	and P
in stage I is	medium	high
in stage II is	high	medium
in stage III is	very high	low

Calculation indeed shows a constant product.

One other observation was made when comparing the solution mix with the three-stage batch experiment. At the point of maximum colour removal about twice as much quaternary salt had been consumed in the batch system. The only difference between the two systems was that solution mix did not contain Accurel. One explanation could be that in the batch system the quaternary has been immobilized on *and within* the Accurel powder. In other words, only a fraction of the former is available for the precipitation reaction as long as no forced flow situation exists. Mere diffusion through sub-micron pores is a rather slow process.

Single column experiments

For all practical purposes the column experiments are much more

DDS Vacuum Pan Processor

DDS

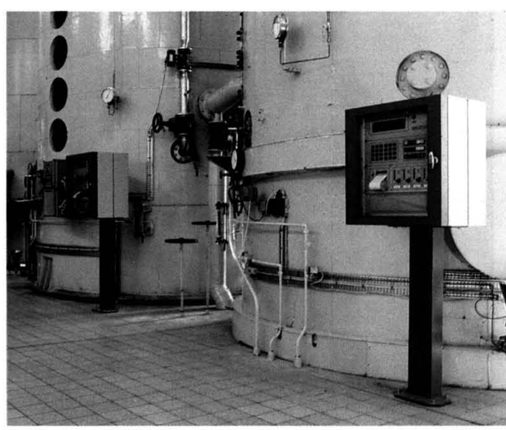
Features

- Increased sugar yield from massecuite
- Higher capacity of vacuum pan
- Fully automatic control of all pan operations
- Control of boiling without additional water
- Control of sugar crystallization at any purity level
- Improved crystal uniformity
- More efficient spinning in centrifuges
- Reduced steam consumption
- Based on a micro-processor control system
- Standard connection RS232 to supervisory computer

Characteristics

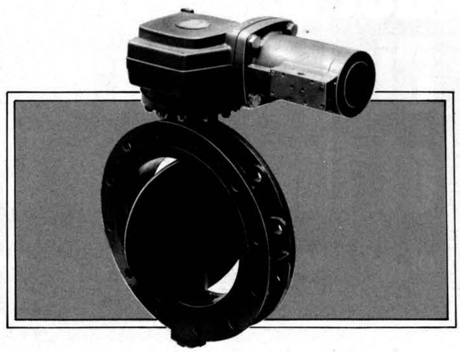
Micro-processor based panel for use with remote transmitters for control of a complete pan cycle, including: Charging, concentration, seeding, dilution, tightening, discharging and cleaning.
With possibility for continuous analog control of feed-, vacuum- and steam supply, temperature and pan agitator.

DDS ENGINEERING supplies:
Turnkey Sugar Factories.
Extension and modernisation of existing sugar factories.
Energy saving projects.
Plant machinery and equipment for cane- and beet sugar production.
Consulting services and staff-training.



DDS Engineering · 1, Langebrogade, P.O.Box 17,
DK-1001 Copenhagen K, Denmark
Telephone: + 45 1 54 61 30, Telex: 31 436 ddse dk


Get a
Bigger Slice
of the Sugar Cake!
Discover Mazer Chemicals for the complete treatment in sugar processing.
For optimum crystallization and general sugar manufacturing, choose the Mazer family of products—carefully formulated to serve you best.
MAZU® 400—Surface active agent for crystallization and production of sugar.
MAZU® 606—Surface active agent for improving sugar processing.
MAZU® EVAP 711—Surface active agent for inhibiting the formation of scale in the evaporators and improve processing capacity.
MAZU® DEFOAMERS—For all foam problems in the production of beet sugar.
MAFLOCS® —Flocculants in the processing of cane and beet sugar.
MAZTREAT® SDC—For clarification of syrups, molasses, and sugar decolorization.
MAZIDE® BC 800—Fungicide and bactericide used in controlling the growth of bacteria and fungus.
M-QUAT® 2950 & 2980—Quaternary ammonium compounds for sugar mill sanitation.
MAZON® CA 120—Descalant for cleaning evaporators, pans and heat exchangers.
MAZON® CA 200—Caustic accelerator.
MAZOL® 300—Additive for improving fluidity and reducing the tackiness and foam in molasses.
MAZVAP® 900—For inhibiting scale formation in the evaporators and distilleries.
MAZYME® I—A heat stable, starch decomposing enzyme for the cane industry.
MAZYME® DX—A dextran decomposing enzyme for the Sugar Industry.
mazer®
CHEMICALS, INC.
MAZER CHEMICALS, INC. U.S.A.
3938 Porett Drive
Gurnee, Illinois 60031 U.S.A.
Tel: (312) 244-3410
Tlx: 25-3310
Cable: MAZCHEM GURNEEILL
MAZER CHEMICALS, LTD.
Irlam, Manchester, U.K. M30 5BL
Tel: 061-775-1888
Tlx: 665546 LIBRA G
MAZER DE MEXICO S.A. de C.V.
Londres 226, Mexico D.F. 06600
Tel: (905) 533-44-83
Tlx: (383) 01761103 MAZEME
MAZER CHEMICALS (CANADA), INC.
Mississauga, Ontario L4Z 1H8
Tel: (416) 848-2500, Tlx: 06960351 CANBIZ MISS



important for judging the merits of the SURE process. In consecutive order, the following steps are involved and have been optimized in our laboratory:

Loading: We typically use 1.5 bed volumes of an aqueous of the quaternary salt. This solution is circulated at 40 BV/hr through the column containing the dry Accurel particles.

Rinsing: One bed volume of water is used to rinse out excess of quaternary (25 BV/hr). The rinse solution can be re-used as loading solution after adding the appropriate make-up amount of quaternary. Although not yet proven, it may be of advantage to use sugar solution for rinsing out the charging solution. This would avoid any dilution effects in the early phases of the operation. The sugar rinse eluate can easily be used for the next loading step.

Operation: Sugar solution of 65°Brix at 60 - 75°C is pumped through the column in upflow mode. Depending on the feed colour level, exhaustion of the column is observed between 14 bed volumes (for 5,000 ICU) and 100 bed volumes (for 800 ICU). Typical space velocities are from 3 to 40 BV/hr. These very high velocities are a feature of the SURE system. It goes without saying that velocities of 40 BV/hr are only attainable with low colour feeds.

Sweetening-off: After exhaustion, remaining sugar values are rinsed out using one bed volume of water at a rate of 12 BV/hr. This eluate can either be used for affination or goes directly to evaporation.

Regeneration: The SURE columns can easily be regenerated using caustic brine solutions as used in the regeneration of ion exchange columns. Typically, 1.5 bed volumes of brine are used at a rate of 3 BV/hr.

Rinsing: Rinsing out the remaining brine regenerant completes the cycle. Two bed volumes of water at 3 - 12 BV/hr are sufficient to prepare the column for reloading. The relatively low flow resistance of the Accurel bed and the high porosity of the polymer (as a reminder: 75%, 0.5 micron pores) allow us to run most of these steps at comparatively high space velocities.

Three -stage column experiments

In order to extend the cycle length, more than one single column have to be used in series. In spite of their shortcomings, the batch experiments have shown indications that three columns in series may yield an optimal performance. Figure 9 shows in graphic form an experiment which could be called typical although the incoming feed colour was higher than most refineries may like to use.

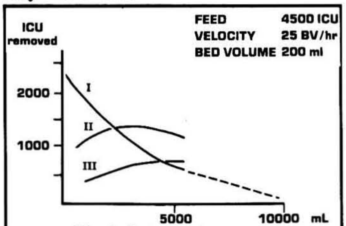


Fig. 9. 3-stage column run

Starting with a sugar solution of 4,500 ICU the effluent from column I initially shows colour removal of 2,000 ICU. It drops steadily to 600 ICU when 26 bed volumes have passed the column. Space velocity in this experiment was as high as 25 BV/hr.

Column II shows an initial colour removal of 1,000 ICU. This increases to a maximum of 1,400 ICU about half-way through the run and stays high to the end. Not surprisingly, column III is almost dormant during the first half of the run but starts to contribute to the overall colour removal when the effluent from column II starts to challenge column III with higher and higher colour levels.

Owing to the exhaustion of column I, the run had to be terminated at 26 bed volumes. It is obvious from the dotted line extrapolation that columns II and III could have been used for at least another 25 bed volumes. This naturally leads to a multi-column system with column rotation. A fresh column IV would go into service when column I goes into regeneration.

Graphic integration of the curves for columns I and II showed an interesting but not unexpected result. The amount of colour removed (measured in ICU) times the weight of sugar solution treated (in kg) per unit of quaternary used appears to be a constant for both columns (Table III). This *Specific Colour Removing Factor* was calculated from numerous other experiments to be *F = 4,500 (ICU × kg/Unit)*. Column II has a factor of 3,980 which, in view of the uncertainty in the extrapolation/integration process, seems to agree very well. This factor again seems to indicate that a mainly stoichiometric phenomenon is governing the colour removal. The analogy with conventional ion exchange is obvious.

Table III. Use factor (ICU × kg sugar/Unit)

Solution mix	3940
Column I	4550
Column II	3980
Average	4500
Range	3270-6470
Batch	2230

Checking our earlier results with solution mixes and batch mixes showed that they fit well with this hypothesis. The specific colour removal factor for the solution mix was calculated to be 3940 whereas in the batch experiment 2230 was calculated for the first stage. What we see here again is the 2:1 performance ratio mentioned earlier.

The conclusions to be drawn from a comparison between the three systems (solution mix, batch mix and three-stage column) are:

(i) columns operate under forced flow conditions and all of the immobilized quaternary is available for the precipitation (Fig. 10);

(ii) batch systems have restricted availability of the quaternary and operate under equilibrium conditions; and

(iii) columns are dynamic systems of a non-equilibrium type.

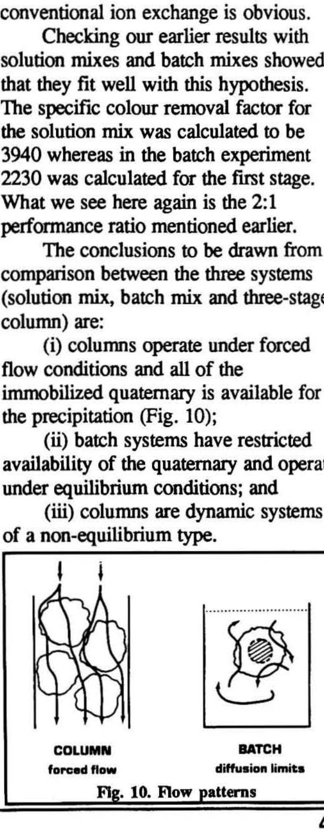


Fig. 10. Flow patterns

Plotting the results of the three-stage column and three-stage batch experiments as a graph of natural logarithm of remaining colour *versus* time seems to confirm this hypothesis. Both individual graphs are linear plots indicating first order or pseudo first order kinetics. The column system, however, is much faster than the batch system as may be seen from Figure 11. A space velocity of 25 BV/hr (or a residence time 2.4 minutes) is very good compared with the batch system (2 BV/hr; 30 min.).

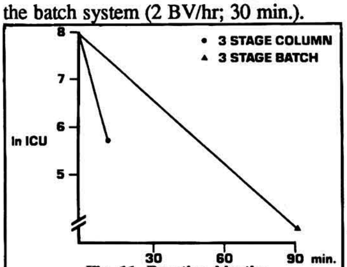


Fig. 11. Reaction kinetics

Results for various sugars and colour levels

The capacity of our columns and the reproducibility of the SURE process were tested in a series of standard runs using three columns in series. Table IV shows that, irrespective of feed colour level, the performance is nearly constant when normalized as colour removed times bed volumes treated (ICU × BV). Over the whole range, from 4,400 down to 800, approximately 80,000 ICU × BV can be expected from the system. Table IV also shows that very high space velocities (25 BV/hr) had been used throughout. These velocities are an order of magnitude greater than the ones used in ion exchange or carbon columns. All these experiments were run with raw cane sugar of various origins.

Beet sugar, as we learned, is not as easy to decolorize. A sample of German raw beet sugar of 4,250 ICU colour was treated in the same way except that only 30°Brix was used. Surprisingly, reasonable colour removal could be recorded (42,075 ICU × BV). Beet juice of U.S. origin, however, was not as easy to decolorize under standard conditions. This phenomenon will have to be investigated further.

Table IV. SURE efficiency

Feed	Colour	BV	BV/hr	% CR	ICU × BV
Cane	4480	27.5	25	69	89,897
Cane	3750	28	25	72	82,292
Cane	1737	38	25	69	45,524
Cane	800	100	25	88	70,400
Beet-G	4250	13.8	25	72	42,075
Beet-U	2128	13.8	25	47	13,750

G = German raw sugar; U = US beet syrup

Technical limits

Every process has it's technical limitations, and the SURE process is no exception. These boundaries are :

(a) The temperature should not exceed 80°C; the long-term stability of polypropylene-based Accurel is poor at higher temperatures. The delicate internal surface area of Accurel will undergo changes during long-term exposure to high temperatures. No change of the surface area could be observed over 35 days at 60°C.

(b) Pressure in the SURE column will increase with increasing column length. Figure 12 shows the dependence of pressure drop on column length for three different space velocities. Assuming a typical flow rate of 22 BV/hr, a 6-foot (2-metres) column will have a pressure drop of approximately 25 psig (1.75 kg/cm^2). These pressures should be easy to handle and were recorded for standard powder of 250 to 450 micron particle size.

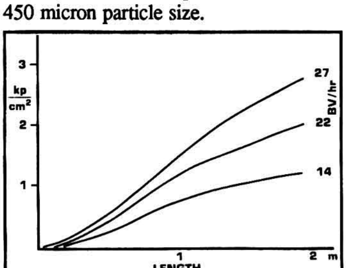


Fig. 12. Pressure *vs.* column length

(c) Geometry: Closely related to the expected pressure drop along the column is the length to diameter ratio of the column. We have worked with ratios of L/D from 4 to 1. The preferred ratio is 1:1. This avoids excessive pressure build-up.

(d) Flow mode: An interesting phenomenon was observed; the "natural" downflow causes bed compaction much quicker than upflow. Upflow has another advantage insofar as during draining the bed will be loosened up.

(e) Space velocity: Whereas regeneration should be done at relatively low velocities of typically 3 BV/hr, the actual operation allows space velocities up to 40 BV/hr. Figure 13 shows that the process is relatively unaffected by space velocities. The drop in relative colour removal from 76 to 71% between 7 and 40 BV/hr may well be within experimental error.

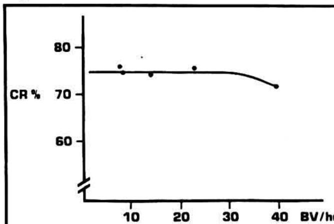


Fig. 13. Colour removal *vs.* space velocity

Service life of Accurel

Notwithstanding its temperature limitation, Accurel powder did not show any significant change in performance when run under standard conditions up to 35 cycles (Table V). Meanwhile, we have continued these runs without any indications of structural changes. An Accurel membrane was exposed to 60% aqueous glycerine for 10 months at 60°C without any loss of performance.

Table V. Service life of Accurel using 2 columns, 30°Brix, 15 BV and 15 BV/hr.

Cycle	Feed colour, ICU	Colour removal, %
1	2230	83
23	2233	82
35	2070	75

Other sorbents

So far we have talked exclusively about Accurel as the support or sorbent. We also tested other porous supports as possible alternatives. All materials tested (Table VI) were loaded in the same way with an aqueous solution of Arquad IIIb. 14.5 bed volumes of 30% sugar solution (2,872 ICU) were processed at a rate of

ISJ Abstracts

Cane sugar manufacture

Hardfacing for unlubricated wear resistance

A. G. Crooks. *Proc. Australian Soc. Sugar Cane Tech.*, 1986, 285 - 288.

A general account is given of hardfacing of steel or cast iron by arc welding where the need is for wear resistance under unlubricated conditions. Optimum microstructures providing maximum resistance are discussed for two different types of electrode.

