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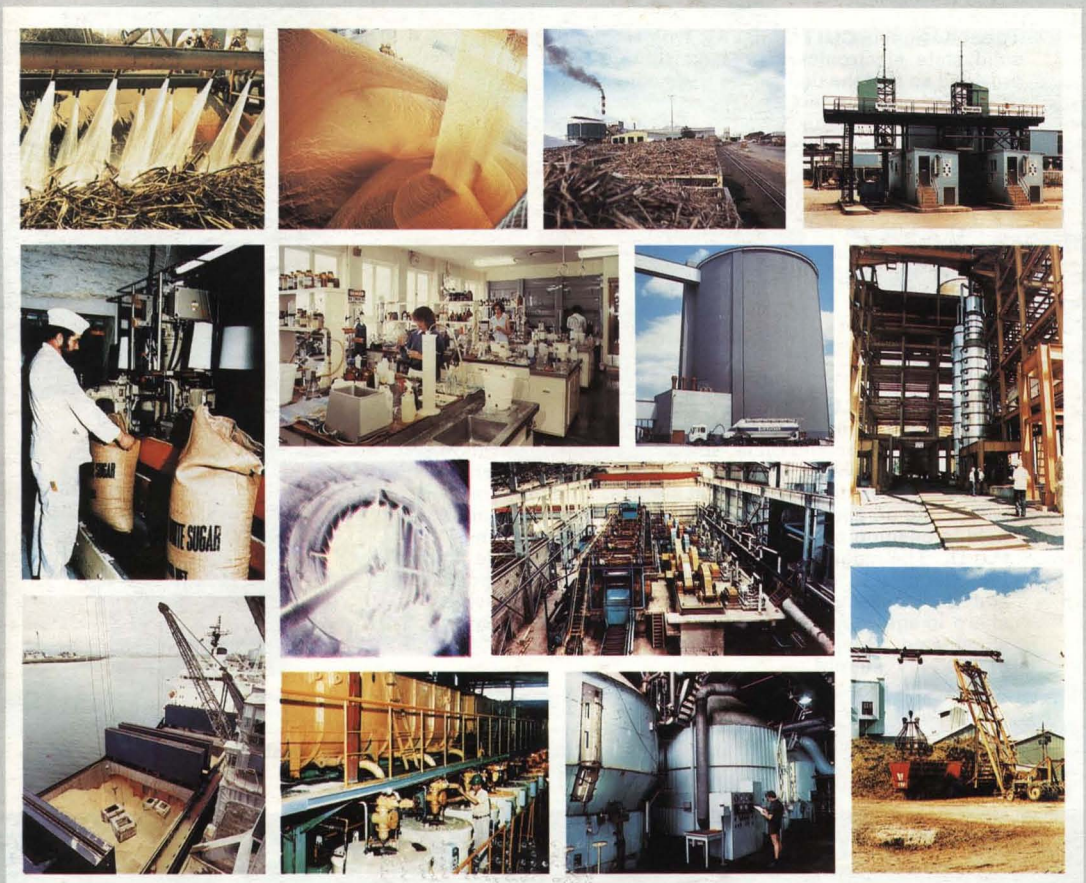

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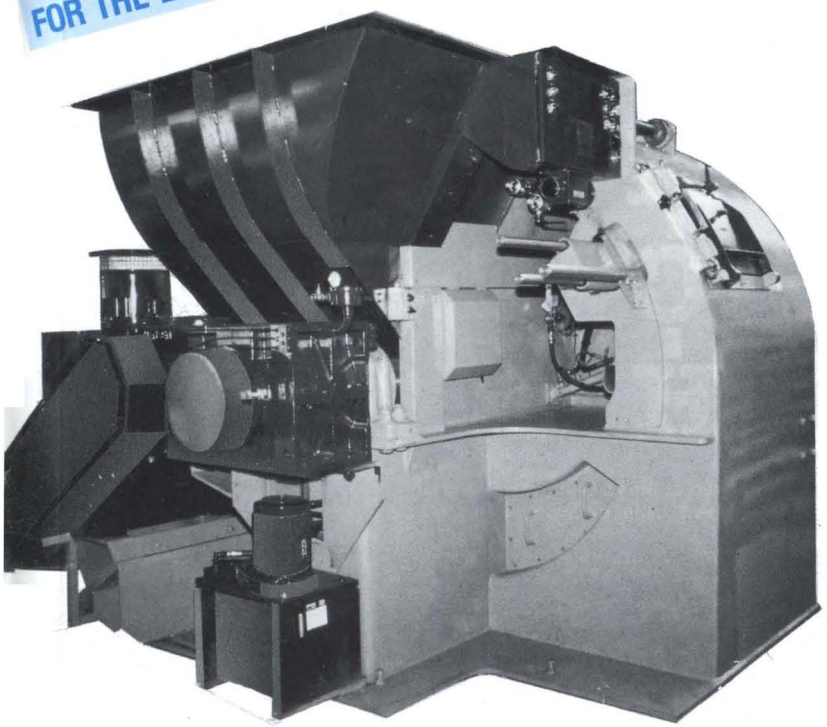

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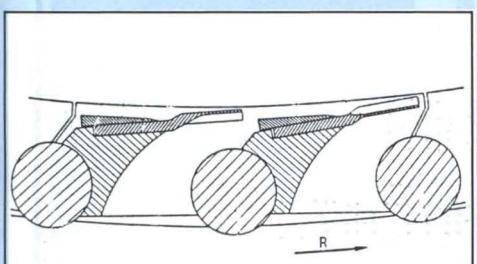

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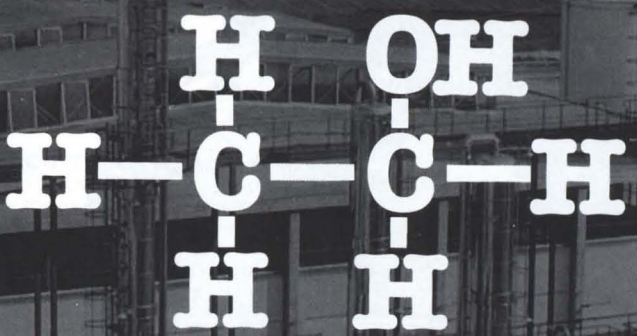

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News and views

International Sugar Agreement

The International Sugar Agreement, which was due to come into operation on January 1, finally became effective following a meeting on March 24 of the UN Sugar Conference. The agreement was negotiated last September but delayed ratification by several leading sugar trading nations has held up its introduction. Signatories include 9 importers and 30 exporters; the latter include Australia, Cuba and the EEC, but Brazil is a notable absentee, perhaps more owing to recent upsets in the organization of the Sugar and Alcohol Institute than to a deliberate intention to remain outside.

The new ISA has no economic clauses and exists only to provide economic and statistical information as well as a forum for debate; however, with strengthening of sugar prices there are hopes that negotiations might start which could lead to the introduction of a mechanism to stabilize world sugar market prices.

Cuba sugar expansion target[1]

Cuba has set a target of an annual production of 9 million tonnes, raw value, by 1990, nearly 2 million tonnes up on production in 1986/87, according to a Central Bank report. A program has been adopted for the planting of 400,000 hectares of sugar cane in order to guarantee a 1989 harvest of a million tonnes more than in 1988. The report said that the effect of a prolonged drought had forced the country to plan for 1987/88 at the same level as 1986/87 when Cuba produced 7.23 million tonnes, raw value, down from the 8.3 million tonnes produced in 1983/84. It said that, in order to meet the 9 million tonnes objective, industrial capacity has been increased through the construction of new facilities with a capacity of 1 million tonnes, with other facilities enlarged or modernized.

Although the production target is nearly two million tonnes above actual output in 1986/87 it does not appear to be unrealistic. However, if the Cubans reach the target for 1990 they may have difficulties in selling their exportable surplus. The government in the USSR, Cuba's main customer, is apparently succeeding in bringing about changes in Soviet agriculture which could push sugar production significantly and consistently above the level of 8.5 million tonnes. This could eventually mean that the Soviet Union will need less sugar from Cuba and practically none from the world market, which would also indirectly hit Cuban exports. Moreover, international trade continues to shrink so that other exporters will have to disappear to make room for the additional Cuban export surplus.

Currently, however, Cuba's problems appear to be more a matter of short supply rather than of surplus. A delegation visited China in March to seek postponement of shipments and it has since been reported that 250,000 tonnes due to sugar brokers in return for deferral of 1987 deliveries would be sent instead to China, the Cubans undertaking to provide the brokers with replacement sugar from the 1988/89 crop. It is also reported that the USSR may be looking for another 500,000 tonnes from the world market to cover a shortfall in Cuban supplies[2]. Cuba has also cancelled some contracts for supplies to Japan and has obtained agreement to deferment of others until 1989.

Kuwait bid for Spanish sugar company

Torras Hostench, a Spanish company controlled by the Kuwait Investment Office through its 45% shareholding, holds a stake in the Spanish sugar company Ebro Cía. de Azucares y Alcoholes S.A. y Filiales and has made a bid for further shares to bring its ownership to a controlling 51%. The Ebro board has treated the bid as a hostile one, claiming that the offer is low and not in the interest of Ebro, coming from a group with no experience of sugar production.

In an unusual tactic to fight off the bid, the Ebro company has pointed out to the Kuwait government that the bid conflicts with Islamic business ethics, since Ebro has extensive distilling interests, and the Islamic code debars businesses from engaging in alcohol-related activities[3]. Ebro is Spain's largest alcohol distiller, producing 30 million litres of alcohol a year from molasses, mainly for use in vodka and gin manufacture.

Tate & Lyle bid for A. E. Staley

Tate & Lyle, which is bidding $1400 million for Staley Continental, is aiming at a larger slice of the US sweetener market; already with interests in beet sugar and refined cane sugar in the US, it would gain an important part of the corn sweetener market which completes the range offered to the US consumer. The British company would dispose of Staley's food distribution business which has been built up over the past three years but considers that it has an important contribution to make to the efficiency of corn syrup and HFS manufacture which is the backbone of the Staley business, contributing some two-thirds of its profits. An earlier bid of $1300 million had been rejected as inadequate by the Staley board but Tate & Lyle claim the support of the Staley work force and leading Illinois politicians for their new bid.

Sugar growers fear price explosion

After a long period of surplus and depressed prices, the world sugar market has moved back into balance. Uncommitted stocks are at low levels and sugar growers are concerned that supply shortages could result in a price boom which would do irreparable damage to demand for sugar, and boost the production of substitute sweeteners.

At the Annual Meeting of the World Association of Beet and Cane Growers, which took place during March 15 - 16 in Brussels, delegates stressed the need for a controlled expansion in sugar production in order to supply fully the needs of the market, and prevent sugar

1 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 134.
2 *Public Ledger's Commodity Week*, April 2, 1988.
3 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 185.

prices from climbing to a level that would give rise to a new, unbalanced situation in the future.

Cane growers from Brazil said they could switch significant quantities of cane from alcohol to sugar production if market requirements dictated. Beet growers said that they could respond to a supply shortage by boosting output of sugar within a year if required.

"We must do everything to avoid a price explosion" said Mr. Fred Soper, President of the Association, "but must be careful not to oversupply the market and again depress producer prices. ... It is vital that governments sign the ISO Administrative Agreement without delay. ... The International Sugar Organization is a unique forum for sugar exporters and importers – both as a source of basic market information and in working to stabilize world markets – which must be retained at all costs.

"Obviously, any action within the ISO must take account of the present negotiations within the GATT. However, it would be tragic if governments were to abandon the ISO and rely entirely on the GATT negotiations to solve sugar market problems".

The World Association of Beet and Cane Growers is studying new, original, simple and effective proposals to stabilize world sugar markets.

Aid proposed for EEC sugar refiners[4]

Among the Commission's price proposals for the EEC sugar industry for the year beginning July 1988 is one for the introduction of aid for the refining of raw sugar, particularly in favour of the UK refiners. One reason is that the refiners have to buy 1.3 million tonnes of ACP sugar at a fixed price and then sell their refined product in competition with beet sugar, which affords a much higher profit than refining. Tate & Lyle have expressed pleasure that their problems have been recognized by the Commission and are working out the details of the benefits proposed before judging whether it would safeguard the future of their two refineries.

Doubts over US beet sugar in 1988/89[5]

Despite a projected increase in US beet sowings this year, sugar production could decline, allowing the import quota to remain static or even increase. The US Department of Agriculture forecast at the beginning of April that the beet area would rise by 1.6% to 1,290,000 acres, but exceptional weather that boosted yields in 1987 is unlikely to be repeated and analysts think that production could fall by 100,000 tonnes. However, although farmers said initially last year that they would sow 1.3% more land to beet, actual sowings were 3.1% greater, and a similar discrepancy could affect the outcome of the 1988/89 beet sugar crop.

Philippines sugar import arrangements[6]

The Philippines government has assigned the import of 66,250 tonnes of raw sugar to the state-owned National Sugar Refinery Corporation (Nasurefco) instead of allocating the volume to different local firms, according to the Sugar Regulatory Administration. The SRA Commissioner said that assigning the imports to Nasurefco would make for better regulation of the shipments; these would be processed at Nasurefco's three refineries and local traders will then be allowed to bid for participation in distribution to the domestic market. The sugar is contracted for delivery between May and July when a supply shortage is expected.

US sugar consumption in 1987[7]

After ten consecutive years of decline, sugar deliveries in calendar year 1987 rose 5% to 8,172,000 short tons, raw value. Sugar deliveries for industrial use increased by 5.7%, with deliveries rising in every category except beverages, according to a USDA report. Once the largest single use for sugar, beverages only took 212,000 short tons in 1987. The largest increases were in confectionery, cereals and baking, while multiple and all other food uses rose by 20.5%; this category includes food uses not covered in other categories and deliveries to manufacturers producing in two or more of the other categories.

Sugar deliveries to non-industrial users rose 4.0% to 3,127,000 tons, much of the increase being to wholesalers, although that to retailers fell 6.6%. This probably reflects changing purchase patterns for grocery as well as more food purchases in restaurants.

Deliveries are forecast to increase by 1.5% in 1988 to 8.3 million tons, as inroads by HFS have slowed, production of crystalline fructose has not grown as rapidly as earlier forecast, and imports of competing sugar-containing products seem to have stabilized in 1987.

Fall forecast in the 1988 Mauritius sugar crop[8]

The Mauritius sugar crop is expected to fall sharply to around 600,000 tonnes in 1988 from 691,134 tonnes in 1987, as a result of below-average rainfall, according to sugar industry sources. Low rainfall and above-average sunshine between July and October boosted the sucrose content of Mauritius's bumper 1987 crop, but the weather conditions proved disastrous for this year's harvest. The Chamber of Agriculture said in a bulletin that, despite last year's good harvest, the Mauritian sugar industry was still financially shaky. The Chamber noted that production costs had increased because of a 15% wage rise given to sugar industry employees in July, and it complained of the labour shortages and rising absenteeism.

Export earnings from sugar improved in 1987 because of rising world prices. The rising value of sterling and French franc against the Mauritius rupee and a 4% devaluation of the "green pound" within the European Community last July also helped. Cane production rose to 6.2 million tonnes from 6.0 million in 1986 and was 200,000 tonnes higher than Mauritius's 10-year average, despite a steady fall each year in the area planted.

4 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 164.
5 *Public Ledger's Commodity Week*, April 9, 1988.
6 *Reuter Sugar Newsletter*, March 18, 1988.
7 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 210.
8 *Reuter Sugar Newsletter*, March 3, 1988.

Deep bed filters

By Philip C. Alder, Andrew Byers, Nicholas Coote and Michael J. Fell
(Tate & Lyle Process Technology, Bromley, Kent, England)

Introduction

The origins of sand filters

The principles of deep bed filtration are rooted in the early 19th century when gravity sand filters were used to clarify water[1]. Quite simply, the water was sprinkled onto the surface of the sand, and the filtered water removed from the base. In spite of being probably the oldest type of filtration, the mechanisms involved are still to this day not fully understood[1,2] and complex theories abound[3-5].

Nearly 200 years on, such filters are still in use in the water industry, which is indeed a tribute to the simplicity of operation and effectiveness of this type of filter. Although advances have been made (mainly with respect to productivity by increasing the flow rate through the bed), the basic sand filter is capable of removing particulate matter of all sizes from water with great efficiency, from sub-micron sizes such as polio viruses[1] to large flocs several millimetres in diameter.