The lubrication of sugar mill gearing

L. F. Piggott. *Proc. Australian Soc. Sugar Cane Tech.*, 1986, 289 - 293.

Centralized spray lubrication of cane mill gears is discussed and a diagram presented of the electronically controlled system installed at South Johnstone for lubrication of the mill pinions and reduction gears. Factors to be considered in installing a system are discussed, and the most suitable types of lubricant indicated.

Cane receivals station — Pioneer mill

A. R. Millett and R. Wellington. *Proc. Australian Soc. Sugar Cane Tech.*, 1986, 303 - 307.

In a study of a cost reduction program at Pioneer, the cane reception station showed greatest potential. Details are given of the reconstruction of this section, which included installation of a new feeder carrier, cane conveyor, shredder feeder and control system, relocation and extension of the tippler, spotter and tramp iron magnet, and conversion of the tippler to a weighbridge/tippler system with computerized grower data entry and weighing control. The new system has permitted a workforce reduction of 10 men and a fall in maintenance costs.

Mathematical models of the stages of the raw sugar production process

N. V. Avila S., D. Valdés V., F. Piñón Y. and V. González R. *Centro Azúcar*, 1983, **10,** (3), 3 - 10 *(Spanish).*

Raw sugar manufacture is divided into five stages — extraction, purification, evaporation, crystallization and centrifugation — and the variables entering and leaving each stage are listed. A method is described for creating mathematical models and the use of a multiple regression equation to obtain correlations between more than two of the variables.

Application of an integral thermo-energetic balance in a sugar factory

S. Machado B., R. Espinosa P. and R. G. Carpi. *Centro Azúcar*, 1983, **10,** (3), 11 - 16 *(Spanish).*

Establishment of a heat-energy balance is an essential step in determining the conditions and efficiency in a sugar factory and thereby to make energy and fuel savings. The method employed in the Las Villas Central University is described with an example and an analysis of the results.

Influence of microbial contamination of juices on the crystallization stage

M. T. Hernández, H. Cuellar and A. Peña. *Centro Azúcar*, 1983, **10,** (3), 21 - 28 *(Spanish).*

Existence of elongated and small crystals in massecuite was found to be associated with the presence of the products of microbial metabolism, namely dextran.

Ambiental microflora of the raw cane sugar factory

T. Sais H., L. J. Hernández and M. M. Hernández S. *Centro Azúcar*, 1983, **10,** (3), 29 - 42 *(Spanish).*

Analysis of the micro-organisms in air taken from 17 locations in a sugar factory were made, with identification of the micro-organisms and their counts per m^3 of air. The results are tabulated and found to be higher than the standards established for food factories, which implies a need for improving hygiene measures.

Description and simulation of the process of boiling first commercial strikes

U. Korn, M. Rodríguez B. and F. Herrera F. *Centro Azúcar*, 1983, **10,** (3), 43 - 51 *(Spanish).*

An analysis is presented of the variables of state and a dynamic mathematical model describing the boiling process for high-grade massecuites in batch vacuum pans. The model was simulated on a digital computer and the results of the simulation presented; it is a basis for furthering the design of an optimal control system.

Economic analysis of the principal factors affecting the cost of sugar production

C. P. B. Nazco F., M. Molina V. and E. Rodríguez P. *Centro Azúcar*, 1983, **10,** (3), 53 - 66 *(Spanish).*

An analysis is made by means of correlation methods of some of the main factors influencing the production cost of raw sugar. The factors are: utilization of installed capacity, cane quality and factory operating efficiency. The analysis is based on actual data for two sugar factories in Cuba "suitably modified for reasons of state security".

Influence of the addition of dextran on cane juice clarification

E. Bello A. and O. Travieso C. *Centro Azúcar*, 1983, **10,** (3), 75 - 88 *(Spanish).*

Laboratory and industrial experiments on clarification under various conditions in the absence and presence of added technical dextran showed that it had no value as a coagulant and instead kept insolubles in suspension, increased turbidity and did not aid compaction of the mud.

Application to industrial cane juice of the balanced clarification process

J. Guerra D. and R. Santana M. *Centro Azúcar*, 1983, **10,** (3), 95 - 106 *(Spanish).*

The balanced process, in which the Ca and PO_4 content of the juice are measured and adjusted to a stoichiometric balance by addition of $CaCl_2$ or NaH_2PO_4, with pH adjustment using 1M NaOH, was applied to samples of juice from a sugar factory and compared with the conventional process of liming to pH 8.5. The Ca content of the clear juice was lower while other important parameters were not affected.

Methods for designing hot liming systems

T. Prieto F. and I. Wong P. *Centro Azúcar*, 1983, **10**, (3), 107 - 116 *(Spanish)*.

Calculations are presented for optimum dimensions of an in-line injection device for liming juice to give optimum mixing.

Analysis of precipitation in simulated cane juices

L. Zumalacárregui, R. Santana and J. Guerra. *Centro Azúcar*, 1984, **11**, (1), 19 - 34 *(Spanish)*.

Experiments were conducted on the addition of NaOH to simulated cane juices at 90°C with the analysis of Ca, Mg, PO_4 and SiO_2 in the treated juices and comparison of the results with theoretical ones. It is concluded that there is evidence that $CaHPO_4$ is formed as the primary calcium phosphate species but that it incorporates further Ca in the solid phase as well as co-precipitated Mg metasilicate formed at pH>7.5.

Raw sugar quality and the refining process

J. A. Bordón C. *Centro Azúcar*, 1984, **11**, (1), 51 - 59 *(Spanish)*.

The quality of raw sugar affects the refining process and a literature survey has been made to discover the factors of greatest importance. These are quoted as filtrability (affected by the contents of starch, dextran, ash and insoluble matter), colour, ash, insoluble matter, starch, pol and grain size. No mathematical relationships exist which relate these factors to refining quality and work is required to establish such relationships.

Methodology for processing of experimental results and determination of sedimentation velocity

N. Mospan, J. Artiles, N. Martínez and N. Vargas. *Centro Azúcar*, 1984, **11**, (1), 61 - 70 *(Spanish)*.

Theoretical expressions are discussed with reference to sedimentation and the Todis equation found to give results which were not significantly different from those found in practice.

Measurement of supersaturation in sugar pans with the aid of the MCS-80 system

F. Alvarez P. and M. Rodríguez B. *Centro Azúcar*, 1984, **11**, (1), 77 - 84 *(Spanish)*.

A low-cost instrument has been developed in the Faculty of Electrical Engineering of the Las Villas Central University which incorporates a microprocessor to calculate the supersaturation directly on a basis of signals from transducers fitted to the pans.

Dextran and *C*-massecuite exhaustibility

M. T. Hernández N., H. Cuellar and A. Peña. *Centro Azúcar*, 1984, **11**, (1), 97 - 104 *(Spanish)*.

An inverse relationship was found between the dextran content of juice and the fall in purity from *C*-massecuite to *C*-molasses. At the same time, the *C*-molasses purity was directly related to the dextran content of mixed juice. The loss in sugar recovery due to the presence of 0.25% dextran on Brix is calculated as equivalent to 2 days production out of a 150-day season.

Investigation of the coefficient of friction in the upper journals of cane mills. Part III. Influence of temperature

C. Rodríguez M. and L. García F. *ATAC*, 1985, (Jan./Feb.), 36 - 38 *(Spanish)*.

Measurements of the coefficient of friction in a test bearing, the temperature of which was measured using a thermocouple, showed that there was a direct relationship, the coefficient rising by 20% over the range 35 - 60°C. Over this range the lubrication remained semi-fluid, but the optimum temperature range of the bearing was 35 - 40°C.

Unconventional products, equipment and processes used in the Cuban sugar industry in the 1940 and 1950 decades

O. Argudín L. *ATAC*, 1985, (Jan./Feb.), 39 - 47 *(Spanish)*.

A variety of processes were used during the title period but the benefits obtained or claimed fell within the normal variation of the standard process, making it difficult to justify their continuance. They include addition of chlorine in water solution to mills and cane juice as antiseptic, use of various phosphates and other additives to improve clarification, use of electrical apparatus for juice purification, magnetic or electromagnetic devices to reduce evaporator scale deposition, etc.

Development of clarification of filtrate by flotation

J. F. Tong, Y. C. Hsiao, C. H. Chen and C. S. Ting. *Taiwan Sugar*, 1986, **33**, (2), 26 - 28.

See *I.S.J.*, 1986, **88**, 111A.

New shredder installed at Illovo mill

Anon. *S. African Sugar J.*, 1986, **70**, 181.

A brief illustrated account is given of a Tongaat shredder installed at Illovo; driven by a steam turbine, it operates at 1200 rpm and is designed to process up to 250 tonnes of knifed cane per hour. The shaft is double-ended to permit it to be turned around in the event of damage of the coupling landing.

Beet sugar manufacture

The use of reverse osmosis in sugar manufacturing technology

K. Urbaniec and J. Serafin. *Gaz. Cukr.*, 1985, **93**, 179 - 181 (*Polish*).

After explaining the fundamentals of reverse osmosis, the authors discuss its possible application in the sugar industry, including concentration of thin juice to 30°Bx, which would help to save steam and reduce fuel consumption. The question of semipermeable membrane selection is considered, and data are given on five membranes. Mention is made of experiments conducted in various countries.

The evaporator station and the level of heat carrier consumption in the sugar factory

A. Laudanski. *Gaz. Cukr.*, 1985, **93**, 182 - 185 (*Polish*).

The question of striking the right balance between the amount of steam needed to concentrate the juice in the evaporator and the amount of vapour required by the various users, allowing for condenser losses and the need to minimize fuel and steam consumption, is discussed with the help of the evaporation factor n (ratio of water evaporated from the juice in the evaporator to the heat requirements of the various users). Hypothetical cases are examined where the steam requirements for juice concentration are smaller or greater than or the same as the vapour requirements of the other process stations, and possible solutions are considered.

Application of ammonium and calcium bisulphites in diffusion

G. Vaccari, G. Mantovani, I. Velentza, G. Sgualdino, V. Maurandi, G. C. Turtura and G. C. Zani. *Ind. Sacc. Ital.*, 1986, **79**, 31 - 38 (*Italian*).

Further experiments were conducted on addition of bisulphite in diffusion as a pulp pressing aid[1] involving both DDS diffusers and a BMA tower diffuser, and three types of pulp press. The total amount of SO_2 added (770 ppm) was divided into 235 ppm ammonium bisulphite added to cossettes on the belt feeder and the rest as calcium bisulphite added to the feed water at the tail of the diffuser. The result was an increase in average pulp dry solids to 26.2% compared with 22.9% when only the feed water was treated with about 320 ppm SO_2. The bisulphite treatment eliminated the need for formalin or other disinfectant and substantially reduced thick juice colour, so that the amount of SO_2 needed for thin juice sulphitation was decreased. No SO_2 was found in the white sugar. Raw juice pH was maintained at 5.9 - 6.1, compared with much greater fluctuation when calcium sulphate was used as a pressing aid in the previous campaign. During the experiments, the bacteriological conditions in the BMA tower were much better than in the DDS diffusers. The inhibiting effect of ammonium bisulphite at 200 ppm intervals up to 1000 ppm on the development of aerobic mesophiles and thermophiles at 30° and 55°C, respectively, and on that of anaerobic thermophiles at 55°C was determined and the results tabulated. It is suggested that further tests be conducted involving the addition of ammonium bisulphite at the head and $CaSO_4$ and/or SO_2 at the tail of the diffuser.

Rational disposal of steam from the boilers

E. Otorowski. *Gaz. Cukr.*, 1985, **93**, 204 - 206 (*Polish*).

Efficient distribution of live steam and particularly its use for power generation are discussed, and various means of increasing the output of electricity per unit of steam are surveyed. For modern sugar factories, thermocompressors are considered too inefficient and inadequately controllable; turbo-blowers are also not recommended, since they are powered by synchronous motors, and the turbines used for rated inputs of the level required are simple but consume a lot of steam, so that a turbo-generator would be more economical; turbo-pumps are also inefficient because of their low-powered drives, while desuperheaters have an unfavourable effect on the amount of electricity produced. Where an automatic evaporator is operated but a traditional boiler is used so that fluctuations can occur in the steam parameters, use of desuperheaters and a Ruths accumulator are recommended to regularize the steam factors before the evaporator.

Parametric representation of the beet sugar extraction process

F. V. Negoda and A. P. Ladanyuk. *Izv. Vuzov, Pishch. Tekh.*, 1985, (6), 60 - 63 (*Russian*).

Since the quasi-stationary mathematical model of the diffusion process developed earlier by the authors[2] was adversely affected by drift caused by uncontrollable perturbations (e.g. variations in beet quality, in heat and mass transfer, in the condition of the equipment, etc.) so that the mean square error rose to 30% when the model was fitted to working conditions, it was decided to apply parametric representation to the process whereby values of diffusion factors were estimated on the basis of current process data. The method used is described and a flow chart presented of the resultant algorithm. A plot of temperature fluctuation in the 4th zone of a diffuser showed that only 3 - 5 iterations and 3 minutes computer time were required to give a high convergence rate and reduce the mean square error to 5 - 10% by comparison with true measurements.

Designing belt conveyors for beet

V. S. Yatsenko, R. K. Kazimirov, N. M. Kichigin and N. A. Emel'yanov. *Sbornik Pishch. Prom.*, 1985, **31**, 20 - 25 (*Russian*).

Aspects of belt conveyor design are discussed and a number of recommendations made concerning their use for the beet piling.

1 Vaccari *et al.*: *I.S.J.*, 1986, **88**, 27A.
2 Negoda & Ladanyuk: *ibid.*, 126A.

Determination of the kinetic heat transfer coefficients in DDS diffusers

A. I. Fel'dman, A. M. Segai and V. M. Lysyankii. *Sbornik Pishch. Prom.*, 1985, **31**, 25 - 28 *(Russian)*.

Values were determined of the coefficients of heat transfer from juice and diffuser wall to cossettes and of thermal conductivity and thermal diffusivity coefficients of the juice-cossettes mixture for three sizes of DDS twin scroll diffuser, viz. 2000, 3000 and 4200 tonnes/day capacity. In all the experiments, the Biot modulus did not exceed 0.01, while the coefficient of heat transfer from juice to cossettes varied from 2.5 to 3.0 $W/m^2/°K$, indicating uniformity in heat flow conditions despite variations in other diffusion parameters.

Investigation of the non-steady process of extractant percolation through a bed of beet cossettes

N. N. Pushanko and B. D. Kovalenko. *Sbornik Pishch. Prom.*, 1985, **31**, 28 - 31 *(Russian)*.

Percolation of extraction liquor through a bed of cossettes was studied in an experimental glass tube unit in which conditions simulated those in a ring-type diffuser. The results were expressed in the form of an equation defining Euler's constant in terms of Reynolds number and the homochronic factor. Percolation occurred under turbulent flow conditions, with Reynolds number ranging from 15 to 35. The results are of application in optimization of process parameters and for dimensioning new diffusers of the ring type.

Allowance for friction in calculating the design parameters of plant for free-flowing products of sugar manufacture

D. E. Sinat-Radchenko. *Sbornik Pishch. Prom.*, 1985, **31**, 37 - 39 *(Russian)*.

The types, coefficients and angles of friction between beet, cossettes, pulp, sugar, limestone, coal, etc. and material of construction of hoppers, troughs, feeders, etc. are discussed, and a nomogram presented for calculation of the relation between angles of slope of abutted walls and angles of slope of ribs connecting the walls.