Modern deep bed filters

In common with all filters, mechanisms must be employed to remove the solids built up in the sand filter during operation. The very first filters collected most of the solids at the surface, and they were cleaned by scraping off the top layer of sand, either manually or by a mechanical system. Modern "high-rate" water filters are cleaned by "backwashing", that is, reversing the flow through the filter such that the sand bed is lifted and fluidized to an extent to discharge the accumulated dirt from the top of the filter without losing any sand. The bed is then re-settled and downflow filtration can commence. However, this was found to lead to surface blinding problems. To make the best use of all of the bed, the solids should be entrapped throughout the bed interstices. Since most fluids to be filtered, including water, contain a range of suspended solid sizes, the ideal bed would be for larger grains of sand to be at the top (with larger interstitial spaces) and the smaller at the base. This will ensure that the larger particles can penetrate the relatively loose upper layers of the bed, while the smaller particles to be trapped will find their way into the lower part, thus making good use of the entire depth of the filter. Unfortunately, fluidizing a sand bed and then letting it settle produces a bed composition which is the exact opposite of that required – the smallest sand particles settle at the top and the largest at the base (Fig. 1). This causes surface blinding as large suspended solids cannot penetrate the fine sand, and quickly foul the surface of the bed. Modern water treatment filters get round this problem by using not just sand, but a mixture of sand and anthracite. As it has the lower density, even quite large anthracite granules will settle above the sand on fluidization and subsequent re-settling, thus getting closer to the ideal composition of large particles at the top and small ones at the base (Fig. 1). These multi-media, "self-grading" filters are now termed deep bed filters or DBF's.

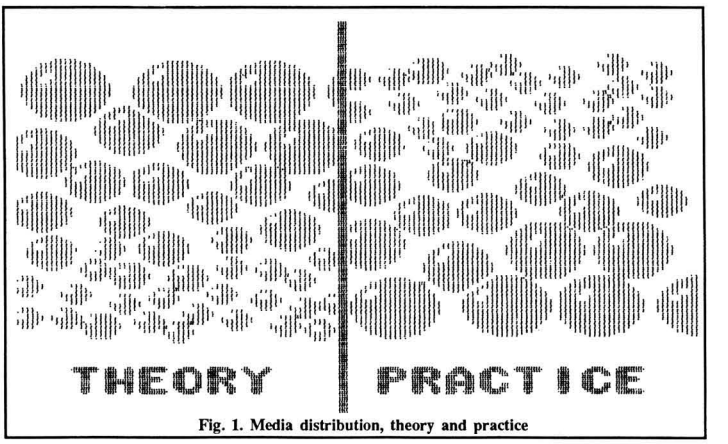

Fig. 1. Media distribution, theory and practice

Compared with other types of filtration, involving disposable filter aids such as diatomaceous earth, DBF's are relatively easy to operate, readily automated, low in running costs, and capable of still retaining a level of performance when poorly-operated or presented with "shock" loads. With such an impressive list of advantages, therefore, it seemed worthwhile to investigate the possible application of this type of filter for clarifying sugar liquors and syrups. The following paper describes the results obtained recently in application of this technology to the sugar industry.

Initial trials with depth filtration using sugar liquor

Initial trials were conducted at Tate & Lyle's Thames refinery in London, using melt liquor pre-clarified by phosphatation and subsequent flotation of the scum by the Talofloc process. Since similar flocculating principles are used in the water industry, and it is known that sand filters and DBF's cope very well with flocculated solids[2,6,7], the flocculated, clarified syrup seemed a logical place to start. It also fitted in well with current operating practice, whereby many refiners world-wide employ phosphatation/clarification followed by a "polish" filtration step (usually employing a conventional filter-aid-consuming device) to protect the downstream processes (e.g. ion exchange, bone char or granular carbon columns) from being fouled, or simply

Paper presented to Sugar Industry Tech., 1987.

1 Culp & Culp: "New concepts in water purification" (van Nostrand Reinhold Company, New York), 1974, Chapter 3, pp. 51 - 108.
2 Kawamura: *J. Amer. Water Works Assoc.*, 1975, **10**, 535 - 544.
3 Isou & Ives: *Chem. Eng. Sci.*, 1969, **24**, 717 - 729.
4 Letterman: *Filtration & Separation*, 1975, (July/August), 343 - 350.
5 Snaddon & Dietz: *Ind. Eng. Chem. Fundamentals*, 1984, **23**, (2), 147 - 153.
6 Steverson: *Chem. & Ind.*, 1982, (February), 88 - 91.
7 Aitken: "Principles of unit operations" (Wiley, New York), 1980, Chapter 6, pp. 65 - 69.

Table I. Application of deep bed filters to sugar liquor after phosphatation clarification in cane sugar refining

Downstream unit operation	*Purpose of filtration*
Bone char	Eliminate column blockage
Ion exchange Granular carbon	Eliminate or reduce filter aid consumption of conventional filtration
Pans	Ensure low turbidity product

to ensure sugar quality if the syrup is going straight to the pans. The ultimate objective of these trials was therefore to replace conventional filters in some, if not all, of these applications (Table I).

With lack of useful theory as to the functioning of sand filters or DBF's, the first experiments were conducted very much on a trial- and error basis. In spite of today's advancement in computer modelling, this still seems to be the best way forward when testing out new filters. It was soon discovered that the observations were made very much in line with those found in water treatment DBF's, namely problems of surface blinding when a mono-bed of fine sand was used, turbidity breakthrough with a coarse sand bed, and noticeably worse performances after fluidization. Interestingly, the high viscosity of the liquor, compared with that of water, seemed to be the least of the problems. The work processed rapidly with many media combinations being tried until, eventually, a bed composition was formulated which had the right characteristics of particle size, self-grading ability, and resistance to temperature and attrition. With respect to fluidization, the high viscosity of sugar liquor was found to be *an advantage* during backwashing, as the flow rate and volume of liquor required to clean the bed is quite small compared with using water. This was a true breakthrough, as it meant that the sugar DBF never needed sweetening-off, adding yet another major advantage to the list for this type of filtration.

Performance assessment

Bearing in mind that one of the main reasons for filtering sugar liquors is to protect downstream processes from fouling, it soon became apparent that assessing the turbidity of the stream was an insufficient measurement on its own. Conventionally, in water treatment and many industries where visual clarity is important, a turbidity meter or nephelometer fits closely with the performance duty of the filter. In water treatment, bacteria removal is very important, and the size of these organisms is such that they scatter light very effectively, and produce a visible haze. Similarly, in the drinks industry, visual clarity is often imperative for customer acceptance, so hazes must be removed.

However, protecting downstream processes from fouling is a very different reason for filtering a process stream; larger particles do not scatter light very well, but are the more likely cause of column fouling. A simple experiment demonstrates this point well: if a 10 ppm suspension of 1 μm latex spheres is visually or nephelometrically compared with a 10 ppm suspension of filter aid (average 30 μm), the latex suspension appears very hazy, whilst the filter aid looks clear, albeit with discrete particles visible; neither does the filter aid suspension register a large signal on a standard nephelometer. However, the filter aid has a much greater propensity to block a column of ion exchange resin or granular carbon than do the latex spheres.

To continue the trials, with meaningful analysis of the filter with respect to column fouling, it became vital to find an analytical technique to show up these larger particles, and a liquid-borne particle counter (Hiac Royco 4100 series) was purchased for this purpose.

Deep bed filter operation to bone char

Introduction

Chronologically, the operation of DBF to bone char was the first application to be tested as a part of the development program. The trials were conducted at a refinery operating phosphatation of washed sugar liquor, the clarified liquor being sent direct to bone char columns. The primary objective was to evaluate a full size prototype filter in a real refinery situation.

Since the refinery was already feeding clarified liquor direct to bone char (as do many other phosphatation refineries), there was no inherent need for filtration and hence this application of the DBF was not considered to be of interest to refiners. However, this point of view has been modified somewhat by further experience, as will be indicated later in this paper.

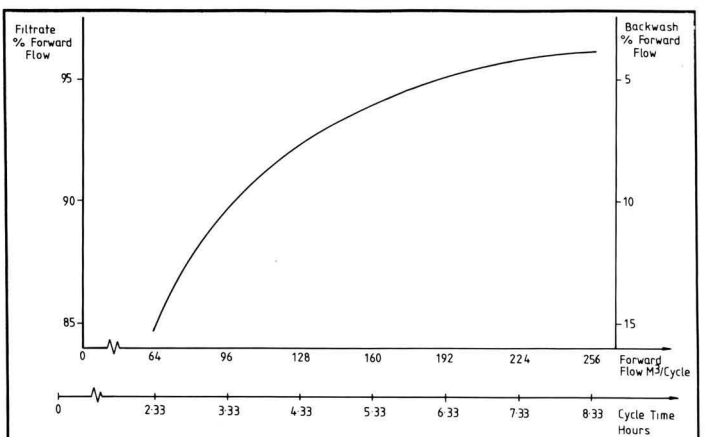

Fig. 2. Filtrate and backwash volumes *vs.* cycle time

DBF productivity

After overcoming the normal problems of site trials with prototype equipment, the DBF was operated for more than 2500 hours, filtering more than 80,000 cu.m. of clarified liquor.

During this time, the average filter cycle (on-line plus regeneration) was 4.9 hours and the average production rate was 27.8 cu.m./hr after taking both backflush and regeneration time into account. Cycle times varied in the range 2.5 hours to 7.5 hours according to the quality of clarified liquor.

Figure 2 shows the filtrate and backwash produced by the DBF for various cycle times while Figure 3 shows actual graph records of the pressure, flow and temperature taken during the trial.

Filtrate quality

Since the normal operation was to run clarified liquor to bone char, it was a formality to run DBF effluent to char. No particular differences in operating pressure or flow rates were noted, which suggests that the suspended solids content of clarified liquor was sufficiently low as not to impede progress through the bone char. Column pressures and flows were then due more to hydraulic considerations than suspended solids loading.

Tests were made on the influents and effluents of the DBF and bone char columns, to establish particle counts and size distribution of the suspended solids in these streams. The suspended solids contained in the bone char effluent remained substantially constant, whether fed directly with clarified liquor, or with DBF filtrate, giving some justification to the term Char Filter. The results are summarized in Table II.

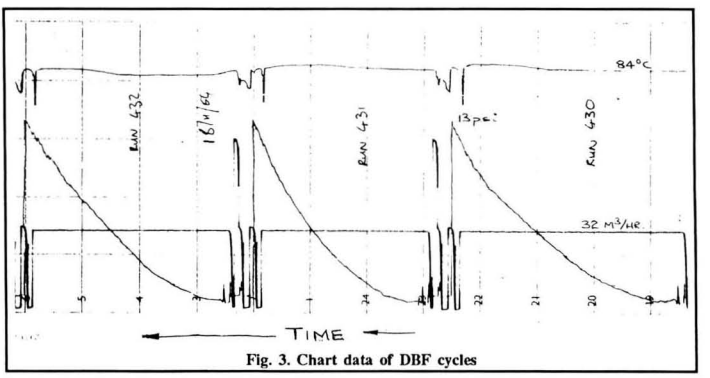

Fig. 3. Chart data of DBF cycles

From this analysis it can be seen there is around 40 ppm (by volume) of suspended solids in the clarified liquor, most of which is deposited in the char.

If the char is assumed to operate at 20 bed volumes/cycle, then the suspended solids contamination represents some 0.08% of the char volume. Expressed by weight, this would be in the region of 0.2% - 0.3% weight of char, after taking into account the bulk density of char and the likely density of the floc.

With a DBF included in the process, the suspended solids in the char feed are reduced by more than 90%, virtually eliminating carryover to the bone char.

Benefits to a refiner

For a refiner, currently operating direct feed of clarified liquor to bone char, there are two advantages to be gained by including a DBF between these unit operations. The obvious first advantage is the reduction of suspended solids load to the bone char referred to above. However, this reduction should not be evaluated in terms of the hydraulic effects to the char cisterns, but rather the long-term effects on the char quality. The carryover in clarified liquor is substantially calcium phosphate which, when kilned with the bone char, can permanently block pores, reducing the activity of the char stock. Evidence of this effect from around the industry suggests that the replenishment rate of bone char stock for phosphatation refineries is about 30% higher than that of carbonatation refineries. Also, where bone char is the main process decolorizer, a reduction in bone char activity will result in shorter service cycles and increased energy consumption for kilning and evaporation.

The second advantage lies within the clarification station; when feeding clarified liquor direct to bone char, great care must be exercised in the operation to minimize carryover and to avoid upset. Many refineries will have experienced lost production and/or blocked char columns through poor clarifier operation, albeit infrequently.

In this situation, clarifiers are usually operated in a conservative way such as to maintain the operation well within the limits of the process. Assuming all other parameters are correct, then viscosity and residence time are the two main factors affecting the amount of carryover in clarified liquor.

As viscosity rises or residence time decreases, there is a progressive increase in the level of carryover present in clarified liquor. With a DBF to protect the bone char, viscosity and residence times become less critical and greater

Table II. Particle distribution of process streams, ppm by volume

Average particle size, μm	*DBF/Char feed*	*DBF effluent*	*Char effluent*
3.25	0.61	0.41	0.29
7.5	1.21	0.56	0.48
17.5	2.1	0.78	0.51
37.5	5.8	0.53	0.34
75.0	12.1	0.58	0.38
120.0	19.7	0.55	0.33
Total	41.52	3.41	2.33

capacity can be achieved by higher Brix operation and increased throughput.

Refineries that typically operate clarification in the range 66°Bx to 68°Bx can realistically expect to extend the operation to 70°Bx with significant energy savings as a result.

These advantages may be difficult to justify in terms of conventional filtration because of the costs of the filter aid and labour. However, since DBF's have virtually no operating cost, the benefits obtained by protecting the bone char may now be cost-effective.

Deep bed filters in a phosphatation/acrylic resin refinery

Introduction

In August 1982 a white-end refinery was commissioned to produce refined sugar from a VHP raw sugar input operating at 35 tonnes/hr melt. The process combination installed was phosphatation clarification, pressure filtration and acrylic resin for decolorization.

During the initial operating seasons between 1982 and 1984, considerable problems caused by filter aid leakage onto the acrylic resins were encountered. The effects of this leakage were hydraulic blockage of the resin columns resulting in short operating cycles, and premature replacement of the resin at a substantial cost.

The problem was partially resolved by eliminating body feed and operating the presses with precoat only, even though this resulted in shorter filter cycles. The ultimate solution was thought to be a capital expansion to the filter station. This would comprise a first pass filtration using a precoat and body feed, followed by a second pass using precoat only.

At this time, Tate & Lyle were about to operate a full size DBF prototype and the refinery decided to defer any investment decision on new filters until the results of the experimental DBF prototype were known.

The prototype DBF performed to the expectations of the development team with no scale-up problems and, as a result, the first production model was installed on a trial basis, in September 1985, to handle a significant portion of the clarified liquor stream.

Operation prior to September 1985

During this period, the refinery operated at a melt rate of 35 tonnes/hr solids, with three 84 sq.m. Suchar Autofilters on line, feeding two parallel resin columns, each containing approximately 7.5 cu.m. of type IRA 958 acrylic resin.

The average consumption of filter aid (Dicalite 471), was 0.15% of melt solids and the average filter cycle 2.7 hours. The sugar recycled around the process from the filter washings averaged 11.4% of melt. A schematic solids balance is shown in Figure 4.

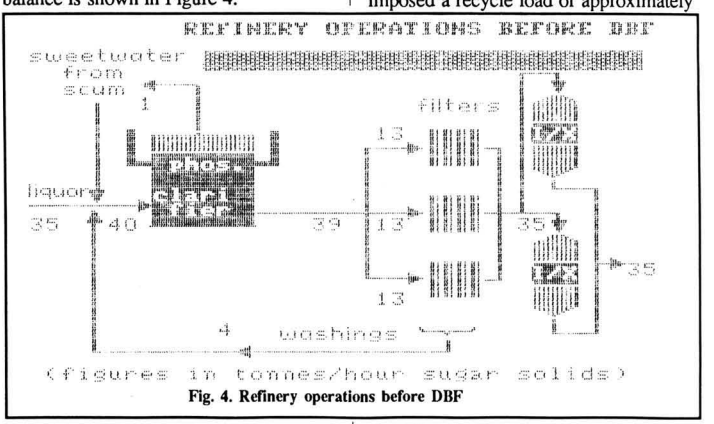

Fig. 4. Refinery operations before DBF

Trial operation with one DBF

The trial DBF was installed in parallel with two of the existing Suchar Autofilters. The remaining pressure filter was arranged to provide second-pass filtration on the total filtrate i.e. DBF filtrate plus first-pass pressure filtrate. A stand-by filter was used for either first-pass or second-pass duty to replace on-line filters as they reached final pressure.

This arrangement allowed 68% of the clarified liquor to be filtered by DBF while the balance of 32% was filtered through the Suchar Autofilters. Figure 5 shows a schematic solids balance of the trial operation.

In this mode of operation, the DBF gave cycle times of between 6 and 7 hours, and regeneration of the filter imposed a recycle load of approximately 5% of melt solids.