Initial experience in operation of a thermocompressor at Novy Bydzov sugar factory

P. Hoffman. *Listy Cukr.*, 1986, **102**, 115 - 120 *(Czech)*.

Novy Bydzov has a daily beet slice of 1000 tonnes and does not generate its own electricity. The 1st stage in the quadruple-effect evaporator comprises two vessels; as the initial stage in a modernization program, a thermocompressor was installed to raise the pressure of their vapour (bled to the pan station) from 235 to 290 kPa at a throughput of 10 tonnes/hr. Observations showed that the compressor operated efficiently at a 20% fall in pressure of working steam from a rated 1.1 MPa but that it ceased to function when the fall reached 35%. It contributed to smoother operation of the evaporator and of the entire factory.

Effects of lime on some properties of cossettes cut from frozen-thawed sugar beets

W. M. Camirand, J. M. Randall and R. H. Edwards. *J. Amer. Soc. Sugar Beet Tech.*, 1985, **23**, (1/2), 59 - 71.

Up to 20% of the beets processed in the USA are deliberately frozen so as to extend the campaign; where freeze damage cannot be avoided, the beets are kept between –20°C and –35°C and slabs cut from them for diffusion, since cossettes would be too mushy. Tests are reported on the possibility of replacing slabs with cossettes by liming the latter after thawing frozen beets (from –17°C) at room temperature. Two forms of treatment were examined: (i) mixing with dry powdered lime (1% CaO on beet) for 2 - 3 minutes followed by 12 or 27 minutes' contact without mixing, and (ii) dipping in thin juice-lime slurry (1 - 4% CaO on beet) for several minutes at 6°, 22° and 33°C, draining and maintaining at the treatment temperature until diffusion (carried out by placing batches of cossettes in wire baskets in running water at 75°C). While liming also increased the shear strength before diffusion, the improvement was affected by diffusion and to a greater extent than with limed, fresh cossettes. Liming also increased the dry solids content of pressed pulp, little further benefit being gained by extending beyond 10 minutes the time of contact between the cossettes and the slurry; again, best results were given by liming cossettes from fresh beets. Sugar extraction rates, already reduced by processing thawed as against fresh beets, fell further as a result of liming, the lowest rate occurring with the 4% CaO slurry treatment. However, the disadvantage of the longer diffusion time needed would possibly be offset by the benefits of greater pulp dewatering and improved purification found earlier[1]. For all of the parameters studied (except shear strength), treatment with 2% CaO slurry at 21 - 22°C gave better results than 4% CaO treatment.

Comparison between the Hungarian sugar industry and results obtained in other countries

K. Hangyál. *Cukoripar*, 1986, **39**, 41 - 51 *(Hungarian)*.

Analysis of the beet and sugar yields for 1977/83 showed that these were higher in Hungary than in other East European countries, were better than in Finland and Turkey and about the same as in Spain, while the beet yield was comparable to that in the UK. However, the specific white sugar recovery in Hungarian factories was very much lower than the average for the EEC and that obtained in Austria; this was attributed to considerable losses in harvesting, storage and processing and to the higher molasses sugar associated with poor beet quality. Possible remedies are discussed.

1 Zaragosa *et al.*: *I.S.J.*, 1984, **86**, 5A.

Treatments of sugar industry effluent

I. Toókos. *Cukoripar*, 1986, **39**, 66 - 70 *(Hungarian)*.

A short survey is presented of the literature on waste water treatment, with particular reference to the various anaerobic processes and their advantages.

Lime kiln accident prevention

M. Tömördi. *Cukoripar*, 1986, **39**, 71 *(Hungarian)*.

Details are given of a Dräger AK-2 sensor which monitors the air surrounding a lime kiln for the presence of carbon monoxide.

Automatic control of a station of batch vacuum pans

W. Assenmacher, H. Merensky and K. Wöhrle. *Zuckerind.*, 1986, **111**, 549, 551 - 554 *(German)*.

An account is given of the development of the Siemens Teleperm M computerized system for automatic control of the station of twenty batch pans and of the white sugar centrifugals at Regensburg factory. The start of boiling in each pan is a function of the levels in the thick juice feed tanks as monitored by the system, which also determines the target vapour pressures and regulates the boiling time. The interval between centrifugal charging is based on the balance between the quantity of massecuite leaving the pans, the level in the minglers and the capacity of the machines, and is increased or decreased with change in the balance. Results are discussed and adjustments to the system described; regularization of sugar house operations has led to reduction in handling times and in energy consumption.

Sugar screening in a very small space

P. Zagers and H. P. Kerlin. *Zuckerind.*, 1986, **111**, 555 - 558 *(German)*.

Details and illustrations are given of the Mogensen, Wedel sugar screen of 130 tonnes/hr capacity, four of which were installed at Dinteloord factory in Holland which produces fine white sugar of 0.20 - 0.78 mm grain size as well as conventional consumption sugar of 0.78 - 1.5 mm. The screens replaced eight of 75 tonnes/hr capacity and occupy 70% less space, allowing additional magnetic separators to be installed without structural alterations. Screening performance has improved with reduction in the noise level.

Experimental investigations of the carbonatation process at increased pressure

T. Bogumil. *Zuckerind.*, 1986, **111**, 565 - 568.

An experimental system for research on pressure carbonatation is described. Based on earlier proposals[1], it is designed for carbonatation at a pressure between atmospheric and 0.5 MPa and a reaction time of 3 - 10 minutes. Experiments demonstrated the benefits of pressure carbonatation in regard to energy saving; at a gas inlet temperature of 20 - 26°C and a pressure of 0.2 MPa, the juice temperature rose by 5°C compared with a fall of 2.6°C at atmospheric pressure, which was also associated with a very much longer reaction time. The economic advantages are briefly calculated.

Pragmatic maintenance in the sugar industry

H. G. Jurk. *Zuckerind.*, 1986, **111**, 576 - 580 *(German)*.

A pragmatic approach to preventive maintenance is discussed, whereby the general state of the equipment is the basic criterion and the aim is to prolong the interval between repairs. The author explains how such a scheme works and how it is best implemented.

Sucrose degradation during lime slaking by sugar-containing solutions

V. S. Shterman, A. R. Sapronov, M. S. Zhigalov, B. Yu. Kravtsov and A. M. Gavrilov. *Sakhar. Prom.*, 1986, (6), 15 - 16 *(Russian)*.

Experiments conducted under conditions approximating to factory conditions in which CaO was slaked with sucrose solution showed considerable losses of sucrose (15 - 50% of the initial quantity) which were far greater than theoretical values calculated using a kinetic equation for alkaline solutions. The discrepancy was attributed to a much higher temperature and greater hydroxyl ion concentration in the diffusion layer at the surface of the lime particles than in the solution generally; once hydration was complete, the degree of degradation fell sharply. Because of the high losses and the introduction of degradation products into raw juice with milk-of-lime prepared in this manner, the use of sugar solution is not recommended for slaking.

Industrial evaluation of the efficiency of raw juice purification by milk-of-lime containing sugar

G. P. Voloshanenko, L. D. Bobrovnik, N. V. Remeslo, Yu. F. Tsyukalo and Z. S. Kiprenko. *Sakhar. Prom.*, 1986, (6), 16 - 19 *(Russian)*.

The use of unfiltered 1st carbonatation juice to slake lime resulted in better juice purification (greater reducing sugar degradation, lower colour, and higher degree of removal of reducing sugar degradation products and melassigenic non-sugars, colloids and nucleic acids) than the use of ammoniacal water, while sugar losses were almost negligible. Favourable results were obtained with both poor-quality and satisfactory juice, although foaming in the lime dosers occurred if the sugar content in the carbonatation juice was below 10%; the use of foam depressants restored normal conditions.

Two new sugar factories for Yugoslavia

J. Rohlena. *Czechoslovak Heavy Ind.*, 1986, (7), 24 - 27.

Details are given of the two Czechoslovakian-supplied white sugar factories, each of 400 tonnes/day beet slice, at Sabac and Pozarevac.

1 Lekawski & Urbaniec: *I.S.J.*, 1986, **88**, 69A.

Sugar refining

The rational use of carbon dioxide in raw sugar processing

L. I. Pankin, A. R. Sapronov and V. M. Leshchenko. *Sakhar Prom.*, 1985, (11), 11 - 13 (*Russian*).

Inadequate CO_2 utilization in remelt liquor carbonatation is caused by the high viscosity of the liquor. Improvement in absorption of the gas is possible with thorough mixing of the liquor and increase in its alkalinity, for which the following scheme is recommended: two-stage carbonatation with elevated alkalinity in the first stage plus fractional liming; recirculation of gassed liquor and spraying of the limed liquor into the vapour space of the carbonatation vessel; and use of colloidal $CaCO_3$ (which also raises the decolorizing efficiency and filtration rate).

PLC's in the food and drink industries

I. Saunders. *Chemical Engineer*, 1986, (424), 50 - 51.

One advantage of the programmable logic controller (PLC) is the possibility of using networking techniques, whereby PLC's for individual process stations are joined to provide factory-wide control while allowing individual process equipment to be shut down when a fault occurs without stopping the entire factory. Another benefit is the greater ease of programming than with a computer, particularly since most factory engineers are inexperienced in the use of computers. In a short survey of PLC applications, reference is made to Raffinerie Tirlemontoise in Belgium, where PLC's are interfaced through mini computers to form a sophisticated supervisory control and data acquisition (SCADA) system. Control is split between the two minicomputers, one of which is on continuous standby, and 16 PLC's. The most important aspect of the installation is operator interface with the SCADA system; three colour video display terminals are used with two printers. The control system covers boiling, centrifugalling, remelting, decolorization and filtration. The complete SCADA system uses 185 proportional integral derivative (PID) loops operating in batch control mode with 480 analogue inputs and 160 analogue outputs. It handles data from about 350 discrete inputs, such as absent/present signals, tank levels and up to 750 valves, pumps and motors with both command and feedback functions. Real-time operations are controlled by 250 process timers. Full PID loop tuning incorporated in the system modifies responses to provide production flexibility.

Filtration of syrup for 1st refined massecuite crystllization at Cherkassy sugar refinery

Ya. O. Kravets *et al. Sakhar. Prom.*, 1986, (3), 29 - 34 (*Russian*).

Details are given of the conversion of a battery of six Stellar candle filters to mud removal and washing of the element *in situ* by pulsation for operation as precoat polish filters (only 30% of the syrup at the refinery being treated with granular carbon). Individual automatic control of the filters was also introduced for round-the-clock operation. In tests, syrup was fed to the filters either from a header tank or by pump; the latter means gave better results and doubled the hourly specific capacity of the filter by comparison with the former method, in which the feed pressure was much lower. Water consumption for sweetening-off was reduced by comparison with the previous system used at the refinery, filter cloth consumption was decreased and the time spent on the ancillary operations was halved.

Refining cane raw sugar

A. Vigh. *Cukoripar*, 1985, **38**, 65 - 73, 151 - 157; 1986, **39**, 23 - 30 (*Hungarian*).

A survey is presented of cane raw sugar refining, particularly in Japan, the UK and USSR. Part I contains 112 references to the literature and outlines the roles and stages of affination, phosphatation and carbonatation, decolorization by the Talofloc process, and mud filtration. Part II (83 references) concerns decolorization by bone char, granular and powdered carbon; ion exchange; boiling; recovery work; and manufacture of specialty products such as edible syrups and soft sugars. Part III, with 76 references (most of them to Soviet literature), is a survey of cane raw sugar refining in both the refineries and beet sugar factories (mostly during the post-campaign period) of the USSR.

Need for refined sugar manufacture in India

D. P. Kulkarni. *Proc. 48th Ann. Conv. Sugar Tech. Assoc. India*, 1984, M.43 - M.57.

Since plantation white sugar as produced in India contains more ash, reducing sugars, SO_2 and colour than refined sugar, it would not be acceptable for export. It is therefore suggested that the larger sugar factories close to ports should install a refining section using e.g. phosphatation of remelt liquor and decolorization with active carbon, and handling raw sugar from factories in the area. Various aspects of refining are discussed, including the economics and the sugar losses to be expected.

Nomogram for calculation of the consumption of carbon in the adsorption operation of a refinery

J. A. Bordón C., J. A. León, J. A. Capote and M. Pérez. *Centro Azúcar*, 1984, **11**, (1), 71 - 76 (*Spanish*).

Experiments showed that the method of Curbelo Sánchez[1] is effective for calculation of the quantity of carbon required for adsorption by filtration. Nomograms were established for calculation of carbon requirement which permit savings of imported material. It was demonstrated that Carborafin, imported from Czechoslovakia, had a greater decolorizing power than Norit, imported from Holland. Best results were obtained by adding the carbon-filter aid mixture to the tank before the liquor.

1 *Centro Azúcar*, 1977, **4**, (1), 29 - 37; *I.S.J.*, 1979, **81**, 184.

The work was carried out at pH 7 which should be maintained in accordance with established parameters.

Microflora of the raw sugar refining process

T. Sais H., L. Jacinto H. and M. Ramos M. *Centro Azúcar*, 1984, **11**, (1), 91 - 94 *(Spanish)*.

Counts were made of micro-organisms in samples of the intermediate materials in a sugar refinery. Bacteria made up the largest group, representing 58.7% of the total. The largest numbers were found in affination syrup, followed by refined sugar and third syrup. The presence of yeasts in the final syrup and refined sugar as well as coliform bacteria and staphylococci in the refined sugar indicates the necessity for implementation of adequate hygiene improvement measures.

Considerations on the removal of colouring matter and dispersed colloids and its dependence on the parameters of the first chemical treatment in the refining process

O. Navia Z., G. Muñiz M., M. Carrodeguas R. and H. Estacio C. *Centro Azúcar*, 1984, **11**, (1), 105 - 112 *(Spanish)*.

A study showed that removal of colour and colloids was significantly affected by the concentration of phosphoric acid and lime used in clarification, by the temperature, but not by the time of contact. The relationship with phosphoric acid was not linear but followed a ($y = a + bx^{1/2}$) pattern. The correlation between colour and colloids removal confirms that colorants are removed in the colloidal state.

Decolorization of industrial liquors by granular activated carbon

J. Jover P., M. Muro M., M. Ibáñez M. and M. Pérez P. *Centro Azúcar*, 1984, **11**, (1), 113 - 120 *(Spanish)*.

Experiments were conducted on decolorization of raw, clarified and filtered liquors through a glass column containing granular activated carbon, under different conditions, the effluent being examined by spectrophotometry for elimination of melanoidins and alkaline degradation products of invert sugar. Decolorization of clarified liquor was some 80%, principally of melanoidins and giving a liquor with a final colour of 1 - 2° Horne. The most important influence on decolorization was that of the concentration, followed in order by the retention time and the temperature. Preferred conditions are 55°Brix, 80°C and 30 minutes.

Relation between the colour of clarified liquor and the dose of ozone necessary for its decolorization

M. Hernández, R. Pérez, M. Gómez and R. Ramos. *ATAC*, 1984, (Nov./Dec.), 16 - 19 *(Spanish)*.

Kinetic methods were used to study the relationship between the colour of clarified refinery liquors and the amount of ozone needed to decolorize them. From the data obtained the correlation between the two was established in the form of an equation which permits calculation of the cost of the ozone needed for liquor decolorization to be applied as a refining technique on pilot and industrial scales.

Development of a hybrid continuous centrifugal

C. G. Smith and R. G. Howard. *Proc. Australian Soc. Sugar Cane Tech.*, 1986, 167 - 171.

A continuous centrifugal is described that was built on site and consisted of a basket from a continuous machine mounted on a batch centrifugal spindle, with a flywheel to provide the basket with additional weight; the monitor case of the batch centrifugal was replaced with a case and integral molasses chamber to suit the configuration of the continuous basket. The centrifugal was intended to affine high-pol raw sugar and process low-grade or remelt massecuite. Results of tests at Millaquin refinery showed that crystal breakage was about 8% at 900 rpm (at which most affination was carried out) but negligible at 700 rpm; however, this was not an important factor in view of the fact that affined and most low-grade sugars are melted. Sugar quality was comparable to that from a batch machine. A problem associated with retention of a crystal layer on the screens was solved by applying steam to the layer through a perforated pipe that replaced one of the water sprays; the result was a reduction in wash water requirements and in the amount of syrup, while syrup purity rise was <1 unit. At speeds greater than 1100 rpm the moisture content of the sugar was higher than normally found with batch centrifugals, but was acceptable at 700 rpm. Power consumption was low.

Liquor evaporation

R. Baker. *Paper presented to 45th Ann. Meeting Sugar Ind. Technol.*, 1986, 17 pp.

In January 1984 a Dedert falling-film evaporator effect of 40,000 ft² heating surface was installed at the Baltimore refinery of Amstar Corporation as the first phase of a project to improve A-liquor density and reduce energy costs. It was operated in series with an existing quadruple-effect evaporator because it does not have a barometric condenser and because the liquor discharged from it has a temperature of 217°F and must be cooled before it enters storage tanks — the quadruple-effect evaporator acted as a flash cooler. Some of the problems encountered are discussed and details given of the Brix and absolute pressure control systems. The evaporator operates completely automatically once the liquor has been fed into it — if a problem arises, the liquor is recycled without evaporation, and if the problem worsens the system shuts down and the evaporator is cooled by flushing with liquor. The various pumps are monitored by programmable controller. Phase II of the project will include installation of a multi-stage vapour compression station, while Phase III has yet to be worked out.

Laboratory studies

The effect of dextran on raw sugar polarization

G. A. Bradbury, R. M. Urquhart, J. H. Curtin and R. J. McCowage. *Sugar J.*, 1986, **48**, (8), 11 - 13.

Polarimetry was applied to five raw sugars before and after addition of 180, 360, 540, 720 and 900 ppm of standard dextrans T- 40, T-110 and T-200 and a native cane dextran. The ICUMSA method of pol measurement was used in duplicate, and dextran measurements carried out by an immunochemical procedure. Results showed that lead clarification removed large quantities of dextran, while both the standard and native dextrans increased the pol of the raw sugars by a far smaller amount than predicted theoretically. Quite good agreement was obtained for the average pol increases as determined and as calculated from the residual dextran in the filtrate. The typical increase in pol attributable to dextran was found to be less than one-third of that generally suggested in the literature.

Spectrophotometric assay of ethanol in fermented molasses and sugar cane juice

R. B. Natu, A. D. Sawant and S. J. Jadhav. *Bharatiya Sugar*, 1986, **11**, (6), 41 - 43.

Details are given of the method of Caputi *et al.*[1] for determination of ethanol in fermented molasses and cane juice using a reagent made up by adding concentrated sulphuric acid to potassium dichromate solution; 1 ml of the sample in 25 ml of reagent is distilled in a 50-ml flask on a hot plate until 20 ml of distillate is collected; this is heated for 20 min at 60°C, cooled and made up to the mark with water, mixed and the optical density measured at 600 nm.

The specific heat of beet tissue

A. K. Buryma. *Sakhar. Prom.*, 1986, (5), 40 - 45 (*Russian*).

Based on the investigations of Schneider *et al.*[2], an attempt was made to find a mathematical expression for direct calculation of the mean specific heat of beet cossettes from their dry solids content at various temperatures. Equations were derived from analysis of experimental data which demonstrated the inverse linear relationship between specific heat and dry solids at 50 - 80°C; these were modified and showed a relationship between specific heat and temperature which was also linear. The findings have been applied to cossettes and pulp parameters at different factories, and the various observations are discussed. The method of Schneider *et al.* is described and a worked example is given.

Two methods to determine colloids and their effectiveness

R. Fajardo G., J. Castellanos E., H. Estacio C. and A. Corral A. *Centro Azúcar*, 1983, **10**, (3), 17 - 20 *(Spanish).*

Results of analyses by two methods (the Dumansky-Jarrin method using alcohol-ether coagulation and the molecular sieve or gel filtration method using Sephadex G-50) for colloids in refinery liquor samples were subjected to statistical examination, from which it was concluded that the latter method was more reproducible and suitable for this type of analysis.

Study of a Cuban surfactant and its effect on sucrose crystallization velocity

C. Pérez B., L. Carrazana R. and M. González O. *Centro Azúcar*, 1984, **11**, (1), 121 - 132 *(Spanish).*

Characteristics and properties of a Cuban surfactant have been studied as has its effect on sucrose crystallization velocity. Isolated crystals were grown in supersaturated sucrose solutions (1.02 and 60°C) at concentrations of 0, 50, 100, 200 and 300 mg/kg of the surfactant and the mass and linear growth rates measured. Growth is aided by the material but, owing to its retention by the crystal at 200 mg/kg, a maximum concentration of 150 mg/kg is recommended.

Ionic equilibria of the system lime-water

L. G. Belostotskii, R. Ts. Mishchuk, A. E. Arkhipets and L. P. Reva. *Sbornik Pishch. Prom.*, 1985, **31**, 31 - 34 *(Russian).*

For determination of the ionic equilibria of the title system, aqueous solutions of $Ca(OH)_2$ were carefully prepared under conditions designed to eliminate factors that could affect solubility. Once equilibrium solubility was reached, the solid phase was removed and the pH, pK and molar concentration of the liquid phase measured at 20°, 30°, 40°, 50°, 60°, 70° and 80°C. The dissociation constant was then found by potentiometric titration of a solution saturated at 20 ± 0.5°C followed by use of an approximation method to establish the ionic strength, activity coefficients and equilibrium ionic concentration. Finally, the constants of the solubility product were established and values compared with those in the literature. The results con-firmed that calcium hydroxide is a base of medium strength which dissociates to a lesser degree as temperature rises.

Isolation of dextran from beet

G. Kandra and G. Hubay. *Cukoripar*, 1986, **39**, 62 - 65 *(Hungarian).*

The polysaccharide component in beet was extracted with methanol, centrifuged and lyophilized before passage through a column of Sephadex G-25 for fractionation by elution with 0.1M acetic acid. This was followed by ion exchange chromatography on a column of DEAE-Trisacryl M and elution with distilled water to yield a neutral polysaccharide fraction (dextran), while elution with 0.5M NaCl yielded an acid fraction. The neutral fraction was homogenized by gel filtration for analysis. The possibility of adapting the above procedure to dextran determination in beet is suggested, as is the use of endodextranases for factory juice treatment because of their high degree of polysaccharide degradation.

1 *Amer. J. Enol. Vitic.*, 1968, **19**, 160 - 165.
2 *Zucker-Beihefte*, 1952, 90 - 100.

By-products

Synthesis of some sucrose esters in the absence of solvent

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

Methyl esters of a number of fatty acids were heated with sucrose for 8 hours at about 125°C in the absence of a solvent but in the presence of a little of the sucrose ester obtained previously, as well as potassium carbonate. The reaction products were analysed by a selective adsorption method and the contents of sucrose esters, potassium soaps, methyl esters, and unreacted sucrose tabulated, together with the Rf values of the sucrose esters. The surface tension of 1% solutions of the crude reaction mixtures was measured and shows their surface activity.

Synthesis of sucrose monoesters of the fatty acids from cane wax oil

M. López L., P. L. Gutiérrez M., L. R. de la Nuez F. and G. Lago M. *Centro Azúcar*, 1984, **11**, (1), 43 - 50 *(Spanish)*.

Transesterification of sucrose with the methyl esters of fatty acids from cane wax oil was carried out in dimethyl formamide solution at 90-95°C for 10 hours in the presence of anhydrous K_2CO_3 as catalyst. The product, purified by removal of unreacted sucrose and methyl esters, showed surface active properties.

Depithing conditions in the sugar industry

E. González S., F. Ramos M. and H. Quirós D. *Centro Azúcar*, 1984, **11**, (1), 85 - 89 *(Spanish)*.

A study was made at the depithing station of a bagasse paper factory in Cuba of the factors influencing the true capacity of the station by a statistical analysis of the effect of variation of the parameters, with the object of obtaining a model which characterized the process. It was found that the most important factor was the throughput in tonnes/hr and that only the prior mechanical treatment of the bagasse affected the separation of the pith. To guarantee a level of 21 ± 1% of pith, the screen number would have to be increased while to reduce the pith below 20% would require replacement of the station by more efficient equipment.

Filter-cake as a renewable source of energy

A. Guillermo N. and M. S. Leal S. *ATAC*, 1984, (Sept./Oct.), 30 - 35 *(Spanish)*.

The composition of filter-cake is discussed and its application as a fertilizer which, on a dry matter basis, contains more N and P than animal manure. It can also be used as a source of methane by subjecting it to anaerobic fermentation, yielding when fresh 330 - 350 litres/kg of total solids, while the muds remaining after fermentation retain fertilizer value higher, per unit of N/ha than urea, compost and fertilizer from an oxidation lagoon.

Cane bagasse: a source of energy and food

Anon. *Revista do Alcool*, 1985, (2), 4 - 9 *(Portuguese)*.

Bagasse may be used, in addition to firing sugar factory boilers, for preparation of cattle fodder and also as a source of energy for other outlets. An account is given of the Bagatex process whereby the bagasse is dried, treated with biochemical agents, compressed and baled, whereby its keeping quality is improved and its calorific value raised.

Bagasse as a ration, sure profit

Anon. *Revista do Alcool*, 1985, (2), 11 - 15 *(Portuguese)*.

Autohydrolysis of bagasse, developed over four years at Destilaria Alcidia in São Paulo, has been tested on an industrial scale since the 1984/85 season. It involves acid hydrolysis of the bagasse at high pressure and temperature and gives a darker and more dense material which is an excellent feed for cattle.

Transformation of vinasse into complete fertilizer. I. Technology

A. Horowitz, J. P. M. Sá, L. M. de Almeida and P. J. Duarte. *Brasil Açuc.*, 1985, **103**, (1), 7 - 14 *(Portuguese)*.

Vinasse is rich in potassium and, by addition of N in the form of liquid anhydrous ammonia and phosphate as a slow-release phosphatic fertilizer, is converted to a fertilizer which is more efficient than conventional materials, as demonstrated by nine experiments in Pernambuco and Alagoas. Use of the complemented vinasse also contributes decisively to solution of pollution problems presented by disposal of this waste material.

Commercial production feeding of cattle with alkali-treated bagasse and molasses

G. D. Tudor, P. A. Inkerman and E. K. Bromage. *Proc. Australian Soc. Sugar Cane Tech.*, 1986, 25 - 31.

Cattle fed solely on diets based on alkali-treated bagasse[1] and molasses supplemented with urea (2% of the final diet) and protein meal consumed sufficient bagasse and molasses to gain live weight, the highest gain being obtained with 60:40 bagasse:molasses mixture supplemented with 500 g cotton seed meal per animal per day. Although the diets are not as good as grain-based diets for intensive finishing of cattle, they are suitable for various uses that are mentioned, and there is no risk to the health of animals provided the NaOH concentration does not exceed 5% on dry fibre. A design for a plant to produce the feed is described.

Alcochemistry in Brazil

C. H. Lopes. *GEPLACEA Bull.*, 1986, **3**, (05), 5 pp.

A brief account is given of alcohol manufacture and uses in Brazil, and

1 Tudor *et al.*: *I.S.J.*, 1986, **88**, 52A.

details are given of processes based on ethanol as feedstock; a list is given of the principal chemical plants involved and of their products.

Evacuation in the distal ileum of pigs with a swill plus a high final molasses-based diet

A. Pérez, A. Grau and A. Maylín. *Cuban J. Agric. Sci.*, 1985, **19**, 273 - 281.

Investigations of pigs fed a ration comprising a 60:40 (dry basis) mixture of sugar cane + molasses and swill as a semi-liquid of 43.5% dry matter confirmed earlier findings of an excess of liquid effluent at the distal end of the small intestine, which had a negative effect on weight gain.

Large intestine digestion of pigs fed molasses. IV. Sodium and potassium status

J. Ly. *Cuban J. Agric. Sci.*, 1985, **19**, 283 - 293.

Although studies showed that the ash contents in the large intestine were far higher where molasses was the sole energy source in rations than in the case of maize, diet had no effect on the Na and K concentrations. Daily Na absorption did not differ substantially between the rations, whereas K was secreted in the case of maize and absorbed when the ratoon contained molasses.

A note on some chemical characteristics of the fibrous residues of the sugar cane harvest

F. Estrada, V. Viant, M. González and O. Rodríguez. *Cuban J. Agric. Sci.*, 1985, **19**, 303 - 306.

In connexion with the use of the fibrous residues from cane as animal fodder, analyses were made of the residues from cane collecting centres, cleaning centres and from fields where cane had been left on the soil by the mechanical harvester. Results showed a greater amount of dry matter in the material from the collecting centres, with the content for the cleaning centre material being the lowest; however, the order was reversed for crude protein and gross fat, while there was little difference between the crude fibre contents for all three sources. The concentrations of total ash and individual ash components were also lower in the material from the collecting centres, the values for the other two sources being very similar.

Process schemes for pectin production from beet pulp

N. S. Karpovich, L. V. Donchenko, E. N. Kioresku, B. M. Myts and V. V. Nelina. *Sbornik Pishch. Prom.*, 1985, **31**, 17 - 20 *(Russian)*.

Details are given of five patented processes for recovery of pectin from beet pulp; the pectin is intended for use as a gelling agent, and each scheme has been tested under factory conditions.

Developments of a method for use of Fructavamorin G10Kh in the manufacture of alcohol from molasses

A. M. Kuts and V. F. Sukhodol. *Sbornik Pishch. Prom.*, 1985, **31**, 57 - 61 *(Russian)*.

Fructavamorin, containing α-galactosidase and β-fructofuranosidase, promotes alcohol production from molasses by reducing the fermentation time and increasing the yield of alcohol and yeast biomass. Details are given of the development of a suitable scheme for its application and for determination of its performance. By comparison with controls, mashes treated with the enzyme mixture contained a greater quantity of higher alcohols, aldehydes and esters and smaller amount of volatile acids and unsaturated compounds.

Low-temperature (beet pulp) drying at Lehrte — mode of operation and working experiences

E. Schröter. *Zuckerind.*, 1986, **111**, 545 - 549 *(German)*.

The five superposed horizontal bands of the Babcock-BSH low-temperature pulp dryer are in staggered formation and operate in alternately opposed directions so as to allow the pulp to fall from the end of one band onto the one below and finally into a discharge hopper. The bands are made up of longitudinal plastic strips with a small space between to allow preheated air to pass from top to bottom of the dryer through the 5 cm deep bed of pulp on each band. Results from the 1985/86 campaign showed that at a pulp throughput of 53 tonnes/hr the dry solids content rose from 28.3% to 46.1% compared with a rated throughput of 48 tonnes/hr and a rated increase in dry solids from 25% to 42.86%. The amount of heat supplied was lower at 74.1 GJ/hr than the rated 94.5 GJ/hr.

New ways of pulp drying

K. E. Austmeyer. *Paper presented to 28th Tech. Conf. British Sugar plc*, 1986, 53 pp.

The theory and practice of beet pulp drying at high temperature and in a Swiss-Combi low-temperature belt dryer[1] are discussed, followed by an examination of drying with vapour. (See also Austmeyer & Poersch: *I.S.J.*, 1984, **86**, 158, 192; 1985, **87**, 20A, 110A.)

Kinetic study of sulphite ion inhibition during alcoholic fermentation of beet molasses

A. Glacet, F. Letourneau, P. Leveque and P. Villa. *Bio-Sciences*, 1985, **4**, (1), 16 - 19; through *S.I.A.*, 1986, **48**, Abs. 86-1116.

Beet molasses was fermented to alcohol in the absence of sulphite or after addition of 1000 - 3000 ppm sulphite. In the presence of sulphite, fermentation time increased by 8 - 40%; this was shown to be due to lengthening of the latent period, while subsequent rates of formation of biomass and ethanol were independent of initial sulphite concentration. Most of the sulphite disappeared during the latent period owing to action of the yeast.

1 Kunz: *I.S.J.*, 1984, **86**, 191.

Patents

UNITED KINGDOM

Enzyme purification

Nabisco Brands Inc., of Parsipanny, NY, USA. **2,156,355.** March 28, 1985; October 9, 1985.