The cycle times of the pressure filters on first-pass duty, improved from

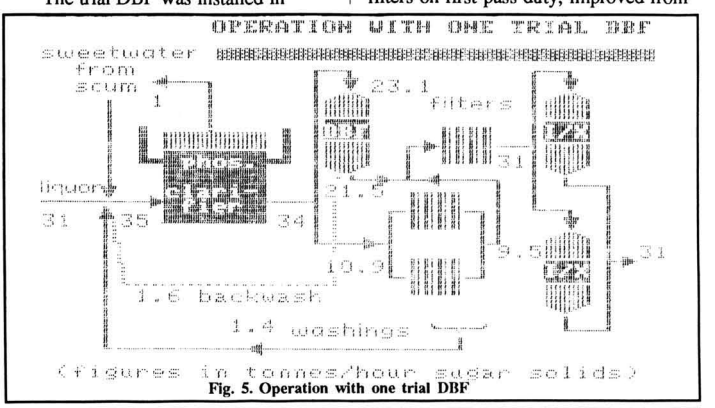

Fig. 5. Operation with one trial DBF

2.7 to 4.7 hours. This was attributed to the reduction in throughput, since the sugar solids processed per filter cycle remained substantially constant.

The second-pass polish filter gave average filter cycles of 14.3 hours and the recycle load from washings of all presses was approximately 4.5% of melt solids (mostly from first-pass operation).

Finally, but most important, the filter aid consumption was substantially reduced from 0.15% to 0.069% of melt solids and no problems were experienced with the resin station. The performance of the filters before and during the trial are summarized in Table III below.

Table III. Pressure filter performance over 8 weeks trial

	Prior to DBF	*With trial DBF*			
		1st filter	*2nd filter*	*Total 1st + 2nd*	*DBF*
No. filter cycles per week	241	71	14	85	22
Average cycle time, hr	2.7	4.7	14.3	-	6.8
Filter aid used per cycle, kg	32.0	32.0	31.9	-	0
Melt solids per cycle, tonnes	21.2	18.2	289	-	125
% Total melt processed	100	32	100	-	68
Filter aid % on total melt	0.151	0.058	0.011	0.069	0

Filtrate quality

During the trial period, the turbidities from the various filters were assessed by measuring the absorbance of the liquors at pH 7 before and after 0.45 µm filtration, using a spectrophotometer set to 420 nm wavelength. The differences were recorded as turbidity in ICUMSA colour units. A summary of these results is shown in Figure 6 below.

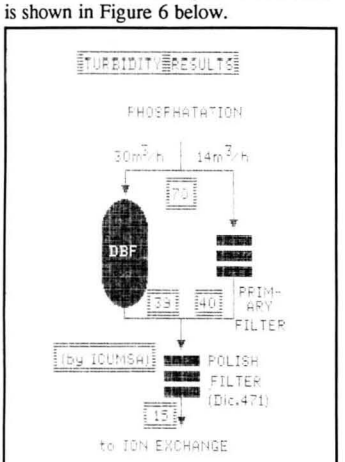

Fig. 6. Turbidity results

Projected operation with two DBF's

From the trial data, a theoretical solids balance was prepared of the final proposed installation. This is shown in Figure 7 below.

One notable difference from the earlier configurations is the treatment of DBF backwash. With two DBF's providing the first-pass filtration, and two Suchar presses on second-pass duty, there is sufficient press capacity to allocate a filter dedicated to recover the DBF backwash and second-pass press washings. This operation had been tested during the trial period and proved to be satisfactory.

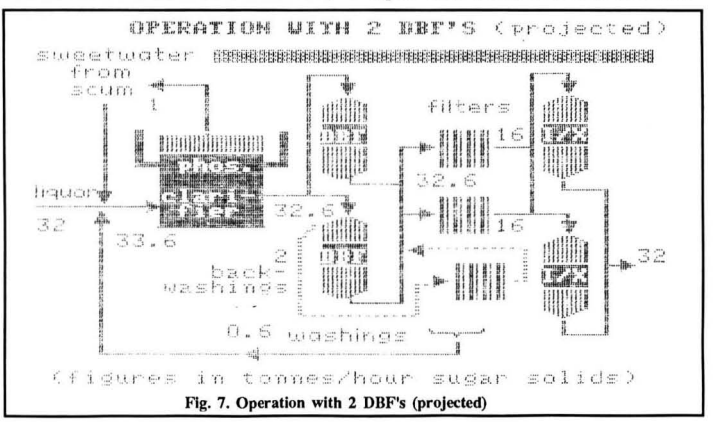

Fig. 7. Operation with 2 DBF's (projected)

Thus, in this final arrangement, the sweetened-off filter cake from the second-pass filters is sluiced into a tank with the DBF backwash. The mixture is then pressed and fed forward in the process. In this way, the recycle stream is reduced to approximately 1.9% of melt solids.

Final installation

In September 1986, two DBF's were added to complete the installation and to provide additional capacity for future expansion. In the ensuing six weeks prior to the end of of crop, the average total filter aid consumption was 0.2% of melt solids.

During the final weeks of the season, a short trial was conducted to evaluate the operation without second-pass filtration Accordingly, the DBF filtrate was fed directly to the resin station and each of the 3 columns (2 operating, 1 standby) was subjected to more than three cycles of operation in this mode.

There was no observable difference in performance, either in terms of flow rates, pressure drops or resin cycles from that obtained with second-pass filtration. There was, however, a turbidity increase in the ion exchange liquor from 5 i.u. to 6 i.u. Future testwork includes evaluation of filter aid grades for the second-pass duty and additional runs direct to resin.

For the refinery described in this report there is little additional benefit to be gained by direct operation to resin, since the major cost savings in reduced filter aid consumption have already been achieved. For a new installation where the pressure filters would represent an additional capital cost, then direct operation to resin would be very attractive.

Deep bed filter operation direct to granular carbon columns

This application has always been

considered to be more demanding than operation to bone char or resin because of the large number of bed volumes per cycle achieved with granular carbon columns. This is supported by the fact that granular carbon stations are always preceded by pressure filtration or by bone char columns, whereas bone char stations are frequently fed directly from phosphatation clarification.

The application was evaluated in a refinery operating with phosphatation clarification direct to bone char columns followed by granular carbon.

Assessing the performance required of the DBF

From a review of bone char and carbon operations around the industry, granular carbon will treat between 80 and 120 BV per cycle whereas an equivalent bone char operation will only yield around 20 BV per cycle, and an acrylic resin system around 50 BV per cycle.

Thus, if we make a simple assumption that each process is similarly affected by particles in the feed, then the maximum level of suspended material which can be tolerated in any stream is inversely proportional to the Bed Volumes treated per cycle, i.e., there is a figure of merit based upon:

Bed Volumes × ppm suspended solids.

This is borne out in practice since many refiners operate directly from phosphatation clarification to bone char whereas pressure filtration is normally required for operation to granular carbon or resin.

When operated correctly, clarifiers produce liquor containing typically 30 to 50 ppm of suspended solids measured volumetrically. Figure 8 shows the particle distribution in clarified liquor.

Since we know this level of performance is acceptable for direct operation to bone char, we make a prediction based upon BV × ppm that the feed required to granular carbon would need to be around 80% lower in suspended solids.

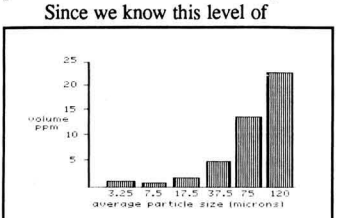

Fig. 8. Particle distribution ex clarifier weirbox

Thus, based upon the initial assumption that char, carbon and resin would suffer equally from fouling by particulate matter and remembering that ppm figures quoted relate to the particular particle size distribution found in clarified liquors, liquor quality required to feed granular carbon should contain less than 8 ppm suspended solids by volume.

Table IV shows a sieve analysis of the char and carbon on site with acrylic resin IRA 958 included for comparison.

Table IV. % Retention of different particle sizes

Size, mm	*Char*	*Carbon*	*Amberlite IRA 958*
2.4	2.6	0.1	0
2.0	25.4	0.1	0
1.4	37.6	17.3	2
1.0	16.2	36.2	8
0.85	-	16.1	18
0.6	12.3	20.5	59
0.4	4.7	8.1	6
0.25	1.0	1.5	4
<0.25	0.2	0.1	3

Deep bed filter effluent

The filtrate from the deep bed filter was measured using the same particle counter settings as previously used on the clarified liquor and the results given in Table V.

It should be noted that 34% of the suspended solids in the filtrate and 84% of that in the clarified liquor resulted from particles greater than 50 μm. Furthermore, the potential errors in volumetric calculations (which can result from assuming the particle size distribution is symmetrical around the mean size of the set range), are great, which particularly affects the lower ranges.

For example, in the clarified liquor, if the particle size distribution in the range 50 - 100 μm were skewed 20 % from the mean value of 75 μm, then the change in volumetric ppm would be greater than the total contribution of all particles below 50 μm.

DBF feed, DBF filtrate, bone char effluent and carbon effluent

To improve accuracy, the maximum threshold on the particle size counter was reduced to 50 μm, thereby giving a greater resolution in the lower ranges. Volumetric ppm were calculated for the lower size ranges and particle populations greater than 50 μm were recorded. The results are summarized in Table VI.

From this table, it is evident that the DBF filtrate contained around 1.6 times the amount of volumetric suspended solids than was present in char liquor. The particle size distribution peaked in the 5 - 15 μm range for all samples, indicating the effects of centrifugal pumps on all streams.

Table V. Particle analysis of DBF influent/effluent, ppm by volume

Average particle size, μm	*ex-Clarifier*	*ex DBF*	*% Reduction*
3.25	0.53	0.38	28
7.5	0.26	0.61	(135)
17.5	1.37	0.70	49
37.5	4.70	0.66	80
75	14.50	0.65	96
120	22.25	0.56	97
Total	43.61	3.56	Average: 92

The above results confirmed earlier development work, viz. (a) the media selected for the filter produces significant removal of particles in the 10 μm size and larger, and (b) there is an increase in particles below 10 μm caused by the shearing action of the centrifugal pump transporting the clarified liquor.

In view of the fact that all of the columns can leak fine media and that hydraulic shearing occurs throughout the process (and presumably some recombination of particles), it was concluded that nothing further could be deduced from additional tests of this type.

Accordingly, a full-scale trial,

Table VI. Particle analysis in refinery operations, ppm by volume

Average particle size, μm	*DBF feed*	*DBF filtrate*	*Char effluent*	*Carbon effluent*
1.75	0.05	0.03	0.01	0.00
3.5	0.70	0.49	0.37	0.09
10.0	2.26	1.04	0.55	0.63
22.5	1.13	0.42	0.34	0.41
40.0	1.14	0.25	0.16	0.21
Total	5.28	2.23	1.43	1.34
Counts/ml above 50 μm	75.4	1.57	1.16	0.96

sending DBF filtrate to granular carbon was run. The DBF filtrate was sent at an average rate of 0.15 BV/hr while the pressure on the granular carbon column was recorded. Figure 9 is a graph of the pressure rise *versus* BV processed. For comparison the normal pressure profiles of granular carbon fed with char liquor is included. From the graph it can be seen that there is a significant divergence from the normal pressure profile after only 6 BV and a continuing pressure increase thereafter. An extrapolation of the curve indicated that the column would reach full pressure after only 15 BV and therefore the trial was terminated.

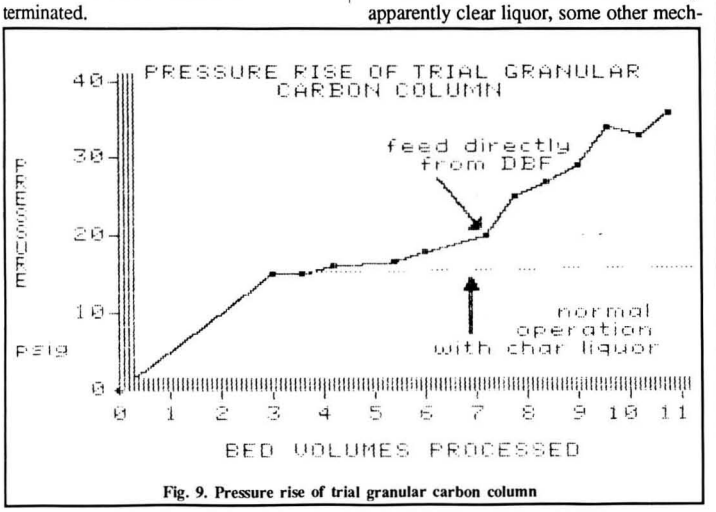

Fig. 9. Pressure rise of trial granular carbon column

It would be an understatement to say this was an unexpected result. From the earlier analysis of suspended solids, a run of at least 50 BV had been expected, if not a full cycle of 100 BV. The trial was repeated on two more occasions with different melt raws. In each case the result was substantially the same.

After fouling, the carbon column was opened for inspection; the visual appearances of the carbon was quite normal, unlike bone char blocked with calcium phosphate carryover (which resembled wet cardboard) or carbon blocked with filter aid. However, the carbon was slimy to the touch and, upon investigation, this sliminess was found to penetrate 2 to 3 inches into the top layer of the carbon bed. This phenomenon became known as "Factor X" within the team.

Since the carbon had been fouled by apparently clear liquor, some other mechanism for the fouling had to be sought. From a review of literature pertaining to the use of DBF's in water treatment, it was clear that granular media is only suitable to capture solids in a non-peptized or non-colloidal condition.

A program, comprising laboratory and site work, was set up to evaluate the phosphatation clarification process and the potential for leaving residual solids in a colloidal or peptized form.

The detailed results from this program, which ran for around 18 months, are beyond the scope of this paper, but the areas investigated are listed below:

(a) Operating pH regime
(b) Operating temperature
(c) Reaction times
(d) Calcium/phosphate ratios
(e) Phosphatation levels
(f) Polymer mixing – time and intensity
(g) Polymer mixing – charge density and molecular weight
(h) Flocculation
(i) Raw sugar.

The investigation established that, under certain operating conditions, colloidal impurities could be present in the clarified liquor which would eventually destabilize, forming a clearly observable after-floc.

It was concluded that this material had been present during the trials of DBF to carbon and had passed through the DBF in its colloidal form, subsequently destabilizing to the after-floc form in the carbon where the residence time is very much longer.

The particular problem at the test site was correlated to insufficient phosphate. This had occurred because a major plant refurbishment had taken place shortly before the trial, and the scaling factors between the acid pump and the computer were not correctly implemented, causing higher acid levels to be indicated than were in fact the case.

Although a substantial amount of time and effort was required for the investigation, it was considered well spent since it showed that the clarification performance could also be optimized for DBF operation.

Improvements to clarifier performance

A number of changes in the design and operation of the clarification station were made based upon the results of the investigation. In addition to the elimin-

Table VII. Improvements to phosphatation clarification in terms of ppm by volume ex clarifier weirbox

Average particle size, μm	*Before*	*After*	*% Reduction*
3.25	0.53	0.37	30.2
7.5	0.26	0.21	19.2
17.5	1.37	0.70	48.9
37.5	4.70	2.34	50.2
75	14.50	7.40	49.0
120	22.25	13.50	39.3
Total	43.61	24.52	Average: 43.8

ation of colloidal residues, there was a general improvement in clarifier performance which should lead to longer DBF cycles in the future. Table VII shows a comparison of the suspended solids in clarified liquor before and after plant modifications.

Field results of DBF to carbon columns

A DBF is currently being commissioned for direct operation to carbon. The initial results from this installation will be included in this section assuming they become available before the final date of submission of this paper.

DBF in raw cane sugar production

Introduction

In October 1986, DBF's were installed in conjunction with a Talodura phosphatation clarifier to produce a clean, high quality raw sugar for direct consumption.

The final evaporator syrup was clarified and filtered immediately prior to pan boiling and the *A*- and *B*-strikes were grown from a *C*-magma footing.

Comparison with normal raw sugar

For comparison purposes, a sample of affined sugar and a sample of Mauritian raw sugar were compared with the sugar produced by the new process. A liquor was prepared from each sample and analysed for particle counts and size distribution. The affined sugar and the Mauritian raw sugar liquors were both prescreened through a 150 μm retaining mesh. The results are shown in Figure 10.

The results showed that the total suspended solids of the liquors expressed as ppm by volume were:

Affined sugar	187 ppm
Mauritian raw	104 ppm
Direct consumption sugar	13 ppm

The Mauritian raw sugar is generally regarded by Tate & Lyle refiners to be a good quality feed, while the affined sugar sample was a typical example.

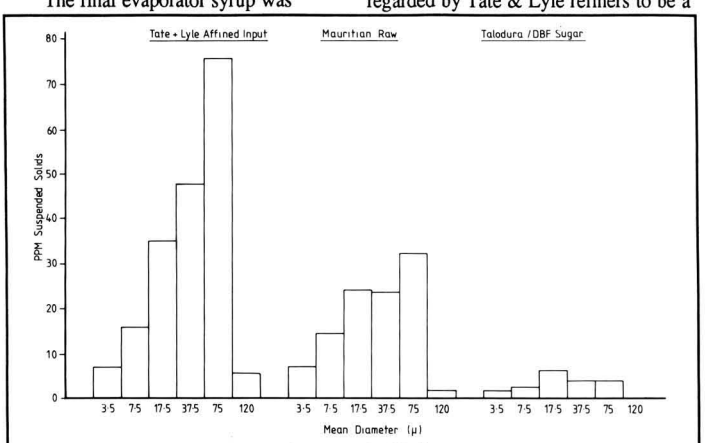

Fig. 10. Comparison of suspended solids in raw sugars

The significance to a refiner

Much discussion has taken place in recent years of the potential to eliminate affination in the refining process if suitable quality VHP raw sugar can be obtained. If VHP sugar can be produced with the very low suspended solids content as demonstrated, then it may be possible to eliminate or greatly simplify the defecation/filtration step prior to decolorization. For example, the sugar tested could probably be melted and fed directly to bone char, provided, of course, the sweetwater used at the melter can be supplied at a similar quality.

Alternatively, a typical pol sugar (98°+) produced by the same process would yield an affination syrup with a suspended solids content very much lower than normal. This could result in operational benefits in the recovery house particularly if the affination syrup can be incorporated into soft sugar blends without additional filtration.

Conclusion

A fully automatic filter, requiring no filter aid and producing no sweet-water, the deep bed filter is already operating in a number of refineries around the world, giving reliable performance and significant cost savings to operators. The application of new technology always presents problems requiring solutions, and the DBF is no exception in this respect. However, the problems encountered to date in applying DBF's in sugar processing have only served to increase our knowledge of clarification and column technology, and the solution of these problems has confirmed our belief that the DBF represents a significant advance in sugar technology.

As with any new development, further advances are envisaged which will include DBF applications in refinery sweet-waters and direct consumption raw sugars. Alternative bed media to extend the potential application of DBF's will also be examined.

ISJ Abstracts

Cane sugar manufacture

Options available to the raw factory for improvement of quality and recovery

M. C. Bennett. *Sugar J.*, 1987, **50**, (3), 16 - 19.

In a review of possible ways of improving raw sugar quality, it is emphasized that 90% of the impurities in the sugar crystal is the maximum amount that can be removed in the boiling process, probably because of the envelopment of minute droplets of mother liquor by the rapidly advancing wall of sucrose molecules on the face of the growing crystal, which in turn is determined by the rate at which the pan is operated; only very slow crystallization under laboratory conditions will increase impurity removal by an order of magnitude. The least efficient part of the crystallization process takes place in the centrifugal, since most of the impurity content is located in the syrup film surrounding the sugar crystal. Options available in boiling, massecuite cooling and purging in centrifugals are listed. Recycling rotary vacuum filtrate (often the dirtiest stream in the entire factory) is considered to have an adverse effect on clarification; advances in clarification in recent years have concentrated on treatment of pan feed syrup rather than on juice, syrup treatment being about four times more cost-effective. Flotation clarification of syrup using phosphoric acid and lime removes more than 90% suspended solids and about 10% colour; the mud is sweetened-off by mixing it with rotary vacuum filtrate and treating it in a much smaller flotation clarifier, from which the sweetened-off mud is recycled to the rotary filters and the filtrate mixed with clear juice going to the evaporator. Deep bed polish filtration of the clarified syrup is important in the manufacture of direct consumption raw or white sugar as well as VHP raw sugar. Syrup clarification greatly reduces the effect of particulate impurity and thus lowers the massecuite and molasses viscosity, so that boiling time and centrifugal wash water quantity are reduced and massecuite of higher Brix can be boiled. Details are given of a pilot plant trial involving syrup clarification and boiling in which an average pol of 98.78 was obtained, compared with a factory average for *A*-sugar of 98.56 over the same period, despite a centrifugal wash water reduction as expressed by a cut in the water addition time from 7 to 3 sec, which reduced molasses purity by >1% (equivalent to a 2% increase in yield from *A*-boiling). Sugar colour, turbidity and ash contents were halved.

Factors affecting raw sugar quality during bulk storage

M. Steele. *Sugar y Azúcar*, 1987, **82**, (10), 18, 22, 24 - 26, 29.

Raw sugar deterioration during storage is discussed, including quality parameters that are susceptible to change (these are particularly pol and colour, moisture and dextran contents), and advice is given on measures to maintain quality, covering pol, safety factor, grain size (which should be medium-to-large, uniform and with no presence of rolled grain or conglomerates), colour content (which should be initially low), dextran content (which should be very low or zero), clarification (aimed at providing a juice relatively free from insoluble non-sucrose matter), temperature (preferably 25 - 38°C) and method of placing the sugar in storage. Desirable features of a bulk storage facility to minimize deterioration are indicated, including treatment of concrete floors, warehouse cleaning, and operation, maintenance and cleaning of front-end loaders and conveyor systems.

Spiral heaters for the cane sugar industry - test results

E. Finlay and H. Bourzutschky. *Zuckerind.*, 1987, **89**, 892 - 895.

Advantages claimed for spiral heat exchangers over the conventional shell-and-tube type include a high self-cleaning effect and hence low fouling tendency, the ability to carry out an entire inspection of juice passages (and mechanically clean them if necessary) by simply removing the bolted-on covers, a high heat transfer efficiency and minimal installation space requirements. Tests conducted at a Jamaican sugar factory with a spiral heater of 9 m^2 heating surface in which limed juice was heated with condensate showed a temperature rise from 38 - 40°C to 55 - 85.4°C at a juice velocity in the range 1 - 2.87 m/sec and a condensate velocity of 0.363 - 2.63 m/sec; the heat transfer coefficient ranged from 1654 to 4313 W/m^2/°C. There was no detectable effect of scale on heat transfer and deposits were easily removed by washing. Marked fluctuation occurred in the heating of mixed juice.

Factors affecting the *C*-massecuite crystallization process

U. Soto H. *Tecnol. Quím.*, 1986, **7**, (4), 68 - 70, 88; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (19), Abs. 19 R409.

The effect of a number of factors on *C*-massecuite exhaustion in cane sugar factory crystallizers is briefly examined, including the crystallization rate, viscosity, total dry solids content, temperature, purity and reducing sugars/ash ratio. It is noted that a 5°C rise in temperature caused a 50% fall in viscosity, while a 0.8% rise in total solids almost doubled the massecuite consistency.

Ethanol as an indicator of burn-to-crush delay

G. R. E. Lionnet and J. V. Pillay. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 5 - 7.

Results confirmed earlier findings that the ethanol content (as determined by GLC) is a suitable indicator of post-harvest deterioration of cane where the delay between burning and crushing exceeds two days; equations obtained of delay as a function of ethanol content, temperature and variety using multilinear regression gave values within about 40 hr of true values where ethanol was used as basis, but if a factory used an equation based solely on its own data, the ethanol content would be suitable where delays of only 1 day were involved. The average

delay for 162 random observations was 104 hr, and it is felt that considerable savings could be made by making efforts to cut this time. In 15 out of 225 samples, the ethanol content was not adequate to measure delays, indicating that cane deterioration can be caused by other mechanisms.

A comparative study of sucrose degradation in different evaporators

B. S. Purchase, C. M. J. Day-Lewis and K. J. Schäffler. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 8 - 13.

See Anon.: *I.S.J.*, 1987, **89**, 67A.

Estimation of pH of sugar cane juices at high temperature

K. J. Schäffler. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 14 - 17.

An accurate estimate of pH at the operating temperature is crucial for theoretical sucrose losses in evaporation found from a mathematical model when pH, temperature, Brix and residence time are known. The pH of about 80 juice samples from a number of factories was determined at three different temperatures, and linearity found between a fall in pH and rise in temperature. Regression analysis provided an excellent 2nd order polynomial relationship between pH and its temperature coefficient; tests indicated that the equation predicted pH at high temperature (125°C) with a good degree of accuracy. The model was used extensively during the 1985/86 season to compare theoretical and measured sucrose losses; the results suggested that the proposed use of higher temperatures in pressure evaporation would lead to higher losses than earlier predicted[1,2].

Syrup clarification in raw sugar mills

P. W. Rein, M. G. S. Cox and G. Montocchio. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 22 - 31.

Laboratory and factory trials on syrup clarification by flotation are reported. A clarifier designed for use at Empangeni is described; results over two seasons showed a turbidity removal that in the second season was generally between 80 and 90%, while colour, ash and gum contents were also lower than when the clarifier was not operating, leading to higher affined sugar and VHP sugar pols. Flocculant usage was optimum at 15 ppm. The effects of modifications to the aeration and syrup offtake systems are indicated. At Felixton, a similar clarifier was operated during a period of very low-quality, drought-affected cane; a lower turbidity removal than at Empangeni was largely a result of operation at 58°C instead of 85°C.

Modified wear plate and sealing arrangements for vacuum filter valves

C. Mack and B. MacKenzie. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 40 - 41.

Details are given of the vacuum filter station at Umzimkulu factory, and areas in which mud filtration was inadequate are listed. Improvements were made in mud mixing and feeding and in bagacillo quantity and quality, while modifications to the valves gave better vacuum at the screen/mud interface and reduced pressure losses between the filter and filtrate receiver, whereby filtration efficiency rose and cake pol losses fell. The valve modifications involved insertion of a grooved nylon ring and a grooved nylon disc to form a wear pad between the static and rotating heads, with O-rings between the two nylon components and one between the ring and the static head. The work can be undertaken in a normal factory workshop.

Sixty-second annual review of the milling season in Southern Africa (1986 - 1987)

J. P. Lamusse. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 42 - 61.

Performance data are presented (mostly in the form of tables) for sugar factories in South Africa, Swaziland, Zimbabwe and Malawi and discussed. A high average extraction in South Africa of 97.66% (96.0 - 98.5%) was attributed to a relatively low cane fibre content and to a steady increase in imbibition % fibre; out of six plants recording >98%, only one was not a diffuser, and the diffuser at Illovo yielded a record 98.25% extraction. Bagasse moisture content (51.27%) was the lowest value reported since the early 1950's, with the lowest (46%) being recorded at Pongola. While the average milling time efficiency was a record 81.74%, the average for Swaziland was far better at 89.73%; Swaziland factories experience fewer scheduled stops and an especially smaller number of stoppages for lack of cane. The average boiling house recovery in South Africa was relatively low at 87.7%, while some factories in Swaziland and Zimbabwe reported very high values. The quality of sugar produced by South African factories was excellent and exceeded the specifications set by the industry; the average pol of all raw sugars was 99.32, compared with 99.1 in Zimbabwe, 99.3 in Malawi and 98.7 in Swaziland. Information is provided on equipment and process modifications, and on by-products utilization in South Africa.

The washing of demister screens at Illovo

K. Taylor. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 62 - 64.

The current favourite entrainment separator in the South African sugar industry is the wire mesh demister, which has a high collection and removal efficiency based on an action which is essentially impingement and redirection of vapour flow. Since the heavier liquid droplets are unable to change direction, in contrast to the vapour, they adhere to the mesh, eventually form larger droplets and pass back into the juice space; however, the screen gradually becomes saturated with sugar solution which,

1 Wittwer & Mauch: *I.S.J.*, 1983, **85**, 309.
2 Wittwer: *ibid.*, 1984, **86**, 139 - 145.

over an extended operating period, is partly caramelized and finally carbonized within the mesh, so that the screen loses performance and has to be removed for cleaning. At Illovo the changing of screens creates problems, and it was decided to investigate *in situ* washing. Initial trials are reported in which the screens in the final effect and two 3rd effects of a quadruple-effect evaporator were sprayed every other hour for 5 minutes with contaminated condensate at approx. 80°C and 300 kPa. Results showed that the screen in the 4th effect was almost as clean after 3 months' continuous operation as when initially installed, whereas cleaning of those in the 3rd effects was less effective, although still better than when no washing was carried out. Further tests were to be conducted. Apart from the possibility of reducing entrainment losses, a demister system (the installation costs of which are relatively low) could extend screen life.

Impurity transfer during *A*-massecuite boiling

G. R. E. Lionnet. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 70 - 75.

The effect of syrup quality on the transfer of colour, phenolics and amino-N to affined sugar during *A*-massecuite boiling was investigated on a pilot-plant scale; syrup samples from four selected sugar factories were boiled under constant conditions at regular intervals throughout the season. The time of year had a greater effect than factory of origin on syrup quality, causing a 50 - 75% variation compared with approx. 40%; a regression coefficient of 0.92 was established for the correlation between time of year and syrup colour at pH 7. The transfer of colour from mother liquor to sugar crystal differed according to the pH of the filtrate used in measurement of absorbance (the other pH values being 4 and 9), with a possible direct proportional relationship between transfer and syrup colour. A significant positive correlation was also found between affined sugar colour and syrup phenolics concentration, and a significant negative correlation between sugar colour and syrup amino-N concentration. Cane cleanliness was of importance for reduced syrup colour.

Modifications to the boiling procedures at Sezela in an attempt to reduce VHP sugar colour

G. F. Mann. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 83 - 85.

Sezela factory has a history of high VHP sugar colour, particularly at the start and end of the milling season. Studies showed that colour rises with specific grain size (SGS); during boiling, increase in colour results from impurity inclusion during the final tightening-up period when circulation is poorest, mother liquor supersaturation greatest and crystal growth consequently highest. By deliberately lowering *A*-massecuite Brix through reduction in the tightening-up period and using standard sugar slurry at 16 ml/m^3 graining charge, a SGS of 0.70 mm was obtained from October to December at a ratio of footing volume:final massecuite volume of 0.09. (During May-September *B*-magma was used as footing for *A*-seed, giving a desired SGS of 0.80 mm.) The result was a marked drop in crystal colour by comparison with the previous season.

The effect of fuel moisture content on the performance of a typical bagasse-fired water-tube boiler

N. Magasiner. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 86 - 89.

The performance of a typical bagasse boiler generating 70 tonnes/hr of steam at 350°C is discussed in relation to bagasse moisture content in the range 0 - 56%. The critical moisture level is 40%, below which there is need to minimize furnace slagging (which can be heavy at <45% bagasse moisture) and boiler fouling; the refractory band should be omitted in a unit designed predominantly for drier bagasse, while the furnace heating surface area should be greater than where bagasse of higher moisture content is used as fuel.

The performance of diffuser bagasse dewatering mills

A. Wienese. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 90 - 93.

While investigations of bagasse dewatering mill performances at six sugar factories demonstrated the difficulty of comparison because the mills were operating under entirely different conditions, and it was also very difficult to establish common factors applicable to each mill, it is believed that a low bagasse moisture content would be obtained: (1) at a relatively low mill speed (a high speed causing poor drainage and hence slippage and high bagasse moisture contents), (2) a thin bagasse blanket (which provides better drainage and hence less slippage, (3) increased hydraulic pressure (giving higher torque) and (4) a rough roller surface. However, there are a number of constraints on selection of optimum conditions, but work so far conducted has indicated the need to concentrate on a rough roller surface, a low speed and a high torque rather than on a thin blanket and low hydraulic pressure. Moreover, no clear reason has emerged for the considerable differences in bagasse moisture experienced within the South African sugar industry, but it is felt that factors relating to the bagasse before it enters the mill may have a significant influence on dewatering.

Ductile iron castings - scope for engineering knowledge

C. R. Stoffberg. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 94 - 98.

Ductile iron (also known as spheroidal graphite or nodular iron) can be cast into complex shapes and varying section sizes within any one component and affords maximum freedom of design and even distribution of stresses during

service. It has better castability and machinability than cast steel, which is superior only when welding is required. Within the sugar industry it is used for coupling boxes, trash plates, scrapers, grate bars and grate shoes, while other potential applications include chain links, casings, gears, conveyor slats and wear pads. The information provided is intended for design engineers.

Steam turbine condition monitoring by vibration analysis

H. A. Searle. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 101 - 106.

Descriptions are given of vibration analysis as applied to a steam turbine and of the equipment used, and the vibration characteristics of common faults are explained, including rotor imbalance, oil film instability in fluid film bearings, misalignment, mechanical looseness, resonance, electric motor faults and problems with rolling element or anti-friction bearings, gears, blades and vanes. While vibration analysis can detect faults at an initial stage without the need to stop or dismantle machinery, it calls for skill in interpreting and analysing the signals obtained; however, the technique is of considerable value in extending the period between major maintenance overhauls and in simplifying planned maintenance scheduling.

Generating power through maintenance stop days

R. V. O'Brien. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 99 - 100.

During its weekly 20-hour maintenance period, Umzimkulu factory utilized public grid electricity despite the ability to provide large quantities of bagasse in excess of the amount required as fuel, leading to a disposal problem. A feasibility study on the use of excess bagasse to generate power for use in the factory and at one of the company housing estates during the maintenance stoppages showed that a significant monetary saving could be made each month by this method provided no coal had to be burn as supplementary fuel; however, occasional protracted stoppages caused by lack of cane necessitated the burning of coal. Calculations indicated a break-even point of 40 hours per month, above which it would be more economical to utilize public grid electricity than burn coal, although coal consumption could be cut by storing extra bagasse. Under the system introduced in 1986, the factory generated its own power over 4 successive months, saving R50,000 in electricity alone, and it was planned to dispense with public utility power over a period of 7 months in 1987 while also supplying electricity to a second housing estate. The costs of valves and piping modifications to allow condensate to be recovered under the new system are indicated. The availability of steam during a stoppage may permit chemical cleaning of the evaporators.