Glucose isomerase is purified by bringing it into contact with a tertiary amine and/or quaternary ammonium compound whereby an insoluble enzyme-amine complex is formed; when added to an ionized salt solution, e.g. NaCl, the complex dissociates and the isomerase and amine become soluble. Separation may then be carried out by ultrafiltration or treatment with cation exchange resin to give a purified, concentrated isomerase of high specific activity.

Deep bed filter

Tate & Lyle plc, of London, England. **2,159,429.** May 30, 1985; December 4, 1985.

A deep bed filter for the treatment of e.g. refinery liquor, corn syrup or clarified juice or syrup, consists of a vertical vessel containing a mixed bed of bone char as the upper layer (having a particle size of about 0.4 - 5.0 mm) and sand (silica sand, fused alumina, etc.) of about half the particle size of the bone char as the lower layer. Elution of the sand from the bottom of the filter is prevented by means of a support layer of coarser mineral material such as gravel. The untreated liquor is fed at the top and the filtrate discharged at the bottom. An upward flow of liquid is used to backwash the bed.

Glutamic acid production

Les Produits Organiques du Santerre Orsan, of Paris, France. **2,170,198.** December 16, 1985; July 30, 1986.

Crystalline glutamic acid, preferably as monosodium glutamate, is obtained by fermentation of beet molasses with a micro-organism such as *Corynebacterium melassecola* followed by ultrafiltration of the must. The permeate is evaporated and the retentate acid-hydrolysed with, preferably, sulphuric acid; the hydrolysate is filtered and at least some of the filtrate mixed with the evaporated permeate. After crystallization by evaporation, a suspension of the crystals is filtered to yield mother liquor (A) and a crude glutamic acid cake. The latter is purified for 1 - 2 hours at 40 - 80°C by washing with water followed by addition of more water, filtration (the washings from which are recycled to the hydrolysate), addition of brine for salification, further filtration, crystallization, separation of the crystals from the mother liquor (part of which is recycled to purification and part to salification) and drying. Mother liquor (A) is neutralized to approx. pH 6 by addition of ammonia, crystallized and the sulphate salts separated (preferably by centrifugal drying) and washed with water to yield an organic concentrate suitable for use as animal fodder, while the salts (containing 20.7% K_2O, 10.7% N and 3% Na_2O) are suitable for use as a fertilizer.

Fructose crystallization

Tate & Lyle plc, of London, England. **2,172,288.** March 13, 1986; September 17, 1986.

In a continuous process, an aqueous fructose syrup containing at least 90% (95%) fructose by weight of dry solids is evaporated under vacuum to at least 95% (98%) total solids at 82°C (81°C) and then cooled to 65 - 90°C (65 - 70°C) (55 - 75°C) (58°C) followed by rapid and thorough mixing with >5% (10 - 20%) by weight of fructose seed crystals measuring 75 - 180 µm (75 - 355 µm) (180 - 355 µm) for up to $2^1/_2$ (2) minutes in e.g. a screw extruder. The syrup is then deposited on trays or a moving band to allow it to solidify under quiescent conditions at 50 - 70°C (60°C) (69°C) (70°C) for 2 hours, followed by cooling for a further 3 hours to yield a cake of crystals in a glossy matrix which is completely free of organic solvent residues and in which 95% of the crystals measure <20 µm, the overall degree of crystallinity is >70% (80 - 90%) and the bulk density is <0.65. The cake is comminuted to yield a free-flowing granular product suitable for further drying.

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 the patent are listed below.

2,103,617	*I.S.J.*, 1986, **88**, 32A.	May 21, 1986
2,128,620	*I.S.J.*, 1986, **88**, 33A.	April 16, 1986
2,129,138	*I.S.J.*, 1986, **88**, 54A.	June 4, 1986
2,129,806	*I.S.J.*, 1986, **88**, 54A.	April 3, 1986
2,129,809	*I.S.J.*, 1986, **88**, 54A.	June 4, 1986
2,133,278	*I.S.J.*, 1986, **88**, 44A.	December 18, 1985
2,134,215	*I.S.J.*, 1986, **88**, 54A.	May 14, 1986
2,135,985	*I.S.J.*, 1986, **88**, 54A.	August 20, 1986
2,136,432	*I.S.J.*, 1986, **88**, 54A.	August 28, 1986
2,141,419	*I.S.J.*, 1986, **88**, 55A.	July 30, 1986
2,141,420	*I.S.J.*, 1986, **88**, 55A.	July 30, 1986

In addition the following application was withdrawn subsequent to preparation of our abstract:

2,107,567 *I.S.J.*, 1986, **88**, 32A.

Photocopies of the original papers abstracted in this section will usually be available, except where prohibited by the publishers. Such photocopies are available only for research purposes or private study; use for any other purpose is a breach of copyright. It should be noted that photocopies are *not* translations but are in the original language of publications which, if not English, is indicated in italic type at the end of the reference. A charge of £0.20 or $0.40 per page is made for such photocopies which includes airmail postages. Payment should be sent with the order. Original papers of abstracts reprinted from *Tate & Lyle's Sugar Industry Abstracts* and *Referativnyi Zhurnal* are not available from us and application should be made, respectively, to Tate & Lyle Ltd., P.O. Box 68, Reading, Berks, England, and Referativnyi Zhurnal, 125219 Moscow A-219, Baltijskaya Ul. 14, U.S.S.R.

In the case of United Kingdom patents, copies may be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price £1.95 each). United States patent specifications may be obtained by application to Box 9, Patent and Trademark Office, Washington, DC 20231, U.S.A. (price $1.00 each).

Table VI. Colour removal with other porous supports		
Support	BV/hr	% CR
Boiling chips	27	4
Molecular sieves	27	21
Active carbon	27	51
Accurel	27	69
Accurel	3	80

27 bed volumes per hour. It is obvious that only strongly hydrophobic porous supports like Accurel can be used in the SURE process. Activated carbon shows some utility, although much lower than Accurel. Its much smaller pores create the diffusion barrier mentioned earlier. Regeneration would also be more difficult unless one opts to continue to use the conventional and energy intensive thermal process.

Scale-up of three-columns runs

Column rotation

In order to maximize the yield for a given system of multiple columns, one has to continue to run the downstream columns beyond the point of exhaustion of the leading column. As has been shown in Figure 8, No. 2 and No. 3 columns could be expected to remove colour for about twice or three times as long before all the loaded quaternary has been used up.

In an experiment with five columns each of 200 ml bed volume, sugar solution of 4,580 ICU feed colour was run through columns 1,2 and 3 to a total throughput of 14 bed volumes (=2,800 ml) at a space velocity of 25 BV/hr. At this time column 1 was taken out of service and a fresh column 4 was added as the trailing column. After a further 14 bed volumes No. 2 (the now leading column) was taken out and No. 5 went in.

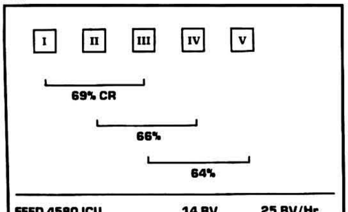


Fig. 14. Column rotation

Figure 14 shows that the system continued to perform as expected. The slight drop from 69 to 66 and 64% colour removal is well within the experimental error range. Normalizing these results by converting them into colour removed times bed volumes treated (Table VII) shows efficiency factors of approximately 42,000 ICU × BV. These numbers are lower than those reported earlier in this paper. The runs were terminated when the effluent colour started to increase beyond a pre-set desired level.

Table VII. Column rotation			
Columns used	Colour removal, ICU	Bed volumes	Efficiency, ICU × BV
I - III	3160	14	44,240
II - IV	3023	14	42,322
III - V	2931	14	41,039

Graphic plots of these runs (e.g. Figure 9) indicate that the systems were not yet completely exhausted at the point of termination. Even at a lower % colour removal, an extension of the run would markedly increase these efficiency factors to close to the "ideal" value of 80,000.

Effect of a trailing carbon column

The SURE system in spite of its merit and interesting performance is not meant to be a free standing unit. It cannot be run as the sole colour removing system. One reason is that the product sugar solution will or may contain some quaternary ammonium salt that was leached off the columns. Another reason is that, according to our present understanding of the process, mainly phenolic colour bodies are being removed by the quaternary salt. The remaining colour after passing the SURE column can further be removed by a carbon bed which also will lower any residual quaternary salt to acceptable levels. This carbon column can be much smaller than the conventional carbon beds used when the bulk of the colour removal has to be achieved using carbon columns.

We were also pleasantly surprised when we found that the trailing carbon bed could be run at higher space velocities (up to 6 BV/hr) and that the total throughput through a carbon bed could be as high as 22 bed volumes. Both of these results compare favourably with a conventional bone char bed (< 1 BV/hr and 15 BV). These results and the amounts of Arquad IIIb in the processed sugar are shown in Table VIII.

Table VIII. Trailing carbon bed (Run length 22 BV; space velocity 6 BV/hr)		
	Before	After
Colour, ICU	700	45
Arquad, ppm	30	0.3
Talofloc[9]	n.a.	0.64

We are currently investigating how much of the low amount of 0.3 ppm in the fine liquor actually will be found in or on the crystallized sugar. We have reason to believe that the bulk of it will stay with the mother liquor.

Runs with a portable pilot unit

After most of the process optimization work had been done using our relatively small laboratory unit of three columns of 200 ml bed volume each, we started a modest scale-up to a unit with three columns of 1700 ml each, plus a trailing carbon column. The unit was intended to be used for laboratory runs as well as for trials under actual field conditions in sugar refineries. In March 1986 it was tested in a refinery using various slip streams from their production. These and a preceding laboratory run can be summarized best in tabular form.

Table IX shows that over the length of the laboratory run (42 bed volumes) colour removal was almost constant. We used raw sugar of 700 ICU at 65°Brix and 60°C. Space velocity was 17 BV/hr. The final colour of 120 ICU was only slightly higher than the initial one (100 ICU). This means that 76 to 86% colour was removed up to termination of the run. This run could have been extended for another 42 and probably up to 84 bed volumes if column rotation had been used.

9 Tate & Lyle Ltd.: *Food Additive Petition*, 1972, No. 2A 2751.

Table IX. Three stage column run

BV	ICU	% CR	ICU × BV
14	100	86	8,400
20	110	84	11,800
42	120	76	24,360

The next table summarizes the plant run of March 1986.

Table X. Field runs with three columns

Run No.	I	II	III
Feed colour	1,500	1,700	3,000
Product colour	380	289 (*)	917
Colour removed, %	74	83	69
BV treated	28	21	14
ICU × BV	31,360	29,631	29,162

(*) 75 ICU after carbon

Experiment I used phosphatated and filtered sugar of 1,500 ICU. After 28 bed volumes throughput, the cumulative colour in the product was 380 ICU, corresponding to a 74% colour removal (Fig. 15).

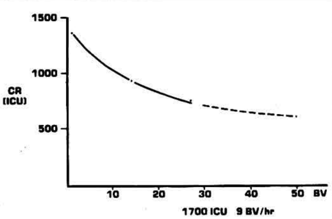


Fig. 15. 3-column run

In the next run, we used affined and filtered sugar. Its feed colour level was 1,700 ICU. Colour in the collected product after 21 bed volumes was 289 ICU. Space velocity in these runs was 9 BV/hr. A trailing activated carbon bed was used to further treat this effluent but, owing to the differences in attainable space velocities, this carbon treatment was done after the termination of the run. The colour could be further reduced to a comfortable 75 ICU (cumulative after 10 bed volumes).

Experiment III was quite a challenge to the SURE system. Here we used remelt sugar of 3,000 ICU. Remelt sugar contains not only plant-produced but also process-generated colour bodies which are different in their chemical nature. In spite of this, over a run of 14 bed volumes the colour was reduced to 917 ICU.

The last line in Table X shows these results in a normalized way using ICU × bed volumes. The numbers reported here vary only slightly with an average of 30,050 ICU × BV Again this seems to indicate that the mechanism of colour removal in the SURE process is mainly a stoichiometric one.

Earlier comments on these efficiencies apply here as well. Following the extrapolation in Figure 15 one can easily calculate an efficiency factor of 78,900 ICU × BV which agrees well with the 80,000 reported above.

Advantage of the SURE process

Various features of the SURE process may be summarized and compared with some of the standard operations in sugar refining.

(i) *Space velocity*: As can be seen from Table XI, space velocities in operation and also in regeneration are greater in the SURE process than in ion exchange, carbon, and bone char operations. The very different type of porosity of Accurel, ion exchange resins and carbon is the main factor in achievable space velocities. Figures 3 and 16 show these differences clearly. At the same magnification, no pores can be seen for ion exchange resin and carbon. Access to the interior of the particles is mainly diffusion controlled.

(ii) *Colour load*: Table XI also indicate that the colour load can be much higher in the SURE process. Even incoming colours of 5,000 ICU should not create any problem if one is willing to run shorter cycles as the column capacity is a pre-set constant.

(iii) *Regeneration*: As SURE in a certain sense is a distant relative of conventional ion exchange, regeneration uses the same chemicals and basic principles as known from ion exchange. Owing to the physical differences between the systems regeneration can be faster, e.g. three-fold in the SURE process.

(iv) *Unit size*: Owing to the aforementioned differences in space velocities, the size of a SURE unit can be significantly smaller than ion exchange or carbon beds. Table XI tries to compare what could be called typical conditions and performance of a SURE system *versus* ion exchange, bone char or activated carbon treatment[3]. Total throughput per cycle is not too different for the four systems with SURE being on the low end (28 bed volumes) activated carbon (85 BV) being the most enduring system.

Total time for one cycle, however, is only 5 hours for SURE, 31 hours for ion exchange , 72 hours for bone char and 750 hours for activated carbon. These times include everything from loading through sweetening-off and regeneration. Taking these numbers and normalizing them as before, we arrive at 31,000 ICU × BV for the SURE process versus 38,000 for ion exchange. Bone

Table XI. Comparison of processes

	SURE	Ion exchange	Activated carbon	Bone char
Decolorization				
BV/cycle	28	50	85	15
BV/hr	9	2	0.12	0.25
Hr/cycle	3	25	720	60
Regeneration				
BV/cycle	3	1		
Hr	0.5	5	20	12
Rinse, hr	0.5	0.5	-	-
Total hr/cycle	5	31	750	72
Feed colour, ICU	1,500	900	1,000	1,000
Colour removal, %	75	85	80	90
Colour removal, ICU	1,120	765	800	900
Efficiency, BV × ICU	31,000	38,000	68,000	14,000
Yield, BV × ICU/hr	6,200	1,245	90	194

Western States at Thames Refinery

For the new Process Block at their Thames Refinery in London, England, Tate and Lyle Sugars chose proven efficiency, minimum maintenance, and long life.

The new Affination Station includes 14 Western States 1200 RPM, 54″ x 40″ x 7″ Automatic Centrifugals.