Mill performance monitoring at Gledhow sugar mill

T. D. Endres. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 114 - 116.

The weekly average bagasse analysis (fibre, Brix and moisture) and mill settings, lift and speeds were inserted into a spreadsheet constructed for the 7-mill tandem at Gledhow, and bagasse volume, work opening ratios, compaction ratios, reabsorption factors and escribed volumes then calculated. Except for mill speeds (found to decrease along the tandem), all the performance parameters were verified by comparing theoretical values with practical results. This showed the discharge compaction ratios, work opening ratios and reabsorption factors to be higher than those generally accepted, although the mills performed well in respect of bagasse moisture content and extraction. The reabsorption factor proved to be an extremely useful measure for monitoring performance because of its interdependence with most other milling variables. The effects of the discharge compaction ratio on bagasse moisture and individual mill extraction and of favourable and unfavourable reabsorption factors on mill performance are discussed, and means of countering an unfavourable reabsorption factor indicated. The benefits of weekly mill monitoring include prompt identification of individual mills showing a fall in performance, determination of the effect of any changes in mill settings and of seasonal changes in cane quality, and provision of a useful management tool in the form of a compact report.

A PLC-based cane yard traffic control system

G. P. N. Kruger, D. S. McLoughlin and R. H. Neilson. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 107 - 110.

The introduction of new legislation covering cane transport to sugar factories has led to an increase in the number of hauliers delivering cane to Maidstone factory. So as to ensure fair access to the factory in proportion to the haulier's cane tonnage and in order to avoid congestion at the weighbridge, it was decided to install a traffic light system controlled by a PLC (programmable logic controller) to regulate the flow of traffic across the weighbridge. Details are given of the system and its advantages, disadvantages and current limitations are listed. The scheme operated very smoothly from early in the 1986/87 season and has resulted in significant cost savings while imposing a discipline on all users of the cane yard, thus leading to more efficient traffic flow throughout the system.

Personal computers as data loggers in the South African sugar industry

A. Wienese, K. J. Schäffler and L. Bachan. *Proc. 61st Ann. Congr. S. African Sugar Tech. Assoc.*, 1987, 111 - 113.

See Wienese & Schäffler: *I.S.J.*, 1988, **90**, 2A.

Beet sugar manufacture

Kinetic optimization of the sugar crystallization process

V. G. Tregub. *Izv. Vuzov, Pishch. Tekh.*, 1987, (4), 60 - 64 *(Russian)*.

A kinetic mathematical model of batch boiling and massecuite cooling is used to calculate conditions under which response to process variables is optimum and the overall process time thus minimized at maximum sugar yield. Operation at optimum fixed values of the kinetic parameters is achieved in the pan by selecting values of supersaturation and massecuite temperature at nucleation and of the syrup drink feed and water evaporation rates and in the crystallizer by selecting appropriate values of the initial crystal content, supersaturation and cooling rate which will provide limiting values of the time constant and kinetic curve shape coefficient. While a 15 - 20% reduction in the process time was achieved in A-massecuite boiling tests by cutting the massecuite to two pans after a given supersaturation was reached, use of the model would allow more precise calculation of optimum values of both fixed and transient process parameters and thus furnish the means for a 25 - 40% reduction in boiling time.

Determination of the coefficient of friction of sugar massecuites

S. V. Danilin and S. A. Gribkov. *Izv. Vuzov, Pishch. Tekh.*, 1987, (4), 64 - 68 *(Russian)*.

Massecuite friction against the surface of a nickel steel centrifugal screen was investigated experimentally and the results subjected to statistical analysis. Details are given of the friction gauge system used. While the coefficient of friction rose linearly with increase in molasses viscosity and rate of slip and fell non-linearly with increased crystal size, saturation and pressure, the moisture content of the air in the basket had a greater effect on the coefficient than did all the other parameters put together; the coefficient tended to have a lower value when this moisture content was in equilibrium with the massecuite moisture than when it was not, since the molasses content in the massecuite under non-equilibrium conditions and hence that on the screen affected the drying rate, while the effect of screen slot width had negligible effect. The question of screen angle of slope is briefly discussed in connexion with the various parameters studied.

Decrease in filtration velocity by polysaccharides and its increment by dextranase treatment in the beet sugar manufacturing process

K. Sayama, T. Kamada, T. Muratsubaki and K. Honjo. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 29 - 40 *(Japanese)*.

In an investigation of the effects of polysaccharides formed by microbial action during beet storage or occurring as beet constituents, standard dextran of high molecular weight ($\geq 5 \times 10^5$) and native dextran from deteriorated beets caused a decrease in the filtration rate of 2nd carbonatation juice when present at >200 ppm in raw juice; these dextrans tended to be absorbed by $CaCO_3$ particles formed during carbonatation and reduced their agglomeration. Standard dextran of low M.W. ($< 7 \times 10^4$) and native levan obtained from beet molasses had no effect on 2nd carbonatation juice filtration but easily passed through the filter to accumulate at the sugar end. Native araban obtained from beet pulp affected neither filtration nor sugar-end syrup viscosity; at a Steffen factory it was recycled in the Steffen process and accumulated in molasses. Filtration in the presence of dextran was improved by addition of an endo-type dextranase at a ratio to dextran of between 1:50 and 1:100.

Operational features of a centrifugal beet slicer of 1400 mm diameter

K. Buck. *Gaz. Cukr.*, 1987, **95**, 73 - 77 *(Polish)*.

Tests conducted on a Polish-built 16-frame slicer during two campaigns at Maloszyn sugar factory were mainly aimed at determining the effect of the condition of the knives and changes in the structural properties of the beets during the campaign on throughput and power consumption as well as the relationship between power consumption, speed of rotation and throughput. The results are discussed with the aid of diagrams and analysed statistically. Cossette quality was to be the theme of other tests.

Investigations of the effect of basic factors on non-sugars transfer from beet cossettes during diffusion

S. P. Olyanskaya, L. I. Zagorodnyaya and N. A. Arkhipovich. *Gaz. Cukr.*, 1987, **95**, 77 - 80 *(Polish)*.

See *I.S.J.*, 1987, **89**, 18A.

The carbonatation vessel as bubble-cap tower – investigations on process optimization

W. Napp, T. Cronewitz and G. Witte. *Zuckerind.*, 1987, **112**, 859 - 867 *(German)*.

While carbonatation is a typical example of the gas-liquid mixing process that takes place in a bubble-cap tower, the conventional carbonatation vessel design and operation generally falls short of optimum process requirements. There is therefore theoretically room for improvement, and the authors examine the general design criteria of bubble-cap towers to see where carbonatation could be made more efficient. The technology and physico-chemical aspects of 1st carbonatation are described, whereby it is shown that crucial for a high mass transfer rate is intimate mixing of the liquid phase and a high rate of $Ca(OH)_2$ dissolution; only when these two parameters are optimum is the movement of CO_2 across the phase boundary layer rate-determining and establishment of equilibrium in conformity with Henry's law will mean that the concentration and pressure of the gas will affect its utiliz-

ation. The fundamentals of the mixing process in a bubble-cap tower are set out and requirements of a suitable vessel to provide optimum carbonatation are listed. The juice level in the vessel before gas is introduced governs the length of the bubble path and thus determines the residence time of the gas bubbles in the liquid phase, while gas solubility and utilization are favoured by a high alkalinity (the sugar content also having a favourable effect on calcium hydroxide solubility and on the gas utilization). By altering the properties of the juice, a higher temperature will favour the formation of smaller bubbles and thus increase gas utilization; viscosity has no effect on gas utilization, while an increased CO_2 content in the fresh gas can even lead to a reduction in it. The contribution of gas and juice velocities to mixing is noted. The effect of vessel design and operation on gas utilization is demonstrated by comparing carbonatation at a number of sugar factories, and details are given of a design that would provide optimum processing.

Process technology fundamentals of mechanical pulp dewatering. I. Basic physical considerations. II. Mathematical modelling

K. E. Austmeyer. *Zuckerind.*, 1987, **112**, 771 - 777, 868 - 872 *(German).*

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

Sugar cooling in a pulsed fluidized bed with cyclically transferred air flow

Z. Gawrzynski. *Zuckerind.*, 1987, **112**, 875 - 880, 882 *(German).*

The traditional Dunford & Elliott drum-type granulator remains a reliable sugar dryer but occupies a great deal of space and consumes much energy; vibratory cooler/dryers perform well with low energy consumption but the vibrations are transmitted to ancillary equipment and cause fatigue in the structural components. Replacement of mechanical vibration with pulsed air flow coupled with fluidization according to Polish Patent 103840 solves these problems at low air consumption and neligigible loss of small sugar fractions. A test unit is described in which air is blown by a battery of fans into a vertical manifold from which it flows along a horizontal pipe to a membrane-type cooler and thence to a disc-type distributor; the air is led up one of three lines in sequence into a corresponding pressure chamber located below the perforated screen carrying the bed of sugar. The sugar leaves the dryer through a vertical funnel from which it flows into the cooling section for batch treatment. Investigations are reported which concentrated on the performance of the air distributor and the air velocity, the sugar bed pulsation amplitude, resistance of the sugar to fluidization and heat transfer from the sugar to air in the cooler, and the results are represented by dimensionless equations that are suitable for calculating the dimensions of a full-scale unit designed to treat sugar having a moisture content of up to 0.1%.

Bent-tube boilers in sugar factories

K. von Paczkowski. *Zuckerind.*, 1987, **112**, 883 - 885 *(German).*

The advantages of bent-tube over straight-tube boilers are discussed and some examples are given of the former type with rocking or travelling grates as used in beet sugar factories. Mention is made of the largest bent-tube boiler currently used in the sugar industry which generates 80 tonnes/hr steam at 45 bar and 450°C.

Beet protection against frost

J. P. Vandergeten and R. Vanstallen. *Betteravier*, 1987, **21**, (223), 13, 16 *(French).*

Advice is given on protection of piled beet against frost by covering with plastic sheeting, particularly when the ambient temperature and that of the pile remain below 3°C; the cover stabilizes the pile temperature and prevents any sharp changes in the weather having effect. In the top part of a pile (down to 0.5 m) investigations have revealed sugar losses of 3% with and 11% without protection; moreover, soil adhering to the beets dries out under the cover and is then left behind when the beets are reclaimed. The point is made that it is useless removing plastic sheeting as soon as the air temperature rises.

Respirometric measurement of sugar losses during beet storage

J. P. Vandergeten and R. Vanstallen. *Betteravier*, 1987, **21**, (223), 14 - 15 *(French).*

A system for measuring sugar losses by respiration comprises 24 hermetically sealed 200-litre drums (each capable of holding about 100 kg of beets) placed in an air-conditioned room. A compressor linked to the bases of the drums blows an exact quantity of air into each drum at hourly intervals, and air is led via an aperture in the upper part of each drum to an infra-red CO_2 analyser; because the system is fully automatic, the CO_2 concentrations are measured for each drum in strict rotation, an interval of 4 minutes elapsing between each measurement, so that 15 samples are analysed per drum per 24 hr. The values are transmitted to a computer for calculation as sugar losses (g/tonne of beet/day), integration and storage. Results from 1980/81 demonstrate the increase in daily losses where beets on the outside of a pile were affected by frost, while beets inside the pile were unaffected and showed a decline in respiration losses up to 25 days after piling; losses in beet that had been frosted while still in the ground were very much lower than for the beets frozen on the outside of the pile, but were still about double those in healthy beet stored correctly. Comparison of losses between beets stored with their leaf stalks intact, with leaves removed and with tops removed showed them to be in the descending order of treatment, the values falling with storage time to a constant after about 25 days but with greater differences between the three classes. Losses were also higher in damaged than in undamaged beets, but fell sharply to a constant after about 25

days. Tests with a number of fungicides, growth regulators or chemicals having a physical effect on beets (e.g. algal extracts that form a film preventing the epidermis from breathing) showed that a number had a positive effect on respiration, but none of the treatments gave sufficiently good results to be regarded as economically justifiable.

Effect of storage period on output of the axial fans in sugar beet ventilation

B. Senge, P. V. Schmidt and E. Manzke. *Lebensmittelind.*, 1987, **34**, 209 - 210 *(German)*.

Earlier investigations at East German sugar factories had shown that the hourly output from axial fans used to ventilate beet piles fell with the period the beets had been stored. Studies in 1985 showed that the height of a pile at Thöringswerder factory fell by 0.4 m from an initial 5 m during 35 days; ventilation reduced the moisture content of the beet, and this plus the weight of the pile contents caused compaction and a decrease in porosity, so that there was greater resistance to air flow. Measurements of the total pressure at the entrance to the air ducts (without allowance for pressure loss in the intake) indicated a 150% rise over 40 days, and the fan output fell by 10%, with the steepest reduction occurring in the first three weeks of storage. No correlation was found between output and period of ventilation. The form of the ventilation system is crucial for a small reduction in fan output; with an optimum arrangement and a flow velocity <2 m/sec, a 100% rise in total pressure resistance had little effect on output and ventilation rate.

Automated beet washer with programmable memory control

H. Gläser. *Lebensmittelind.*, 1987, **34**, 213 *(German)*.

Details are given of the automatic system used at Jarmen sugar factory in East Germany to control the flow of beet between the flume and the beet slicer feed hopper. Supervision is from a control console provided with mimic diagram; flow is stopped when the beet hopper is full or the washer capacity is exceeded or in the event of any faults or breakdowns, and is resumed when the levels are at a minimum or faults eliminated. Continuous or periodic centralized lubrication is also incorporated in the system, which operated faultlessly during the its first campaign in 1986/87. Results and advantages are indicated.

Improvement of massecuite exhaustion by vertical vacuum crystallizers in an Italian sugar factory

F. Buja. *Ind. Sacc. Ital.*, 1987, **80**, 121 - 128 *(Italian)*.

See *I.S.J.*, 1988, **90**, 5A.

Raw juice purification with preliminary non-sugars coagulation using mineral salts and polyacrylamide

V. A. Loseva, R. P. Lisitskaya, D. F. Efanov, V. V. Pokhvashchev and L. A. Novikova. *Sakhar. Prom.*, 1987, (10), 14 - 17 *(Russian)*.

Tests are reported on pretreatment of raw juice with ammonium or sodium sulphate or sodium sulphite followed by addition of 10, 20, 30 or 50% recycled 1st or 2nd carbonatation mud of pH_{20} 7.0 - 7.4 and then 0.001% (on juice) polyacrylamide; subsequent preliming was carried out with a small amount of lime to pH 10.8 - 11.2 and recycled carbonatation mud to make up a total in the two process stages of 100% on juice. By comparison with the typical system (preliming with recycled 2nd carbonatation mud at 100% on juice but omitting pretreatment), the test schemes all increased the settling and filtration properties of the juice, reduced the lime salts contents and raised 2nd carbonatation juice purity. Factory-scale tests lasting one month confirmed the preliminary investigations; ammonium sulphate was added at 0.02 - 0.03% on juice followed by preliming with all the recycled 1st carbonatation mud added (at 100% on juice) in one stage and polyacrylamide at 0.001% on juice introduced in the 3rd compartment of the progressive prelimer (under the normal scheme at the factory, unfiltered 1st carbonatation juice was added at 5 - 10% on juice in the 1st compartment, the remaining 95 - 90% introduced in compartments 3 and 4, while milk-of-lime was fed in compartment 7). Separate investigations showed that ammonium sulphate at 0.02% and sodium sulphate and sulphite at 0.08% on juice did not increase the melassigenic coefficient of standard molasses nor, consequently, molasses sugar.

A mathematical description of sugar extraction from beet

A. K. Buryma. *Sakhar. Prom.*, 1987, (10), 17 - 20 *(Russian)*.

An equation developed by Oplatka[1] for calculation of diffusion losses is analysed, and the validity of a coefficient φ (introduced by Oplatka to define the deviation of the diffusion process from the theoretically ideal) to indicate the comparative performances of different types of diffuser is investigated. It is shown that while φ defines the interaction between various diffusion parameters and hence characterizes the current operation of a given diffuser, it is not a performance coefficient and is therefore not suitable for comparative evaluation of diffusers; at a constant sugar loss, its value will be low at a high juice draft and vice versa. A modification is presented of the Oplatka equation.

New dryer-coolers for white sugar

A. F. Zaborsin, V. V. Bibik, L. G. Ivanitskaya and E. P. Tkachenko. *Sakhar. Prom.*, 1987, (10), 39 - 42 *(Russian)*.

Details are given of various types of Polish and Soviet sugar dryer/coolers, including both drum and fluidized-bed types, and information is also given on a vibratory fluidized-bed unit designed in collaboration with Cuban technologists and installed in Cuba for raw sugar conditioning.

1 *Zeitsch. Zuckerind.*, 1954, **80**, 471 - 477, 511 - 519.

Laboratory studies

Wetting of scaled copper surfaces by pure sucrose solutions and cane juice

M. Derivet, R. González and S. Mesa. *CubaAzúcar*, 1985, (Oct.-Dec.), 42 - 47 *(Spanish)*.

Wetting of scaled copper surfaces, in terms of contact angle values, were measured for sucrose solutions and cane juices at different temperatures and concentrations, and the results shown in graph form. Cane juice produced more intensive wetting then pure solutions, and wetting by the latter at 20°Bx is enhanced by the addition of surfactants.