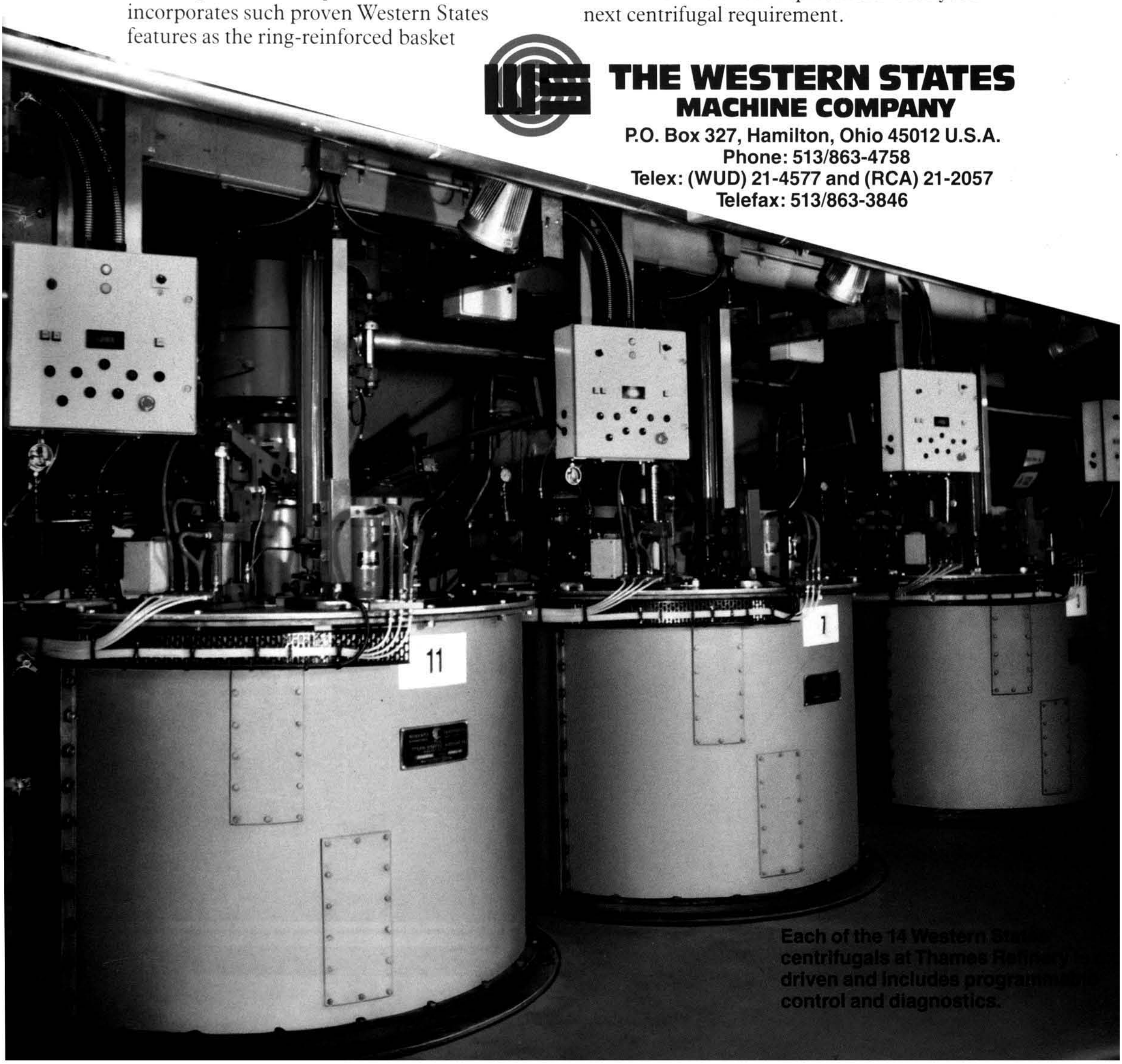
Each machine is driven by a thyristor-controlled d.c. motor. Each has automatic cycle control and machine diagnostics through its own single board computer. And each incorporates such proven Western States features as the ring-reinforced basket and the "Roller Wedge" massecuite feed gate.

This Affination Station was designed specifically to meet the needs of Thames Refinery's one million tonnes per annum sugar refining capacity, through close cooperation between Tate and Lyle and Western States engineers.

Tate and Lyle chose a company with proven technology, expertise, and a worldwide presence. Can you afford any less? Contact Western States or our representative for your next centrifugal requirement.

THE WESTERN STATES MACHINE COMPANY

P.O. Box 327, Hamilton, Ohio 45012 U.S.A.
Phone: 513/863-4758
Telex: (WUD) 21-4577 and (RCA) 21-2057
Telefax: 513/863-3846



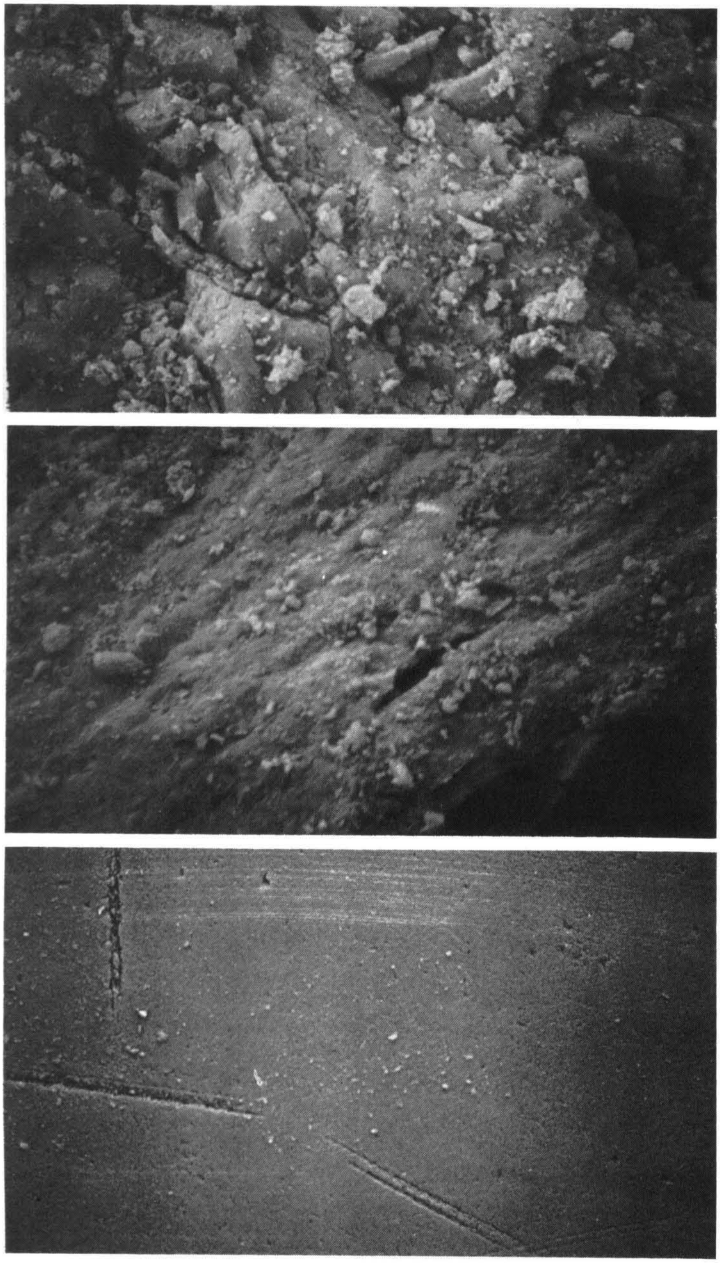


Fig. 16. Adsorbent surfaces at 1050× magnification : (Top) Activated carbon C; (Middle) Bone char; (Bottom) Ion exchanger 900

char and carbon are on the low and high end of the range.

One can also calculate a "yield" factor, measured as ICU removed times bed volumes treated per hour (ICU × BV/hr). Here we see that the four systems are different by almost an order of magnitude. The factor is 6200 for SURE, 1245 for ion exchange, 194 for bone char and as low as 90 ICU BV/hr for activated carbon. These numbers convert directly into very low space requirements for a SURE system.

(v) *Environmental issues*: The use of Arquad IIIb certainly has to be FDA-approved. Discharging of spent regenerant could cause some problems in certain locations not using ion exchange at present. We are currently working on some alternatives to caustic brine. Other avenues to be pursued are certain recycle loops which could eliminate or at least lower the environmental discharge load.

SURE in the sugar refinery

In spite of the fact that we have spent considerable time and effort during the last few years on learning as much as possible about the modern sugar industry, in no way do we claim to be experts in this field. From what we know today, we believe that SURE can replace conventional ion exchange and parts of the bone char or carbon treatment. From recent discussions in the field, it seems possible to use a SURE unit as an "insert" to increase capacity of the refineries which mainly depend on bone char and activated carbon decolorization. In this scenario a SURE unit would follow affination and discharge a much lower colour syrup into bone char or carbon treatment.

We will continue to test our process in a few refineries using our small portable unit (Fig. 17) while a larger (but also mobile) pilot plant is being built in the second half of 1986. Depending on the outcome of these field trials, our collegues from Armak Chemicals will be discussing with the sugar refining industry how SURE can improve profitability of its operation.

Acknowledgements

Sincere thanks and appreciation are

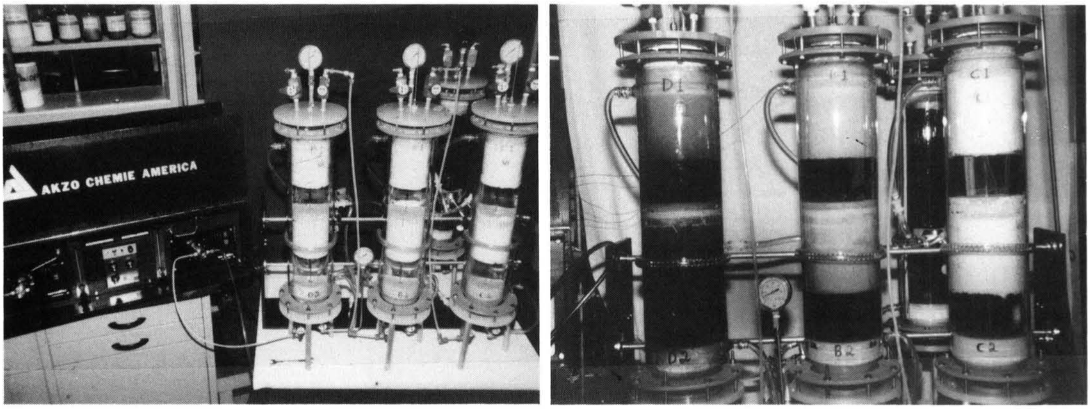


Fig. 17. (Left) control unit and column before processing (Right) Columns during processing. Carbon column is between columns 2 and 3; note how sugar solution clarity improves from column 1 to column 3

offered to Dr. A. Castro, the inventor of the Accurel porous polymer, to Madelyn Ashum, Dan Pauling and Robert Case, the lab team, to Dr. Margaret Clarke, for encouraging reviews of the project at an early stage of developement, to various sugar refineries for their support in providing us with samples of sugars and to the Management of Imperial Sugar Company, for giving us the opportunity of testing our new process in their Sugarland refinery.

PROCESS TECHNOLOGY

Recycling of non-sugars in sugar refineries*

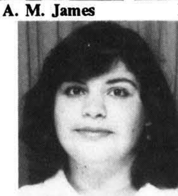
By A. M. James†, M. A. Clarke‡ and R. S. Blanco‡

Introduction

At the 1985 meeting of Sugar Industry Technologists in Saint John, New Brunswick, Sugar Processing Research Inc. presented a paper entitled 'Colour components in sugar refinery processes' which set out to follow the various colour components through the stages of refining.

A. M. James

M. A. Clarke



R. S. Blanco

Generally speaking, conclusions drawn could only be indicative because of the limited number of samples and because of the variations created by different raw sugars as well as a diversity of processing procedures. The paper, however, did not consider the effect of additions to the melt liquor which contributed to its properties to vary them from those of the washed sugar.

As Henry Gerstner, retired vice-president of Colonial Sugars, is wont to say (and Dr. George Meade before him): a refining operation is a series of separations. At each step, non-sugars are removed from sugar and, emphasizes Mr. Gerstner, should not be put back. In general, refineries accomplish this separation successfully. But the melt house is one area where non-sugars are indeed put back into sugar. Most

Paper presented to the 45th Meeting of Sugar Industry Technologists Inc., 1986.

†Sugar Knowledge International Ltd., Oxted, Surrey, England.
‡ Sugar Processing Research Inc., New Orleans, Louisiana, USA.

refineries recycle a certain amount of remelt sugar back into the melter, and everyone uses high grade sweet waters as melter water. We all know the reason: these materials contain sugar which cannot be discarded. But these materials also contain non-sugars, some similar to those in the incoming raw and others – some types of colour – case-hardened and made more intractable by their initial pass through the refinery, are put back into process right at the beginning in the melter, and some are sent all the way through again, doubling – at least – the work done by the refinery on these particular non-sugars.

Historically, there has been no solution to this problem; the sucrose in sweet water had to be recovered, and there was no economical way to clean up this stream. In recent years, with severe belt-tightening in sugar refineries and emphasis on optimum efficiency, it may now be cost-effective to clean up this stream, and reduce overall refining costs.

Several new processes have been developed that we think might be applied to cleaning up the sweet water and remelt streams going back into the melter. To this end, samples from several refineries have been studied, and the levels of colour in washed raw sugar compared with those in melt liquor. In some cases, the comparison is carried through to clarified liquor; the colorant that is recycled is notoriously difficult to remove in clarification. In certain cases, the types of colour have been analysed: phenolics, or plant-derived colorants, amino nitrogen-based colorants, and the indicator value of the sample have been determined.

This paper will report results of these studies and estimate the quantity of colorant recycled to melt liquor and the increase in colour load thus sent to the refinery. Several processes will be presented in the light of their application to cleaning up this stream. It is our aim to direct the attention of each refiner to his own melt house, and to encourage him to investigate the means to improve the input into his refinery process by cleaning up a stream that is small in volume but high in non-sugars.

Table I

	Routine lab daily average colour		Test data	
	Day A	Day B	Brix	Colour
Raw sugar	2677	2468	—	—
Washed raw sugar	672	614	—	759
Remelt sugar	1951	1762	—	1419
Dilution water	—	—	6.5	1396
Melt liquor	1300	1621	68.3	959
Clarified liquor	783	341	—	—
Fine liquor	152	103	—	—

Table II. Colour data from three refineries, I.C.U. at 420 nm and pH 7

	Refinery A	Refinery C		Refinery D
	Set b	Set a	Set b	
Washed raw sugar	402	907	1110	802
Melt liquor	987	2032	1378	1500
Colour addition, %	143	124	24	87
Clarified liquor	764	1378	1143	632
Colour reduction, %	22	32	17	57
Colour change, % (Washed raw-Clarified)	+90	+52	+3	-21
% Colour load in melt liquor from recycle	58.9	55.4	24.4	46.5

Earlier studies

At a Chilean refinery using carbonatation and bone char, it had earlier been noticed that liquor colour after carbonatation was at times worse than washed raw sugar colour and a simple series of tests had been carried out to identify the cause. The routine lab figures and the test figures are shown in Table I. The conclusion drawn on this occasion was that the remelt stream was the culprit and efforts were made to improve it[1].

Superficial study of the tables in the 1985 report[2] showed that some refineries suffered the same problem of higher colour in clarified liquor than in washed raw sugar. Analysis of the four sets of results which had figures for the complete range of samples showed, in Table II, that three of the refineries exhibited this phenomenon. As it happened, all these three were phosphatation plants while the fourth, refinery D, employed carbonatation. In the absence of information on the whole processing procedure this cannot be considered significant but it would be worth further investigation.

Tables III and IV repeat the data in Table II using phenolics and amino nitrogen as the measured variables. The result with phenolics is broadly comparable with that for colour at 420 nm but, as might be expected in view of the likely source of this colour, amino nitrogen values do not exhibit any reliable pattern.

Although this paper is concerned with colour recycling in particular, there is evidence in the literature that polysaccharides and ash components are also recycled back to the melter. In 1978, Roberts and the S.P.R.I. group examined levels of total polysaccharides throughout phosphatation and carbonatation refineries[3]. Table V shows amounts of polysaccharide recycled back to the melter and into process. Fowler, in a 1981 study on dextran flow through a refinery, found a high degree of recycling[4]. When the relative dextran level in washed raw sugar was 70% (relative to 100% in whole raw), dextran in melt liquor was increased to 99.3% through addition of remelt and sweet water, and remained at 76% in clarified liquor.

With regard to ash components: work some years ago on recycling of

1 James: Unpublished observations, 1979.
2 Clarke *et al.*: *Proc. 44th Meeting Sugar Ind. Tech.*, 1985, 53 - 88.
3 *Sugar J.*, 1978, **40**, (8), 21 - 23.
4 *I.S.J.*, 1981, **83**, 74 - 77.

Table III. Phenolics data from three refineries, ppm

	Refinery A	Refinery C		Refinery D
	Set b	Set a	Set b	
Washed raw sugar	90	108	228	140
Melt liquor	161	551	doubtful	300
Addition, %	79	410	—	114
Clarified liquor	146	160	306	123
Reduction, %	9	61	—	41
Change, % (Washed raw-Clarified)	+62	+48	+34	-12

Table IV. Amino N data from three refineries, ppm

	Refinery A	Refinery C		Refinery D
	Set b	Set a	Set b	
Washed raw sugar	3	10	41	9
Melt liquor	68	22	59	22
Addition, %	2300	120	44	144
Clarified liquor	8	17	44	15
Reduction, %	—	86	0	90
Change, % (Washed raw-clarified)	+167	+70	+7	+67

Table V. Recycling of polysaccharides in a phosphatation refinery (A) and a carbonatation refinery (B) (all results in ppm on solids)

	A	B
Washed raw sugar	671	450
Melt sweet water	2669	562
Remelt liquor	—	2040
Melt liquor	614	675
Clarified liquor	588	378
% Change, washed raw sugar to melt liquor	-8.5	+50.0
% of load in melt from recycle	—	33.3

silicates showed that the level of silicate in melt liquor could be double that in washed raw sugar[5], with clarified liquor also showing a higher level than washed raw.

Methods and materials

Samples were obtained as 4-hour or 8-hour composites from refineries' regular sampling schedules, and stored under refrigeration until collected (on the same day as sampled) by S.P.R.I. Samples were then stored at 4°C until analysis. Sets of samples were obtained at various times over a period of several months, and analysed as soon as possible.

Procedures for analysis of phenolics, amino nitrogen compounds, and colour readings at various pH adjustments and wavelengths are as described in earlier papers from S.P.R.I.[2,6]. These tests were adapted from those devised by Smith and Paton at CSR Ltd.[7]. Other data were collected by the senior author, from analyses made in laboratories at the refineries concerned.

The present work does not go as far as clarified liquor but attempts to provide more data on the extent to which the washed raw sugar is contaminated by lower grade inputs. Refineries A and B in this paper are not the same refineries identified as A and B in the 1985 S.P.R.I. paper[2].

Results and discussion

Results on refineries A and B (samples from the current study reported here) are summarized in Tables VI and VII.

Refinery A

Refinery A uses phosphatation, char and resin and dissolves washed raw sugar in sweet water from filter muds, clarifier muds and dust collectors. Of the 16 sets of readings taken, 4 have been discarded in the averages presented in Table V because some of the figures were suspect.

Affination removes 70 - 75% of the colour in raw sugar. On any count the melt liquor colour is some 60 - 80% higher than the washed raw sugar colour

5 Godshall *et al.*: *Proc. Sugar Ind. Tech.*, 1976, 58 - 67.
6 Clarke *et al.*: *Proc. Sugar Process. Res.*, 1984, In press.
7 Smith & Gregory: *Proc.14th Congr. ISSCT*, 1971, 1415 - 1425.

Table VI. Refinery A - phosphatation/char (Average of 12 readings)

	Brix	Colour at pH 7 420 nm	Colour at pH 7 560 nm	I.V.	Phenolics, ppm	Amino N, ppm
Raw sugar	—	2927	542	3.33	56	88
Washed raw sugar	—	811	157	4.08	14	24
Washed sugar liquor	65.2	1319	284	3.15	23	41
Dilution water	15.0	2532	547	2.47	400	438
% change from washed raw sugar to melt liquor	—	62.6	80.1	—	64.3	70.8
% load in melt liquor from recycle	—	38.5	44.7	—	39.1	41.5

Table VII. Refinery B - carbonatation/char (Average of six readings)

	Brix	Colour at pH 7 420 nm	Colour at pH 7 560 nm	I.V.	Phenolics, ppm	Amino N, ppm
Raw sugar	—	3390	668	2.49	58	57
Washed raw sugar	—	902	178	3.60	15	15
Remelt	56.8	11134	2358	1.77	162	111
Dilution water	6.3	4336	1216	1.90	1211	1842
Melt liquor	66.1	2052	427	2.26	36	39
% change from washed raw sugar to melt liqour	—	127.5	139.9	—	140.0	160.0
% load in melt liquor from recycle	—	56.0	56.2	—	58.3	61.5

and clearly this is the result of the high colour of the dilution water which, however, it should be noted, is at a commendably high Brix for this stream. The recycled material contributes over half the colour in almost half the cases studied. The average contribution of colour from dilution water to melt liquor is 38.5%, that is, over four times the solids contribution of the dilution water.

It will be noted that the I.V. of washed sugar is appreciably higher than that of the raw sugar suggesting that the majority of the residual colour is of plant origin, but that the I.V. of the dilution water is lower indicating a preponderance of breakdown products and the introduction of colouring matter which is less easy to remove. In view of the source of the dilution water this is no surprise. However, while a marked increase in amino nitrogen might be expected, a similar increase in phenolics is less easy to explain.

A possible explanation appears when the nature of the sources of the sweet waters are considered. Filter and clarifier mud waters are all washes from low sucrose, high non-sugars materials and by the usual solubility rules, would be expected to contain more non-sugars and less sugars (i.e. would have a higher non-sugar solids/sugars ratio) than a process liquor.

The slightly lower I.V. in melt liquor compared with that in raw sugar is presumably principally associated with colour produced in process. Phenolic compounds become polymerized, or reacted with amino compounds to generate intensely coloured compounds that are difficult to remove by most processes.

Refinery B

Refinery B uses carbonatation and bone char and dissolves both washed raw sugar and remelt sugar into the melt liquor using wash water from filter presses and dust collectors for dilution. Six sets of readings were taken and these are averaged in Table VII.

Again, affination removes 70 - 75% of the colour in raw sugar. In this case, colour increase from washed raw sugar to melt liquor is broadly the same at about 150% by any of the colour measurements. This is a greater increase than in Refinery A because Refinery B adds remelt back to the melter; Refinery A does not.

The I.V. of washed sugar is a lot higher than that of the raw sugar and those of the dilution water and the remelt stream are a lot lower but the net drop from raw sugar to melt liquor is much as in Refinery A.

Amino nitrogen has, as one might expect, risen more in the dilution water where the risk of inversion, etc. must be higher. Of the total colour of melt liquor going to carbonatation, 56% on average comes from the recycled material.

Decolorization

While the earlier paper provided some data on the overall decolorizing performance, these have not covered the effect on clarification processes. In particular the argument that colour and other impurities recirculated in sweet waters from clarification filters are those that are readily removable on the next passage through the clarification has not been tested but this could be a development of the study. If the colour bodies are changed chemically upon their first removal and are recirculated in a form different from their initial form, their removal the second time around will be more difficult to predict.

Remelt

While remelt streams will always remain a problem for those refineries which cannot dispose of them in soft sugars or elsewhere, the markedly increased decolorization problem at Refinery B highlights the need for maximum attention to this product. Six-monthly average results in a U.K. refinery, Table VIII, show that it is possible to bring remelt sugar up to the standard of a reasonable melt liquor by careful control of process.

Table VIII. 6 - month colour averages at a U.K. carbonatation/char refinery

	Summer	Winter
Remelt liquor	1136	907
Melt liquor	1493	1178
Clarified liquor	786	703
Fine liquor	68	60

The remelt stream can obviously be improved by one form of chemical treatment or another and Talofloc/phosphatation comes to mind. The economics of installing and operating an extra process station as opposed to whatever savings in existing processes can be achieved has not been studied but could be worth consideration.

Dilution water

It is clear that washed raw sugar is downgraded by the water in which it is dissolved. It is also clear that, from the economic point of view, the practice of melting sugar in high purity sweet waters is correct. Little attention has, however, been paid to the merits of improving the quality of these sweet waters prior to the affination melter.

Processes to clean up recycled materials

It is not the purpose of this paper even to guess at either possible savings in processing costs at clarification, decolorization and crystallization arising from an improvement in melt liquor quality or the costs of installing and operating processes to effect any improvement. It is our purpose to present some potential means for improving the quality of melt liquor through improving the quality of melter sweet water and remelt, and to allow each refiner to work out his own cost-benefit situation.

Refiners put a great deal of effort, time and money into seeking improved raw sugar quality, with colour as a major quality factor. It is apparent from the data shown here that some attention might be paid to the quality of washed raw sugar liquor, the actual input into the refining process. Calculations show that, as a general average, half of the colour in a melter comes from material recycled in the refinery.

There appears to be little relationship between the colour load in melt liquor from the recycled material and either the whole or washed raw sugar colour. The correlation between whole raw sugar colour and % load of recycled colour in melt liquor is 0.109 for Refinery A, and 0.195 for Refinery B. The correlation between washed raw sugar colour and % load of recycled colour in melt liquor is – 0.41 for Refinery A and – 0.59 for Refinery B. There is an interdependence between the washed raw and the recycled figures that can account for their higher correlation coefficients.

In the light of the significant amount of colour added to the melt liquor through melt sweet water and remelt, it is worthwhile to examine some means for cleaning up these materials, either separately, or in combination. Remelt dissolved in the sweet water is estimated to be in the 15 to 25°Brix range, and therefore a candidate for processes that are suitable for low Brix material.

Potential processes are listed briefly below, in no particular order. No figures on costs or sugar losses are included.

Ultrafiltration

De Danske Sukkerfabrikker have conducted tests[8] with membranes on cane sugar factory juices at about 16°Bx. Mixed juice required screening before effective treatment but clarified juice required no pretreatment. A completely clear filtrate was obtained and decolorization was about 30%, with a capacity of 3 cubic metres of juice per square metre of membrane per day.

A summary of this work is given in the Appendix. The substrate for these tests, cane juice, is of 12 - 20°Brix and contains higher colour and higher colloidal levels than melter sweet water, or even a mix of sweet water and remelt, both in the same Brix range as these ultrafiltration tests. The classic problem with ultrafiltration has been fouling of the membranes with suspended solids. A sweet water-remelt mixture should be lower in suspended solids than is cane juice, and thus should give fewer fouling problems than were found with cane juice.

Other work on purification of sugar beet juice by ultrafiltration has been reported by Suiker Unie[9] of Holland.

Deep bed filtration

Deep bed filtration (D.B.F.) is a rather new process, described briefly in a paper at the 1985 S.I.T. meeting[10]. It is a downflow filtration, at normal pressures, over a bed of special adsorbent material. Application has been to syrup filtration, but use in treatment of a sweet water-remelt sugar mixture is worth consideration. The deep bed filtration process is comparatively cheap to operate and install but can only be expected to remove suspended solids which are likely to be removed without difficulty at a later stage. However, early removal of these solids, particularly from wash waters that make up melt sweet water, may reduce colour formation and sugar degradation. There is evidence, from some preliminary work at S.P.R.I., that D.B.F. can remove dextrans from syrups, and so could be useful in cutting down the recycling of these compounds.

Talo clarification processes

There are several types of adjustments in current clarification, or installation of new clarification on remelt, that are of interest. A full Talofloc process could be installed to effect a substantial colour reduction on the remelt side of the refinery. However, the simple addition of Talofloc to the final stage of mud or scum treatment could result in the deposition of a significant amount of colour, and could decrease the total colour recycled. This could apply particularly in refineries where the Talo scum sweetening-off process is already in operation following phosphatation.

There is a process in operation in raw sugar factories in many countries that may be appropriate for sweet water clean-up. This is the Talofiltrate process, used on mud wash filtrate from rotary vacuum filters. This flotation process uses a polyacrylamide additive in a small round clarifier, and removes primarily colloidal and suspended solids, but also some colour. Because it works on low Brix material, it appears appropriate for use on sweet water, and possibly on a sweet water-remelt sugar combination.

Ion-exchange resins

The improvement in colour of sweet water appears to be a very suitable application for acrylic ion-exchange resin treatment[11]. The low Brix of the input will cause very little pressure drop, enhancing the sturdy qualities of acrylic resin. The low temperature of the stream should increase resin life; acrylic resins are suggested because of their toughness and ease of full regeneration.

There are various other treatments that might be considered, including electrodialysis, and the possibility of using exhausted bone char or granular activated carbon to remove some colorant material from the combined remelt-sweet water stream. The carbon and adsorbents could not give the high level of decolorization required of service materials, but could effect some improvement – perhaps 30% to 50% in the colour of melter material.

Conclusion

In view of the amounts of colour that are recycled back into the refinery through melter sweet water and remelt sugar, it may be of interest to add a small-scale process step to clean up and especially to decolorize this melter input before it is mixed with the raw sugar. If such a process is under consideration, a refinery might also consider using this installation for treatment of additional sweet water. Wash waters, or condensate, that are usually of too low a quality to be sent to melt sweet water could be upgraded, with further increase in the overall efficiency of the refinery.

Summary

One goal of the refining process is to remove non-sugars from the raw sugar input. The first step in many refineries is an affination process. The removal of non-sugars in affination, and the subsequent addition of non-sugars back to the process stream in melter water and by recycling of remelt material, have been studied. Several process

8 Barfoed: *A/S Danske Sukkerfabriker, Internal Report*, 1979/80.
9 Hanssens *et al.*: *I.S.J.*, 1984, **86**, 227 - 229, 240 - 243.
10 Bennett: *Proc. Sugar Ind. Tech.*, 1985, 1 - 16.
11 Fries. *ibid.*, 1982, 1 - 13.

combinations are considered here, from the point of recycled non-sugars. An analysis of colorant recycled to the refinery melt house is presented. Recycling of polysaccharides is also considered. Suggestions for process modifications to decrease the quantity of recycled non-sugars are proposed.

APPENDIX

Summary of ultrafiltration experiments on cane juice

Experiments with ultrafiltration of cane juice were made at the Tanganyika Planting Company in December, 1979. The experiments were made using a DDS pilot module with 2.25 m^2 membrane area. The results showed that ultrafiltration is possible with high capacities; up to more than 3 m^3 juice per m^2 membrane area per 24 hours.

Ultrafiltration can be used on mixed juice or diffuser juice (from a cane diffuser) after proper screening. With clarified juice no pretreatment is required and the UF capacity is higher. The UF capacity is related to the turbidity of the juice.

In all cases, a completely clean filtrate is obtained, and in clarified juice the average colour reduction is 30%. From an ultrafiltration permeate, sugar has been crystallized in the laboratory with a colour of 340 ICUMSA, compared with the factory product, boiled after remelting, having a colour of 600 ICUMSA.

Sugar loss in the concentrate is of the order of a few percent. For a 2000 t.c.d. factory during a 150 days/season, the investment is calculated to be 6 million D. Kr. or about £500,000, and the operating costs, including 20% depreciation and interest, D. Kr. 74/kg

Facts and figures

The Viacheslav & Helen Savitsky Memorial Award

One of the most monumental contributions to the beet sugar industry has been the introduction of the genetic monogerm character into sugar beet seed. The discovery and development of this germplasm has spelled the virtual survival of the beet sugar industry. The industry owes this good fortune to Drs. V. F. and Helen Savitsky who discovered a single plant containing the monogerm character in an Oregon seed field in 1948. The line derived from this plant, although weak and without resistance to any of the common beet diseases, proved to be homozygous recessive for one gene which conditioned the monogerm character; the transfer of monogerm to productive varieties was relatively easy. Because of their dedication, monogerm became a reality and subsequently has been introduced into nearly all commercial sugar beet varieties. Viacheslav died in 1965 and Helen in May of 1986. The directors of the Beet Sugar Development Foundation have elected to memorialize their scientific accomplishment by establishing the Viacheslav and Helen Savitsky Memorial Award. Presently it is planned to be a cash award (or awards) to be given to candidates proposed from the world wide beet sugar and sugar beet scientific community. The cash award will be funded by proceeds earned from a trust fund. Contributions to the Savitsky Memorial Award Trust Fund are being accepted by the Beet Sugar Development Foundation at P.O. Box 1546, Fort Collins, CO 80522, USA.