A study of the effect of dextran on sugar solution viscosity

O. V. Chopik. *Sakhar. Prom.*, 1987, (9), 25 - 28 *(Russian)*.

Investigations are reported in which dextrans of four different molecular weights were added to sucrose and beet molasses solutions and the effects of some variables on viscosity determined. Results, statistically analysed and from which a mathematical model was obtained for predicting increase in viscosity, showed that this increase was independent of temperature, sucrose content and molasses non-sugars but was a function of dextran molecular weight and concentration.

Colorants separable by cation exchange resin

I. F. Bugaenko, M. Garcia F. and N. V. Maslennikova. *Sakhar. Prom.*, 1987, (9), 28 - 29 *(Russian)*.

A 30% filtered cane raw sugar solution was treated with KU-2 cation exchange resin in Na^+ form (preliminary tests showed that the resin in H^+ form did not adsorb cane sugar colorants), the bed rinsed with distilled water and the colouring matter then eluted with 1% HCl solution. The eluate was neutralized to pH 7, concentrated under vacuum at 30°C and the colorants then separated from NaCl and free amino-acids by passage through a column of Acrylex R-10. Spectrophotometric measurements were carried out at pH 2.3, 7.1 and 10.3; pH had little effect on the nature of the spectra. The smoothness of the curves suggested that the colorants were polymers. Concentration and drying at 30°C yielded a dark brown powder containing 1.4% nitrogen emanating from amino-compounds. Acid hydrolysis followed by HPLC revealed 17 amino-acids, the contents of which are tabulated. The presence of nitrogenous compounds confirmed that the colorants were melanoidins.

Sugar moisture measurement

Anon. *Ann. Rev. Sugar Research Inst.*, 1986/87, 7.

Direct-contact conductivity probes used to monitor the moisture content of stored raw sugar require frequent cleaning, while moisture determination by drying and weighing is slow and labour-intensive. In a search for a better method, the SRI has been investigating the relationship between sugar moisture and dielectric properties. A Q-meter designed by the CSIRO Division of Applied Physics and operating at microwave frequencies showed good correlation between sugar moisture and dielectric loss, confirming results obtained at radio frequencies using a SRI-designed instrument. However, dielectric loss is also a function of sugar temperature, density and impurities, relationships that are the subject of further investigations. The main advantage of dielectric measurements lies in the lack of need for direct contact and the ability to design trouble-free monitors for on-line quality control. More accurate moisture meters or ones that provide a result more rapidly may also be feasible.

Measurement of dextran in raw sugar

Anon. *Ann. Rev. Sugar Research Inst.*, 1986/87, 12.

The haze method of dextran determination lacks specificity, shows variability in response to different dextrans and does not measure dextrans of low molecular weight. The first problem could be solved by using a well-characterized dextranase whereby the difference in haze intensity between untreated and enzyme-treated raw sugar samples would provide an estimate of dextran concentration; there is some doubt about the importance of the second and third problems in regard to raw sugar dextran analysis. Other improvements to the original haze method have included the use of a more appropriate standard and increased sensitivity at low dextran levels, but poor results from an ICUMSA study of raw sugar haze analysis suggest that a modified method incorporating the latter improvement is unlikely to be approved. An absolute method for raw sugar dextran determination developed by SRI is based on measurement by HPLC of the products of enzymatic hydrolysis of all dextrans present in the sample; the method appears to overcome the problems associated with haze analysis and is less expensive than other biological assay methods because of the ready availability of the enzyme in large quantities. A major advantage lies in the fact that the chromatogram acts as a "fingerprint" of the dextran, permitting ready detection of abnormal dextrans in the sample or of incomplete enzymatic breakdown of the dextran.

Trace analysis of water

Anon. *Ann. Rev. Sugar Research Inst.*, 1986/87, 16.

A method of trace analysis developed for cooling water used in sugar factories involves initial determination of highly volatile organic contaminants such as ethanol, using gas chromatography and direct injection of the sample. Less volatile organic contaminants that are usually present in smaller quantities are concentrated by extraction with a small amount of methylene chloride in two stages; the sample is first made alkaline with NaOH to permit only neutral and basic organic contaminants (e.g. higher alcohols, sterols and amides) to be extracted, after which the sample is acidified with HCl to allow extraction of acidic contaminants such as fatty acids

(esterification of acidic contaminants facilitating their identification). The two extracts are analysed using gas chromatography-mass spectrometry; the mass spectra obtained are used to identify the contaminants by comparing them with reference standards selected from a library of mass spectra using a computerized search.

Analysis of dextran by dextranase in a beet (sugar) factory

K. Sayama, Y. Senba, T. Kamada and T. Muratsubaki. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 45 - 50 *(Japanese)*.

Two methods of dextran analysis in press juice, raw juice, 2nd carbonatation juice and molasses were compared: (i) enzyme dialysis using dextranase, and (ii) the method of Roberts based on precipitation with alkaline copper sulphate[1]. Method (i), involving dialysis in running tap water for 72 hr using a Union Carbide 36/32 dialysis tube, removed almost all the sucrose, while recovery of standard dextrans was 74% for those having a molecular weight of 10^4 and 100% for those of $>4 \times 10^4$. Complete dextran degradation was achieved by treatment with an excess of the enzyme for 30 min at 55°C. While the method is simple and suitable where many samples are being handled, it is time-consuming. Method (ii) determines dextran selectively, regardless of its M.W., and recovered 98 - 103% of standard dextran from process juice; however, the analytical procedure is very complicated. The two methods are of similar accuracy and can measure down to 10 ppm, but their disadvantages make them unsuitable for use in routine control. A more rapid method is gel filtration coupled with the use of dextranase. Determination of total polysaccharides and dextran in beet and factory juices using method (i) showed an increase in both types of impurity with deterioration of stored beet; 2.1% dextran and 2.6% polysaccharides were found in very deteriorated, frozen beet, whereas beet stored under ideal temperature and humidity conditions for 150 days contained no dextran at all and 600 ppm or less polysaccharides.

Trace components in sugars. V. Quantitative determination of niacin

S. Saito, T. Miki, H. Ito and M. Kamoda. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 51 - 55 *(Japanese)*.

A gas-liquid chromatographic method for determining niacin (nicotinic acid) in sugars is described. Derivatives of the acid were hydrolysed by boiling under strongly alkaline conditions, and the free acid was adsorbed on anion exchange resin, washed with ammonium hydroxide solution and water and then eluted with HCl. The eluate was passed through cation exchange resin which was then washed with HCl and water and the nicotinic acid eluted with ammonium hydroxide solution. The eluate was evaporated to dryness and butyl alcohol and concentrated sulphuric acid added to the dried residue followed by refluxing in boiling water for 1 hr. Chloroform and saturated sodium carbonate solution were added to the cooled solution and shaken gently; the chloroform layer containing nicotinic acid butyl ester was separated and washed with saturated NaCl solution followed by evaporation to dry-ness, addition of methanol and analysis of the solution by GLC. The detection limit was 0.5 ppm and recovery of nicotinic acid added at 200 µg to cane raw sugar, beet and cane white sugar, soft white sugar and final molasses was in the range 92 - 100% at a standard deviation of 5.78 µg. The nicotinic acid content in cane raw sugar from various countries ranged from 0.6 to 1.8 ppm; 14.1 and 24.4 ppm was found in two refinery molasses samples, and 20.4 ppm in a cane molasses sample.

Sugar analysis by high performance liquid chromatography. II. Amino column

K. Sayama, T. Muratsubaki, Y. Senba and S. Muranaka. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 56 - 62 *(Japanese)*.

HPLC analysis of beet molasses using a Nucleosil 5 NH_2 column failed to separate glucose, fructose, galactose and betaine but gave good separation of sucrose, kestose, raffinose and galactinol. The column is suitable for raffinose determination in Steffen molasses, and was better than an enzymatic method for raffinose determination in *B*-syrup because of the presence of galactinol.

Methods of analysing the sucrose content in sugar beet. I. Comparison of aluminium and lead salts as clarifying agents in cold water digestion. II. Comparison of results of analysis of fresh and frozen brei using the cold water digestion method

I. T. Sanbuichi *et al. Proc. Sugar Beet Res. Assoc.*, 1987, (27), 148 - 154. **II.** A. Yanagisawa, Y. Matsuzaki and T. Sanbuichi. *ibid.*, 155 - 159; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (19), Abs. 19 R385, 19 R386.

I. Lead acetate pollutes the environment and is a toxic substance. Results are given of comparative investigations into its replacement as a traditional clarifying agent for analyses in sugar manufacture with $AlCl_3$ and $Al_2(SO_4)_3$. Drawbacks with Al compounds as clarifying agents lie in the slower filtration and intensive coloration of the filtrates, particularly where aluminium sulphate is used. It is noted that both aluminium salts can be used as clarifying agents.

II. Results are presented of comparative analyses, by cold water digestion, of the sucrose content in fresh and frozen beet brei. The difference between the contents in fresh and frozen brei averaged 0.02%, while it ranged from 0.32% to 0.42% in each of the parallel series of tests for a given form of brei. Freezing beet brei was found to have negligible effect on the results of the analyses, but it is necessary to determine the optimum conditions for freezing and preserving samples (temperature, type of container, time, etc.).

1 *I.S.J.*, 1983, **85**, 10 - 13.

By-products

Natural drying of baled bagasse

J. L. de Sobral and C. G. de Oliveira. *STAB*, 1986, **4**, (3), 52 - 57 *(Portuguese)*.

Weight loss of baled bagasse, due to moisture reduction and to pre-hydrolysis, fermentation and dust loss through handling, was measured and related to initial moisture content and time. The relationships were best expressed by exponential equations for covered and uncovered piles, the latter showing the greater loss. Excessive handling greatly increased weight loss.

Study of the utilization of sugar cane pith for obtaining hydrolytic syrup and forage for animal feeding

G. Damián I., C. Ramos, I. Nápoles and R. López P. *ATAC*, 1985, **44**, (5), 35 - 40 *(Spanish)*.

Studies were made to find the best conditions for prehydrolysis of bagasse pith using a mixture of sulphuric and nitric acids in order to obtain a reducing sugars syrup by hydrolysis. Laboratory work identified the conditions as a ratio of 2:1 for the acids, concentration of 0.2 - 0.3N, and reaction at 100°C during 2 - 3 hours, when a yield of 20 - 25% of sugars was obtained; these conditions were confirmed by pilot plant trials. The product, mixed with sugar factory molasses and treated with KH_2PO_4 and urea, was fermented with the thermophilic yeast *Candida pseudotropicalis*; it gave 7 - 10 g/litre of biomass containing 37% of protein, consuming 86 - 88% of the sugars present over 20 hours of fermentation. Feeding trials with rats and birds gave similar results to those with Torula yeasts grown on cane molasses. The hydrolysed pith was also fermented with cellulolytic bacteria (*Cellulomonas* spp.); 2 - 3 g/litre of biomass containing 40 - 50% of protein was obtained with a substrate consumption of 60% over 72 hours fermentation.

Sedimentation characteristics of the effluents from fermentation of sugar residues

D. Cuevas D. and A. Guillermo. *CubaAzúcar*, 1985, (July-Sept.), 8 - 11 *(Spanish)*.

After anaerobic fermentation of a mixture of filter-cake and waste water, the liquid and solid phases must be separated, the former for irrigation or recycling to the manufacturing process while the solids can be used as fertilizer. The solids do not have a significant effect on sedimentation rate when they are more than 20% of the total, or when they are more than 10% if lime is added to assist coagulation. Such treated samples show a significant reduction in mineral, insoluble and mainly organic contents of the clarified effluent; 74.43% of the COD is removed. Use of CO_2 as a neutralizing agent not only reduced pH but also gave high solids removal.

New surface-active agent from sugar and shark oil of potential use in the sugar industry

M. A. López and P. L. Gutiérrez M. *CubaAzúcar*, 1985, (July-Sept.), 42 - 45 *(Spanish)*.

Transesterification of shark oil and sucrose in the presence of potassium carbonate and an unnamed co-catalyst at 125°C during 6 hours, in the absence of any solvent, produced a sucroglyceride which, without further purification, reduced the surface tension of water, was of low foaming power and was comparable with material produced using tallow.

Characterization of alkali cellulose from bagasse pulp

O. Quintela, D. Paul, H. Schleicher and B. Philipp. *ATAC*, 1985, **44**, (6), 23 - 28 *(Spanish)*.

Manufacture of viscose from bagasse pulp requires different conditions from those when using wood pulp, and a study has been made of the effects of different parameters on formation of alkali cellulose from bagasse to identify the differences in the pulp properties. Reactivity of bagasse pulp is improved by treatment with ammonia and with 18% NaOH and this reduces the resistance of the pulp to mercerization with NaOH at 12%. Treatment of pulp with 12% NaOH gives almost total formation of cellulose II and in the practical range of NaOH concentration in the viscose process the supra-molecular order of reaction in the chain cellulose I – sodium cellulose – cellulose II is not affected. The reactivity of bagasse pulp is less than that of pulp from beech wood, which indicates the importance of the morphology, determined by the elements which form the cell walls.

High fructose syrups: possibilities of production from sugar products

N. Polanco and E. Duarte. *ATAC*, 1985, **44**, (6), 50 - 54 *(Spanish)*.

Enzymatic hydrolysis of sucrose in solution can give a product comparable with HFS produced from corn and suitable for various uses in the food industry. However, selection of the product from sugar manufacture which is to be used requires study of all those available and of development of processes for increasing the fructose content, and purification to give a syrup with the desired characteristics.

Scales produced on evaporating vinasses from sugar cane molasses under different working conditions

G. J. Cárdenas, E. J. Yocca and L. E. Aralde. *Rev. Ind. Agríc. Tucumán*, 1985, **62**, (1), 23 - 40 *(Spanish)*.

Vinasse was concentrated in a stainless steel laboratory evaporator which worked discontinuously and was used to simulate the stages of a quadruple-effect evaporator. Using the same vinasse, tests were made of concentration from 12° to 65°Bx at below and above atmospheric pressure, and a third test concentrated the vinasse to 80°Bx with the first three effects under pressure and the fourth under vacuum. The amounts of scale

deposited in each simulated effect during the experiments were calculated from the mineral contents of the vinasse before and after concentration. The Brixes of the concentrated vinasse from each effect in the first two experiments were similar, as were the scale depositions, i.e. most in the 1st effect, similar and smaller amounts in the 2nd and 4th effects, and least in the 3rd effect. In the third experiment the largest rise in Brix occurred in the 3rd effect and this also received the largest amount of scale.

Variation with pressure of boiling point elevation of vinasses of different origins and concentrations

G. J. Cárdenas, E. J. Yocca and J. C. Díaz L. *Rev. Ind. Agríc. Tucumán*, 1985, **62**, (1), 41 - 59 *(Spanish)*.

Boiling point elevation of different vinasse samples obtained from molasses fermentation were measured at pressures between 0.3 kg/cm^2 and atmospheric and at concentrations between 12.9 and 65°Bx. The influence of organic and inorganic matter on the B.P.E. is discussed and a comparison made with pure organic and inorganic solutions and with cane juice of different purities.

Physical and physico-chemical characteristics of bagasse celluloses

C. J. Triana F., M. Leonard A. and E. Cabo de Villa B. *CubaAzúcar*, 1985, (Oct.-Dec.), 13 - 21 *(Spanish)*.

Cellulose was prepared by sulphate prehydrolysis of dry and wet depithed bagasse, by the soda process and by nitric digestion and the chemical, physical, physico-chemical and physico-mechanical properties of the products measured and recorded to provide information for evaluation of Cuban celluloses as raw materials.

Bagasse as a cattle roughage

Anon. *Ann. Rev. Sugar Research Inst.*, 1986/87, 6.

Investigations of the keeping quality of sealed and unsealed bales of treated alkaline bagasse, with or without molasses and urea incorporated, showed that the high pH effectively inhibited fungal growth, so that both types of bales were still safe to feed to animals after a 6 months' storage period despite preparation at an initial moisture content of 40 - 43%. Although some ammonia was lost from the urea, 60 - 80% of the nitrogen was retained, even in the unsealed bales. The protracted "shelf life" of the bagasse greatly increases its potential as cattle fodder in drought conditions. The bagasse has a digestibility equivalent to that of medium-quality lucerne, thus meeting the requirement for a roughage to be used as an intensive finishing ration. In a mixture containing 10% bagasse, 10% molasses and 80% grain all the protein needed is provided by the grain, so that there is no requirement for added urea.

Fermentation of molasses deionized by electrodialysis

K. Fujisawa, T. Takezaki and R. Tohyama. *Proc. Research Soc. Japan Sugar Refineries' Technol.*, 1987, **35**, 76 - 80 *(Japanese)*.

Samples of cane molasses from Japan and the Philippines were subjected to electrodialysis using cation-exchange and non-selective ion-permeable membranes to reduce the ash content to approx. 4%; this was followed by fermentation with *Saccharomyces cerevisiae* to ethanol and with *Corynebacterium glutamicum* to L-lysine. Results showed that deionization raised the ethanol yield of the Japanese and Philippine molasses from 36 to 59% and from 72 to 81%, respectively, and raised the L-lysine yield from 21 to 34% and from 17 to 28%, respectively.

Palatinose

P. J. Sträter. *Zuckerind.*, 1987, **112**, 900 - 902 *(German)*.

Palatinose (a name registered by Süddeutsche Zucker-AG) is slightly less sweet and is of lower solubility than sucrose from which it is produced by fermentation with immobilized enzymes and rearrangement of the 1-2 to a 1-6 linkages, followed by crystallization. Because palatinose is almost completely unaffected by microbial action in the mouth, it does not contribute to tooth caries.

Molasses preparation for fermentation with the aim of removing calcium ions

O. N. Naumenko, V. N. Golovchenko, E. O. Remez and M. Ya. Savchuk. *Pishch. Prom.*, 1987, (2), 29 - 31; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (20), Abs. 20 R367.

A technological scheme proposed for pre-fermentation treatment of molasses to remove calcium ions involves acidification of a 40 - 50% dry solids molasses wort with sulphuric acid to pH 4.5 and addition of sodium sulphate in a 1:2 ratio to the Ca ion concentration. The wort is then held for 30 minutes at 80 - 100°C and filtered. Investigation of this method showed that up to 80% Ca is removed without adversely affecting the technological parameters of the wort.

Preliminary report of the bagasse silage project

R. C. A. Millington. *Ann. Conf. Barbados Sugar Tech. Assoc.*, 1986, 3 pp.

After an experiment in 1985 had shown that whole bagasse (after the 1st mill) gave a slightly better growth performance than hay when fed to young lambs in a ration containing 11% bagasse on dry matter, it was decided to determine if the nutritive value of factory fresh whole bagasse was sufficiently better than that of factory fresh ordinary bagasse to justify its commercial production for use in animal fodder. While a study of animal growth had not yet started at the time of this report, preliminary results for intake by sheep and digestibility suggest that, at 10% roughage inclusion in the rations, there was no difference as a function of the nature of the roughage provided the nitrogen content in the ration was the same; however, at 25% inclusion and above, there are significant differences in performance that have yet to be clarified. Both types of bagasse ensiled well.

Acknowledgements

The authors wish to thank the staff of the various operating and technical units of Tate & Lyle PLC who have contributed the facilities and resources necessary to complete the test programs outlined in this paper. The authors acknowledge with thanks the assistance given by C. G. Smith Sugar, Durban, South Africa, in giving their permission to publish data obtained in their refineries. They also wish to acknowledge the various sugar refiners and raw sugar factories for their support in providing samples for analysis.

BY-PRODUCTS

Protein extraction from sugar cane press mud

By V. S. Dhamankar, S. M. Chavan and S. J. Jadhav
(Deccan Sugar Institute, Manjari, Haveli, Pune, India)

Introduction

In the process of sugar production from sugar cane juice, one clarification method involves liming followed by sulphitation[1]. The precipitate separated as press mud during this clarification process carries large quantities of organic and mineral matter including most of the proteins originally in the cane juice.

In India, total cane crushing for sugar production is around 60 million tonnes per annum, and nearly 540,000 tonnes of dry press mud is discarded by the sugar factories. The cane carries about 70% of its weight in juice and the protein content of juice[2] is 0.1%. Thus about 42,000 tonnes per year of proteins is carried in the press mud.

The present investigation was aimed at the recovery of protein from press mud for which an extraction procedure was developed.

Materials and methods

Chemicals

All chemicals used were of Analytical Reagent grade; acrylamide, N,N'-methylene bisacrylamide, N,N,N',N'-tetramethylethylenediamine (TEMED), Tris, glycine and Coomassie Brilliant Blue G250 were from Sigma Chemical Company.

V. S. Dhamankar

S. M. Chavan

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Extraction of proteins

Press mud was obtained from the sugar factory located at Theur, Pune, India, and sun-dried. One gram amounts of press mud were suspended separately in 25 ml of various reagents in conical flasks and shaken at 26° - 28°C for 4 - 5 hr. The contents of the flasks were centrifuged at 8000 rpm for 30 min and the supernatant was siphoned off. The pH of the collected supernatant was adjusted to 7.0 with 0.1 HCl. These samples were assayed for protein by the dye binding method[3], while the carbohydrate content was determined by the phenol-sulphuric acid method[4].

Fractionation of proteins

For fractionation purpose, proteins from 6.0 g press mud were extracted with 150 ml of 1 N NaOH under similar conditions. The extract (pH 7.0) was brought to 90% saturation with ammonium sulphate; the precipitate obtained was separated by centrifugation and dissolved in water. The solution was dialysed extensively against large amounts of water. Protein fractions soluble in water, salt, alcohol and acetic acid solutions were prepared as described by Chen & Bushuk[5]. The protein fraction which was soluble only in 1 N NaOH was designated as the alkali-soluble fraction.

Protein solubility

Aliquots of the alkali soluble fraction were adjusted separately to pH values ranging from 2.0 to 8.0 with 0.1 N HCl. The different samples were centrifuged and the clear supernatants were examined for protein; in this way it

1 Dubey & Varma: "Sugar by-products and subsidiary industries" (Deccan Sugar Institute, Pune, India), 1979 p. 64.
2 Paturau: By-products of the cane sugar industry" (Elsevier, Amsterdam), 1969, p. 259.
3 Bradford: *Anal. Biochem.*, 1976, **72**, 248.
4 Dubois *et al.: Anal. Chem.*, 1956, **28**, 350.
5 *Can. J. Plant Sci.*, 1970, **50**, 9.

Table I. Extraction of press mud proteins with different reagents

	Concentration*	pH	mg protein extracted /g press mud
Sodium dihydrogen phosphate	0.5 M	4.5	1.75
Sodium chloride	0.5 M	6.5	6.25
Sodium acetate	0.5 M	8.0	6.50
Sodium sulphate	0.5 M	6.9	5.75
Sodium citrate	0.5 M	8.2	6.25
Sodium nitrate	0.5 M	6.8	5.75
Sodium hydroxide	0.5 M	12.0	41.25
Sodium hydroxide	1.0 M	12.5	74.00
Potassium hydroxide	1.0 M	12.0	71.00
Sodium carbonate	0.5 M	11.0	5.75
Disodium hydrogen phosphate	0.5 M	9.2	6.00
Sodium borate	0.5 M	9.0	-
Tris buffer	1.0 M	10.4	5.70
Urea	1.0 M	8.1	8.75
Butanol	10%	6.1	9.00
Ethanol	10%	7.4	7.50
Acetone	10%	7.1	5.00
Amyl alcohol	10%	5.6	5.50
Pyridine	10%	8.7	4.00
Dimethyl sulphoxide	10%	6.8	2.50
Dimethyl formamide	10%	6.6	3.75
Toluene	10%	7.0	1.25
Methyl cellosolve	10%	2.7	3.75
HCl	1.0 M	0.6	-
Sodium dodecyl sulphate	0.1 M	7.4	38.00
Water	-	6.8	5.60

* Concentration is expressed as M = Molar, % = v/v

was possible to determine the isoelectric point.

Electrophoresis

A gel electrophoresis unit (AB. Pharmacia GE-4), was used for carrying out polyacrylamide gel electrophoresis. Buffers for electrophoresis were prepared as described by Davis[6]. Both upper and lower reservoir buffers contained 0.005 M Tris and 0.04 M glycine at pH 8.3. Polyacrylamide gel concentration was 7% acrylamide, Bis 0.18%, TEMED 0.03% and ammonium persulphate 0.03%. For electrophoresis 100 µg of protein sample in 0.01 M sodium phosphate buffer (pH 7.0) was loaded on 7% polyacrylamide gel (9 cm × 0.5 cm). The electrophoresis was carried out at a current of 3 mA per tube. Bromophenol blue was used as a tracking dye. After completion of electrophoresis polyacrylamide gels were stained with Coomassie Brilliant Blue G250[7].

Results and discussions

The effectiveness of various reagents for the extraction of proteins from press mud is summarized in Table I. Of all the reagents, strongly alkaline solutions of sodium hydroxide or potassium hydroxide were found to be the most effective extractants of press mud proteins. An ionic detergent, sodium dodecyl sulphate (SDS), solubilized 50% of the total proteins extractable by alkali, but increase in concentration of SDS did not improve extraction.

The solubilization of proteins did not seem to be strictly dependent upon pH of the extracting reagent. Lower or higher concentrations of reagents other than alkali did not increase amounts of extracted proteins. Extraction with various reagents was performed only once as the purpose was to determine the relative efficiency of the extractants to solubilize the proteins.

Different concentrations of sodium hydroxide, viz. 0.01M, 0.1M, 0.5M, 0.7M and 1M were found to extract 0.15, 2.5, 4.2, 5.6 and 7.4 g protein/100 g press mud, respectively. The optimum time required for the extraction of protein was 4 - 5 hr whereas optimum volume was 25 ml NaOH/g of press mud at 26° - 28°C. There was no difference between the stirring and shaking methods for protein extraction.

Extraction of fats with n-hexane prior to protein extraction from press mud with alkali did not enhance the amount of extracted protein, which is in agreement with the report of Hill & Bridenbach[8], who suggested that fat extraction from soybean seeds prior to protein extraction was not essential.

The recovery of proteins after ammonium sulphate precipitation (90% saturation) and dialysis was found to be 77% of the total protein extracted by NaOH. Further fractionation of the proteins showed 91.5% to be water-soluble, 1% soluble in 10% Na_2SO_4 and 3% soluble in 70% ethanol. However, acetic acid-soluble protein was not detectable. The remaining 4% proteins could be solubilized only with 1N NaOH (Table II). Although more than 90% of the proteins in press mud are water-

6 *Ann. N. Y. Acad. Sci.*, 1964, **121**, 404.
7 Blakeley & Boezi: *Anal. Biochem.*, 1977, **82**, 580.
8 *Plant Physiol.*, 1974, **53**, 742.

Table II. Percentage of different fractions in press mud proteins

Protein fraction	Volume, ml	Total protein, mg	% Protein
Ammonium sulphate (90% saturation)-precipitated proteins	290	340	100
Albumin (water soluble)	290	311	91.5
Globulin (10% Na_2SO_4-soluble)	25	3.4	1
Alcohol-soluble (70% aqueous alcohol)	25	10.2	3
Alkali-soluble (1M NaOH)	25	13.7	4

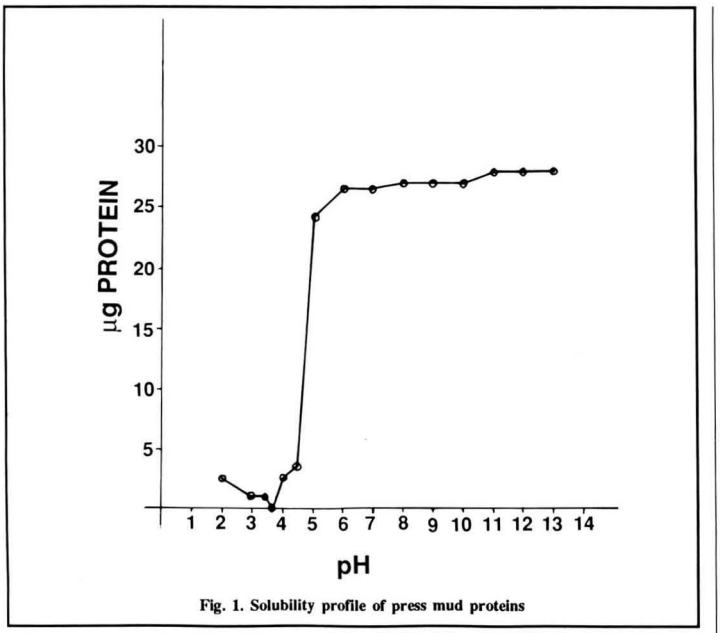

Fig. 1. Solubility profile of press mud proteins

soluble, they cannot be extracted directly with water. This might be due to the strong adsorption of these proteins on precipitated calcium phosphate, calcium sulphite, etc. formed in the process of juice clarification. Firm binding of the proteins on these salts could make them insoluble in the various reagents employed for protein extraction. The carbohydrate content of total press mud protein was found to be 1.9 - 2 mg/100 mg protein.

The alkali-extractable protein of press mud has minimum solubility at pH 3.7 (Figure 1). The protein solubility pattern indicated higher protein solubilization in the alkaline pH range.

Press mud proteins (ammonium sulphate precipitate after dialysis) when subjected to electrophoresis in polyacrylamide gel (7% pH 8.9) showed a single major band with few other diffused bands. Another sharp band moving fast along with the dye bromophenol blue was also observed (Figure 2).

In summary, 7.4 g of proteins

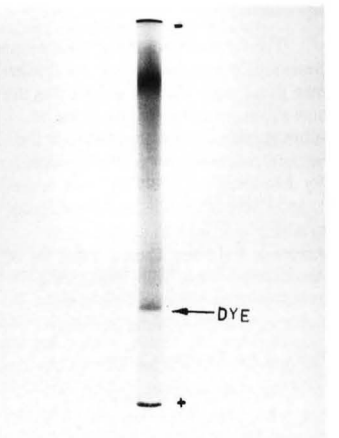

Fig. 2. Polyacrylamide gel electrophoretic pattern of press mud proteins

could be extracted from 100 g dry press mud. Thus, nearly 40,000 tonnes of proteins are extractable from 540,000 tonnes of dry press mud which is discarded from various sugar factories in India.

Summary

The protein content of press mud was found to be about 7.4%. The proteins were extractable only with strong alkali or with an anionic detergent such as sodium dodecyl sulphate. Different fractions accounted for 91.5% albumins, 1% globulins, 3% ethanol-soluble and 4% alkali-soluble proteins. The isoelectric pH of the protein was 3.7 and it contained 2% carbohydrates. Polyacrylamide gel electrophoresis of protein is also discussed.

Facts and figures

Indonesia sugar estimate cut[1]

Indonesia's raw sugar output in 1988 is expected to rise only to 2,175,000 tonnes, compared with an earlier forecast of 2,375,000 tonnes and the 1987 production of 2,125,000 tonnes. The revision has resulted from last year's drought which affected more than half of the 201,000 hectares planted on Java and 55,000 hectares planted elsewhere. Consumption for this year is forecast at 2,100,000 tonnes, against 2,030,000 tonnes in 1987 so that, theoretically, there is no need to import sugar; however, it has already been announced that Indonesia will import 125,000 tonnes of sugar to buttress stocks and to meet demand in the Moslem fasting month of Ramadan which begins in mid-April, during which consumption doubles. The area planted to cane is expected to rise to a total of 320,000 ha this year and to 365,000 ha in 1989 as part of plans to raise sugar output to keep pace with rising demand and Indonesia's population increase.

Austria sugar production, 1987/88[2]

The five Austrian sugar factories sliced 2,128,298 tonnes of beet in the 1987/88 campaign to produce 353,742 tonnes of white sugar.

Costa Rica sugar production decline[3]

Sugar production in the 1987/88 season is forecast at 203,000 tonnes, raw value, down 26,000 tonnes from the 1986/87 output which was itself 10,000 tonnes higher than the 219,000 tonnes of 1985/86. Consumption in 1987/88 is expected to reach 170,000 tonnes against 166,000 tonnes in the previous crop year.

1 *Financial Times*, February 18, 1988.
2 *Zuckerindustrie*, 1988, **113**, 167.
3 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 102.

ICUMSA News

Editor: R. Pieck
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Introduction

The serious work of the 20th Session is now underway after a slower than usual start. This, of course, was the consequence of the reorganization of subjects with the need to reallocate the recommendations of the 19th Session. By this time everyone who has a desire to serve will have indicated the subjects to which they wish to contribute as Associate Referees. The complete list of Associate Referees with addresses is available from National Comittees, Referees and the General Secretary.

Work of the Steering Committee

The Steering Committee, comprising Dr. A. Emmerich, Mr. J. V. Dutton, Dr. M. A. Clarke and the President, have now considered the many submissions made about reallocation of the 19th Session Recommendations to the new list of subjects.

It was not a simple task to allocate recommendations among the new subjects and obtain a perfect fit. The reason for this difficulty lies in the change in philosophy adopted for the 20th Session. The General Refereeships are expected to reflect the needs of the market place and if a recommendation does not appear to have relevance to one of the General Referee's subjects then one must question whether the recommendation should be pursued. In few cases 19th Session Recommendations remain unallocated because appropriate referees could not be found. The reallocation of Recommendations has been prepared in tabular form and these have already been distributed to Referees and the Chairmen of National Committees from whom copies may be obtained.

New methods book

The Chairman of the Publications Committee, Mr. Dutton, has advised that his committee is now ready to undertake the publication of methods for our new book. The president's view on the form of this book was set out in the Special Committee's reform proposals in 1986. This involves the publication of individual methods as booklets which could be distributed individually or else combined in a suitable binder. A format similar to that used for ISO methods would be adopted so that mutual recognition of methods between organizations would be facilitated. Methods could be sold by the Publications Department at a price designed to recover costs but based on the number of pages involved. The status of a method, official or tentative, would be indicated in its title. As methods are upgraded, a new booklet would be produced to contain any changes involved. In this way a collection of methods could be continually kept up to date by simply purchasing new method booklets as they were issued.