The first S.P.R.I. Science Award

The S.P.R.I Science Award, made by Sugar Processing Research Inc. for research and development accomplishments distingushed by their orginality and by their contribution to the sugar processing and production industry, was presented for the first time on October 21, 1986, at its Conference in Savannah, Georgia. The winner was Dr. Andrew VanHook, Professor Emeritus of Chemistry at the College of the Holy Cross, Worcester, Massachusetts. Dr. VanHook, author of two books and numerous articles on sucrose crystallization, received the award for his outstanding achievements in science and technology in the area of sucrose crystallization. The Award Lecture, presented at the S.P.R.I. Conference and entitled "Recent events in sugar crystallization" summarized the award winner's past work and discribed his current activities and plans for future research on sucrose crystals. Although Prof. VanHook was awarded Emeritus status several years ago, he continues an active research career, publishing results frequently.

American Society of Sugar Beet Technologists 50th Anniversary Meeting

The 50th meeting of the A.S.S.B.T. will be held in Phoenix, Arizona, during March 1 - 4. On Sunday March 1 delegates will register, with the next day devoted to General Sessions, to be addressed by Rep. de la Garza of the US House Committee on Agriculture and by the Society President, D. L. Oldemeyer. Presentations will be made on "Economic prospects for the US sugar beet industry, 1987 - 1990" by M. J. Bateman, "The role of the Western European beet sugar program in the world sugar beet scene" by T. P. J. Dyke, "The role of biotechnology and germplasm development in the future of agriculture production" by H. L. Shands, and "Exploding the ugly myths about sugar and health" by G. N. Bollenback. March 3 and 4 will be occupied with sessions split among the various sections of the society, concerned with agronomy, physiology, genetics and variety improvement, entomology and plant pathology, chemistry and factory operation.

Japan beet sugar production, 1985/86[1]

The beet sugar factories in Japan sliced a total of 3,920,838 tonnes in the 1985/86 campaign, which ended in June last. The crop was grown on 75,117 ha in 1984/85. Sugar outturn was 574,243 tonnes, white value, in 1985/86 against 598,334 tonnes in the previous campaign.

Philippines sugar industry contraction[2]

President Aquino said vast tracts of cane plantations in the central Philippines could be planted with new crops in a bid to restructure the failing sugar industry. However, the government needs time to effect the changes and learn about new agriculture, she told a meeting of farmers and plantation owners on Negros island, which accounts for more than half the Philippines annual sugar output. Local officials said that dwindling sugar demand and falling prices had brought poverty, with about 96,000 sugar industry workers unemployed. The rationalization program should include closure of several sugar factories, Aquino said. She later announced a land distribution scheme under which lands foreclosed by the state-owned Philippine National Bank would be distributed to displaced plantation workers and farmers.

Alcohol from beet in India[3]

IFB Agro Industries Ltd. is setting up a project for manufacturing industrial alcohol from sugar beet in West Bengal. Technical know-how for the project comes from Starcosa GmbH of Germany.

Belize alcohol possibility[4]

It is reported that the Libertad sugar factory, closed in 1985 after reduction of the Belize quota for sugar exports to the USA, might be re-opened for the manufacture of alcohol instead of sugar.

1 *Zuckerindustrie*, 1986, **111**, 1083.
2 *S. African Sugar J.*, 1986, **70**, 358.
3 *Sugar Scene*, 1986, **4**, (11), 5.
4 *ABECOR Country Rpt.*, November 1986.

Finland sugar imports, 1986[5]

	tonnes raw value
Cuba	60,109
Germany, West	2,367
Holland	10
Mauritius	13,274
Other countries	12
	75,772

Bangladesh sugar expansion plans[6]

The Bangladesh government has decided to revitalize the sugar industry in order to reduce the curent level of imports. Improvement of efficiency and output will ensure that fair prices are paid to the country's sugar cane growers. The scheme includes the allocation of an additional 12,600 acres of land for cane cultivation.

Sudan sugar factories rehabilitation[7]

Rehabilitation of the four state-owned sugar factories in the Sudan is to be attained by 1989, thanks to freeing of the investment funds from Arab countries which had been blocked. ABA International and Arkel, both of the US, have jointly won the contract for the New Halfa modernization, which will involve bringing annual output back to the full capacity of 80,000 tonnes from the 1985/86 level of 53,710 tonnes, according to an AED report. The companies will provide assistance in all areas, from field operation to cost accounting and workshop operation. India's Agrima company has been awarded a similar contract for the Guneid factory, while Tate & Lyle Agribusiness and Booker Agriculture International have won contracts for Sennar and Assalaya factories, respectively. The contracts are worth about $1.4 million each and are part of an $80 million program jointly funded by the International Development Association, the Saudi Fund for Development, and the Arab Fund for Economic and Social Development. The executing agency is the government's Sugar Project Implementing Committee, assisted by the Hawaii-based consultancy John H. Payne Inc.

Taiwan sugar contraction[8]

Production in Taiwan continues to dwindle; the campaign which has just started is not expected to yield more than 500,000 tonnes, raw value, the lowest level for many years and comparing with 575,000 tonnes in 1985/86. Consumption needs are put at around 480,000 tonnes so that it is thought unlikely there will be any sugar available for export to the world market after the small US quota has been met.

New York white sugar futures contract

The New York Coffee, Sugar and Cocoa Exchange has submitted to the Commodity Future Trading Commission for approval a proposed new white sugar contract to join the Exchange's two raw sugar contracts, No. 11 (world) and No. 14 (domestic). The new contract will have a unit of 50 tonnes of white beet or cane sugar and delivery months will be January, March, May, July and October, traded on an 18-month cycle. World white sugar will be deliverable from specified ports in Europe, Brazil and the US, with prices quoted in US dollars. The Exchange expects the new contract to have international appeal and therefore to become a competitor for the Paris white sugar market; trade views are, however, that the appeal will be primarily on the domestic front.

Sweden sugar production, 1986/87[9]

Six of the seven Swedish sugar factories sliced a total of 1,776,073 tonnes of beet to produce 286,799 tonnes of white sugar in the 1986/87 campaign, while the seventh factory at Jordberga produced 71,757 tonnes of raw sugar from 421,860 tonnes of beet.

China sugar expansion plans[10]

China plans to raise sugar output to six million tonnes in 1990 from 5.16 million tonnes in 1985/86 (November/May) and 4.31 million tonnes in 1984/85, according to the New China News Agency.

Poland sugar production, 1986/87[11]

The 78 Polish sugar factories processed 13.9 million tonnes of beet in their shortest-ever campaign (86 days against the average of 105 days). Sugar production reached 1.89 million tonnes, up 86,000 tonnes from the year before. The short campaign helped to limit losses usually caused by exposure to low winter temperatures. Average sugar content was 12.55%, the second highest after the record 12.62% of 1983. Production will be sufficient to cover domestic requirements and will leave a limited quantity for export.

High fructose syrup in Austria[12]

According to newspaper reports and unofficial information, Austria will begin to produce HFS in 1987. Expected production will be 43,000 tonnes and it will only be available to the food industry.

Switzerland sugar imports, 1986[13]

	tonnes, white value
Belgium	408
Colombia	31
Cuba	2,989
France	27,093
Germany, West	117,477
Spain	7
UK	102
US	9
Other countries	252
	148,368

White sugar packaging plant in Cuba[14]

An 8-line unit to package white sugar in 1-kg bags was installed in Cuba at the port of Matanzas to diversify their exports to the international market. This equipment — from Japan — cost more than 1.5 million pesos (around $2.1 million).

Interest in restarting US sugar refinery[15]

Six separate companies are interested in restarting the Godchaux-Henderson sugar refinery in Reserve, Louisiana, closed since January 1985 when its owner, Great Western Sugar Co., declared bankruptcy. The companies have proposals for importing sugar from various origins and supplying different markets; they have asked the South Louisiana Port Commission to issue revenue bonds to assist in buying and restarting the facility and the requests are under study.

Denmark sugar production, 1986/87[16]

The five sugar factories in Denmark sliced a total of 2,850,000 tonnes of beet in the 1986/87 campaign to produce 425,900 tonnes of white sugar during a campaign of only 84 days.

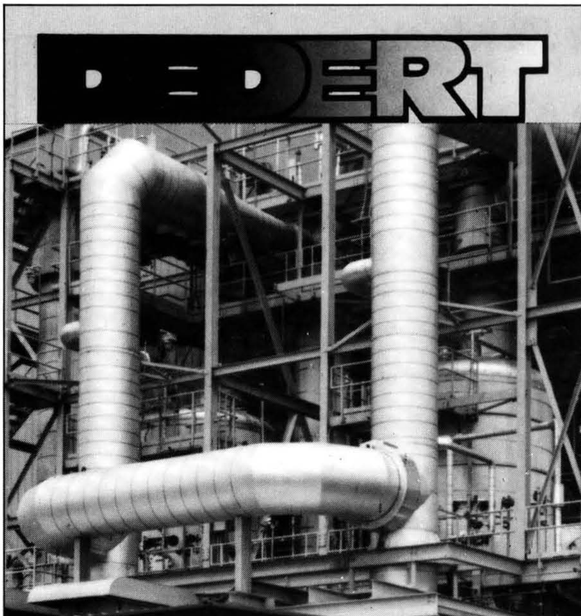
Vietnam sugar production increase[17]

From 45,600 tonnes, white value, in 1975, sugar production rose by 1985 to 433,700 tonnes. The cane crop grew from 1.6 million tonnes to more than 5.7 million tonnes in the same period but is reported to have fallen in 1986.

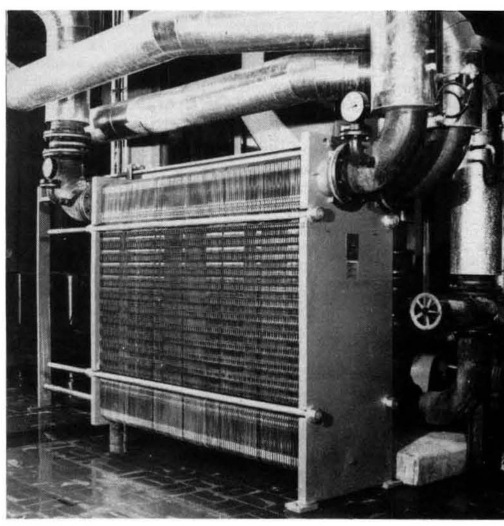
5 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, S60.
6 *Standard Chartered Review*, December 1986, 25.
7 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 15.
8 *Czarnikow Sugar Review*, 1986, (1756), 189.
9 *Zuckerind.*, 1987, **112**, 80.
10 *Reuter Sugar Newsletter*, December 18, 1986.
11 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 34.
12 *Amerop-Westway Newsletter*, 1987, (158), 12.
13 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, S60.
14 *Amerop-Westway Newsletter*, 1987, (158), 12.
15 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 36.
16 *Zuckerind.*, 1987, **112**, 79.
17 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 39.

PERSONAL NOTES

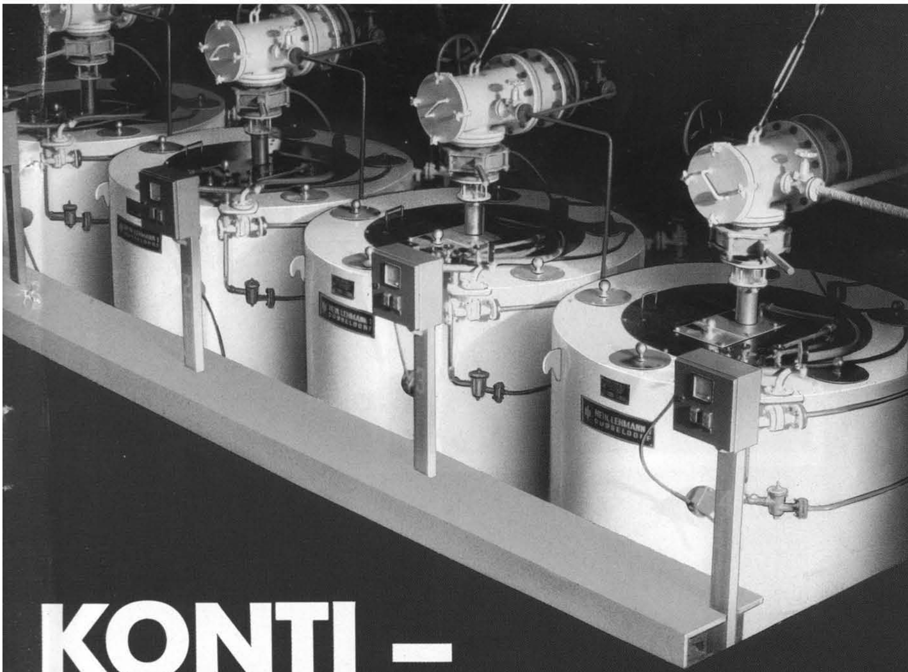
We regret to report the death of **J. A. C. Hugill** at the age of 71. He joined the Royal Navy Volunteer Reserve at the outbreak of the 1939/45 war, directly after leaving Oxford University, and was decorated a number of times. In 1946 he joined Tate & Lyle Ltd. as a shift manager, rising by 1953 to being Managing Director of the company's subsidiaries in Jamaica and Trinidad. He was instrumental in establishing the Central Agriculture Research Station in Trinidad and also encouraging the move of Tate & Lyle's Group research laboratories to the University of Reading campus in 1972. He had returned to Britain when the West Indies Sugar Co. Ltd. and Caroni Ltd. came under local control, and in 1975 became the Executive Director of World Sugar Research Organization, the London based successor to the International Sugar Research Organization, formerly the Sugar Research Foundation based in New York. He wrote a number of books, including "Sugar and all that", an official history of Tate & Lyle, which appeared in 1978.



New plate heat exchanger applications



Index to Advertisers



- Safety basket made of two shells
- High efficiency inner heating system
- A low noise level
- A stainless steel casing
- An automatic control to cooperate with your computer

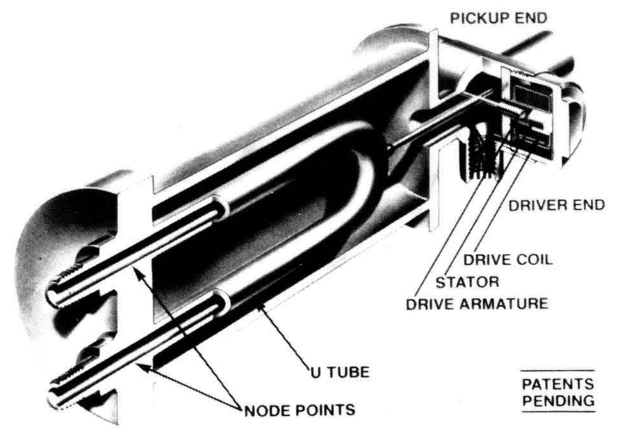
KONTI – CENTRIFUGALS

HEIN, LEHMANN AG

Abt. Massentrennung
Fichtenstr. 75
D-4000 Düsseldorf 1
Postfach 41 09
Telefon (0211) 7 35 01
Telex 8 582740 hl d

On-line density measurement

The Dynatrol system is for accurate measurement of Brix, density or specific gravity in sugar mills and refineries under process conditions. The Dynatrol cell is rugged, very accurate, easy-to-install, and has no moving parts. This on-line sensing cell provides immediate and continuous response to slurries, liquids, and highly viscous materials, without being sensitive to changes in ambient temperatures, pressure, or flow velocity. The Dynatrol is highly respected and relied upon, being well proven and widely used in sugar factories on process streams of sugar syrups, molasses dilution, etc.



More information concerning the Dynatrol Cell may be obtained from:

AUTOMATION PRODUCTS INC.

3030 Max Roy Street, Houston, Texas 77008, USA

Telephone: 713 869-0361 *Telex:* 775-959