Method review by General Referees

At the request of the President, General Referees have reviewed the analytical methods used by commerce and industry in their particular subjects. One of the results of this exercise is to show where there is duplication of methods between competing organizations and where commercial methods do not yet exist. It is to be hoped that discussion between the various interested parties will resolve issues revealed in this review. The methods used for the analysis of molasses, white sugar and raw sugar are discussed in this issue of *ICUMSA News*.

Molasses analysis

The General Referee, Mr. D. S. Martin, has reviewed the methods used for analysing molasses. Vacuum drying is used for measuring dry matter or water content but there are competing methods emerging. One is the Karl Fischer method which needs inter-laboratory testing, while near infra-red analysis holds some promise of a very rapid determination but requires further development. Total reducing sugars as reducing substances may also be determined by alternatives to the Lane & Eynon constant volume method; the Luff-Schoorl method is used by some organizations while HPLC and enzymatic methods hold great promise

Table I. Methods required by legislation and commerce needing high priority attention by ICUMSA

Parameter	*ICUMSA method*	*Status*	*Other organizations specifying*			
			A	B	C	D
Pol	*Proceedings*, 1982, Subject 19, p. 341	Tentative				
	ICUMSA methods of analysis, p 23	Tentative	*	*	*	*
Reducing sugars <0.04%	ICUMSA methods of analysis, p. 59	Official	*	*	*	*
Reducing sugar >0.04%	ICUMSA methods of analysis, p. 55	Official	*	*	*	*
Loss on drying	*Proceedings*, 1986, Subject 19, Rec. 1	Official	*	*		*
Solution colour	*Proceedings*, 1978, Subject 22, p. 343	Official	*	*	*	*
Sulphur dioxide	ICUMSA methods of analysis, p. 98	Official	*	*	*	*
Visual appearance	*Proceedings*, 1982, Subject 22A, Rec. 4	Official		*		*
Conductivity ash	ICUMSA methods of analysis, p. 85	Official	*	*	*	*
Arsenic	*Proceedings*, 1978, Subject 17, Rec. 4	Official	*	*		*
Lead	ICUMSA methods of analysis, p. 92	Official	*	*	*	*
Copper	ICUMSA methods of analysis, p. 90	Tentative	*	*		*
Particle size	*Proceedings*, 1986, Subject 19, Rec. 3	Tentative				*
Microbiological tests	ICUMSA methods of analysis	Official and Tentative				*
Solution turbidity	No method					*
Insoluble matter	ICUMSA methods of analysis, p. 187	Tentative				*

A = Codex Alimentarius; B = EEC legislation; C = European Pharmacopaeia; D = Customer or Manufacturer Specification

but need further development. Total mineral matter is determined as sulphated ash while individual cations are determined by atomic absorption methods.

There is a need for methods to measure total fermentable compounds, rheology and colour although, in the latter case, the specification of a methodology for molasses is all that is required.

White sugar

The methods required for white sugar have been reviewed by the General Referee, Dr. Charles Harvey, who also reports on the priorities he has set for work leading up to the next Session in 1990.

The methods required by the Codex Standard for White Sugar, European Economic Community legislation, the European Pharmacopeia specification for sucrose and the requirements of commercial users and producers of white sugar have been assembled and divided into high and medium priority lists shown in Tables I and II.

The high priority list includes all the methods required by the Codex Standard for White Sugar, those procedures for which there is an EEC statutory specification and those methods for quality parameters regarded as essential by commercial users. Commercial users' and producers' specifications for white sugar may include other parameters, such as pesticide residues, gravimetric ash and radio-nucleides. These additional requirements are in the medium priority list.

The high priority methods are thought to be of fundamental importance to users and producers of white sugar and are essential for the quality assurance of the product.

Validation of existing ICUMSA procedures

Over the years, ICUMSA has published many of the methods listed, either in the "Methods of Analysis" book or in later *Proceedings*; some methods have attained "official" status whereas others remain "tentative". At the last Session in Cannes, considerable emphasis was placed on the need for ICUMSA methods to be validated by collaborative testing so that they are readily acceptable by other organizations such as ISO and AOAC. Dr. Clarke's working group on this subject has recommended that all ICUMSA methods be validated to IUPAC standards.

An additional incentive to validation is provided by the current Codex review of standard methods for white sugar. The Codex Committee for Methods and Sampling requires evidence that methods have been fully tested and may not accept ICUMSA methods without this validation.

Raw sugar

The General Referee for Raw Sugar, Mr. R. J. McCowage, has reviewed the methods of analysis for raw sugar and set priorities for work for the current session. Raw sugar is a commodity; it is handled, transported and stored as an intermediate product, not a foodstuff. To date, legislative bodies have shown little interest in it, primarily focusing their attention on white or refined sugars which are intended for human consumption, either directly or indirectly. The Codex Coordinating Committee for Latin America and the Caribbean expressed some interest in establishing a standard for raw sugar at its meetings in 1984 and 1985. However, while the 17th Session of the Codex Alimentarius Commission held in Paris in 1987 concluded that a standard should be established this has not yet appeared and it is likely it would be limited to raw sugar intended for direct human consumption.

Thus, with no legislative provisions relating to raw sugar, the highest priority for the General Refereeship for Raw Sugar is that of methods of analysis required in commerce. These are methods which form the basis for payment and/or product specifications. At a slightly lower level of priority are methods used to assess particular quality attributes of raw sugar which are of significance to refiners but which do not impinge on terms of trade. These primarily relate to processing characteristics but can also cover trace levels of impurities which can pass through a

Table II. Methods required by legislation and commerce needing medium priority attention but for which there is no ICUMSA method

Parameter	*Organization specifying*
Pesticides	Customer/ Manufacturer
Foreign colouring matter (blueing agents)	European Pharmacopaeia
Gravimetric ash	European Pharmacopaeia
Acidity/ Alkalinity	European Pharmacopaeia
Barium	European Pharmacopaeia
Dextrins	European Pharmacopaeia
Ammonia	Customer/ Manufacturer
Radio-nucleides	Customer/ Manufacturer

Table III. Methods required by commerce and industry needing high priority attention by ICUMSA

Parameter	*ICUMSA method*	*Status*
Pol	ICUMSA methods of analysis, p. 25*	Official
Reducing sugars	ICUMSA methods of analysis, p. 55	Official
	ICUMSA methods of analysis, p. 57	Official
Sulphated ash	ICUMSA methods of anlaysis, p. 83	Official
Conductivity ash	ICUMSA methods of analysis, p. 85	Official
	Proceedings, 1982, Subject 16, p. 278	Official
Moisture	*Proceedings*, 1986, Subject 13, rec. 5	Tentative
Colour	ICUMSA methods of analysis, p. 125	Official
pH	ICUMSA methods of analysis, p. 132	Official
Fine grain	No method	
Dextran	No method	
Standard affination	No method	
Temperature	No method	

* plus amendments

refinery into refined sugars and other products.

Methods used in raw sugar trade - high priority

The high priority methods set out in Table III are those which are currently used in the international trade of raw sugars, either to establish base value or to apply quality incentives.

The rules of the London Commodity Exchange Raw Sugar Contract No. 6 and of the New York Coffee, Sugar and Cocoa Exchange Contract No. 11, which apply to the world's raw cane sugar futures trade, include no more than raw sugar pol in description of payment conditions. Nonetheless, the polarimetric method is of prime importance in world commerce.

The New York Exchange Contract No. 14 Rules, which apply to US domestic production specify Standard Quality Ranges in respect of moisture, ash, grain size, affined raw colour, whole raw colour and dextran. These quality criteria have been adopted, either in the contract No. 14 or slightly amended form, in international sales contracts by a number of US refineries and have financial incentives associated with them. These methods are therefore of importance to raw cane sugar producers supplying the US market.

In the EEC beet raws trade there is an agreed formula for calculating net yield. This formula is based on raw sugar pol, conductivity ash and reducing sugars content. There are also specifications covering pH, reducing sugars content, temperature and security factor or moisture content. These methods are thus of fundamental importance to that trade.

Legislation in Europe and the United States appears likely eventually to preclude the use of lead. With pol measurement being the single most important analysis in the raw sugar trade, work to prove a new clarification agent for this procedure must assume a high priority. Of course Subject G1 is not the only area which this legislation will affect, making work in this problem extremely important for ICUMSA as a whole.

Methods used for quality checks

Methods used for quality checking do not appear in international sales contracts; however, they can be applied either routinely, to monitor raw sugar quality, or intermittently, to check on particular processing irregularities. A list of such methods appears in Table IV where medium to low priority has been judged to be appropriate. This list is not exhaustive and others may wish to include additional methods. Lists themselves are dynamic, changing as particular quality issues rise and decline in importance.

Table IV. Methods required by commerce and industry needing medium to low priority attention by ICUMSA

Parameter	*ICUMSA method*	*Status*
Citric acid**	ICUMSA methods of analysis, p. 110	Official
ERH	ICUMSA methods of analysis, p. 122	Official
Calcium	ICUMSA methods of analysis, p. 87	Official
Crystal wash	ICUMSA methods of analysis, p. 192	Tentative
	ICUMSA methods of analysis, p. 191	Official
Crystal size and distribution	ICUMSA methods of analysis, p. 182	Tentative
Phosphate*	*Proceedings*, 1986, Subject 17, Rec. 2	Tentative
Buffer power	ICUMSA methods of analysis, p. 189	Tentative
Lead	ICUMSA methods of analysis, p. 91	Tentative
Starch	No method	
Sulphite	No method	
Floc	No method	
Total polysaccharides	No method	
Insoluble matter	No method	
Solution turbidity	No method	
Filtrability	No method	
Frothing propensity	No method	
Crystal habit modifiers	No method	

* raw cane sugar
** raw beet sugar

Pump types currently used in the sugar industry

By J. B. Westwood
(SSP Pumps Ltd., Eastbourne, England)

Although it is normally impossible for the consumer to distinguish between the end products of the two principal sources of sugar – beet and cane – when the refined white granular product is tipped out of the bag, the physical nature of the raw crops differs considerably, as does the processing, particularly in the early stages of purification. What is common to both is the use of pumping throughout the process, from the actual juice extraction to the feed to the centrifugal which supplies the granulator with damp sugar. Between the beginning and the end of manufacture, the sugar is processed in a liquid form, whether as juice or syrup, and pumps are the mechanical devices used to transport the liquid sugar material with high efficiency.

The physical nature of this liquid sugar varies considerably, depending on the stage in the process that is being considered. This physical nature has a direct bearing on the efficiency and

effectiveness of a pump in handling the material. Hence, in the process as a whole, one frequently finds many different pump types and designs being employed. Each has particular characteristics which make it more or less suitable and more or less effective in performing the duty required of it.

It is significant that so many pump types are used, revealing that few of these pumps are effective at more than one or two stages in sugar manufacture. This article examines the characteristics of several different commonly used types, and discusses their suitability for different applications in the sugar industry.

Choosing a pump

As a starting point, it is relevant to explain briefly some of the basic and important factors to be considered when assessing pump designs for this industry. The two fundamental types of pump used are centrifugal and positive displacement pumps.

Centrifugal pumps are widely used in the early stages of the process where juice is thin; they are also used on service and water duties. Their efficiency falls off rapidly with increasing concentration and viscosity. As a result these pumps cannot be used effectively to pump a liquid with a viscosity significantly greater than that of water. Pumping unsuitable liquids can adversely affect the pump's performance and often physically damage it. Solids carried in a liquid can also cause rapid wear and abrasion damage.

The centrifugal pump is very inefficient at the slow rotational speeds that are frequently required for pumping viscous media. For a variety of reasons, therefore, this type is unsuitable for most process pumping duties in the later stages of sugar manufacture.

Positive pumping

Positive displacement pumps are characterized by having a volume or chamber which is swept by the mechanism of the pump, and any medium contained within that volume is displaced from it. The two major groupings are rotary action and reciprocating action pumps. Positive displacement pumps can operate efficiently at a wide range of speeds and, indeed, the flow rate is proportional to the operating speed.

Reciprocating action positive displacement pumps require valve mechanisms in the flow path of the fluid through the pump in order to ensure one direction of liquid movement. With high viscosity liquids the valve action is dampened, rendering it and the pump ineffective. Many valve designs are susceptible to abrasion damage by sharp solids such as sugar crystals which can also cause crystal structures to break down. Raggy or stringy solids and slurries of fine particles can jam the valves. Reciprocating positive displacement pumps consequently find limited application in general sugar processing.

Rotary designs

There are many rotary pump designs, most of which operate without valves, and several different designs are employed in the sugar industry. Some are restricted to certain duties whilst others have a much wider range of applications. A detailed description of the pumping action of each design cannot be attempted here, but a general appreciation of the merits and drawbacks inherent in each design will be made.

The major rotary pump categories involved in sugar manufacture are: the single rotor (cam and pawl), the progressing cavity, sliding vane, gear pump and, more recently, their close relative, the twin rotor rotary-lobe pump.

Single rotor pumps

The single rotor pumps involve a driven, bilobe rotor (actually a form of ellipsoid) revolving in a circular chamber. The pumped material is drawn into the space between rotor and chamber wall and carried round to the discharge. A pawl arm, one end fixed to the pump wall and the other in free contact with the rotor, prevents the pumped material from being carried back to the inlet.

Rotational speed is low, around 30 - 40 rpm, to cope with the high viscosities involved. Typical applications are the pumping of magma, massecuite and molasses, with viscosities generally in the 10,000 to 50,000 cp range, although over 100,000 cp is relatively common.

These pumps are simple in operation but maintenance time and costs are high. They are prone to abrasive wear from trapped sugar crystals. This can occur under the pawl or between the front and back faces of the rotor and the walls of the chamber. The pump's efficiency is not high, as product tends to leak past the pawl arm, the drive shaft seals tend to leak excessively, and dry running for any period is inadvisable.

Progressing cavity pumps

The progressing cavity pumps involve a helical metal rotor inside a helical rubber stator. The pumping chamber is relatively long, many times the length of the other pump types mentioned here, and motors have also to be large. Although this pump can handle virtually any application, from heavy magmas to juice and milk of lime, it cannot tolerate dry running, which causes catastrophic pump failure. Wear of the stator can be unacceptably high on very abrasive materials. Shear is low and sugar crystals are not damaged.

Sliding vane pumps

Sliding vane pumps incorporate a rotor eccentrically sited within a circular chamber. The rotor is fitted with a number of freely sliding vanes which provide a sealing fit with the chamber walls, and carry the pumped medium in the spaces between the vanes. Many of the characteristics of the progressing cavity pumps apply to this design, except that it is of a more convenient size for process plant. Although dry running is not so immediately disastrous, it is not recommended.

Gear pumps

Several different varieties of gear pumps are used in sugar manufacturing processes, as they tend to be slow running, with low shear, and so do not damage the sugar crystals in magma or massecuite; they are generally easy to

maintain. Several designs depend on the liquid being pumped to provide lubrication between metal-to-metal surfaces. These types are not very suitable for abrasive slurries or the high contents of sugar crystals which can cause abrasive wear. Dry running tends to cause expensive damage to these pumps.

Twin rotary lobe pumps

Relatively recently, twin rotary-lobe pumps in ductile (spheroidal graphite) iron have been successfully used in applications including the pumping of lime slurries, carbonatation slurries, green syrups, juices, melt liquors, various molasses, magma and massecuite with viscosities up to 500,000 cp. These duties even include magmas with up to 40% sugar crystals.

A typical example is the GP tri-lobe rotor pump from SSP Pumps Limited. This pump is now being successfully used in beet and cane sugar manufacture and refining, as well as handling molasses for animal feeds, liquid sugar syrups and carbonatation slurries. Models are installed in the UK, France, Denmark, Australia, Japan, Africa, South East Asia and the USA.

The GP range of pumps includes units with up to 300 mm diameter inlet connexions. Flow rates can be up to several hundred cubic metres per hour on thin juices and as high as 50 to 60 cubic metres per hour even on high viscosity massecuites. Three features particularly distinguish the GP pump; these are the absence of rubbing contact between the intermeshing rotors or between the rotor and the pumping chamber wall; the comparatively large volume of liquid in the rotor cavity; and low rotation speeds, which help minimize shear, emulsification and air entrainment.

The two rotors are profiled according to a highly advanced computer derived geometry and are cut extremely accurately with CNC machining techniques which ensure complete repeatability, interchangeability and ease of maintenance.

As a result the pumping chamber is swept with excellent volumetric efficiency and, as there is no rubbing contact, the pump can run dry for long periods with impunity. The pump has good abrasion resistance. The very close tolerances achieved by the advanced manufacturing techniques used in the rotor production allow the pump to be extremely effective when pumping water and other low viscosity fluids whilst maintaining the non-rubbing contact.

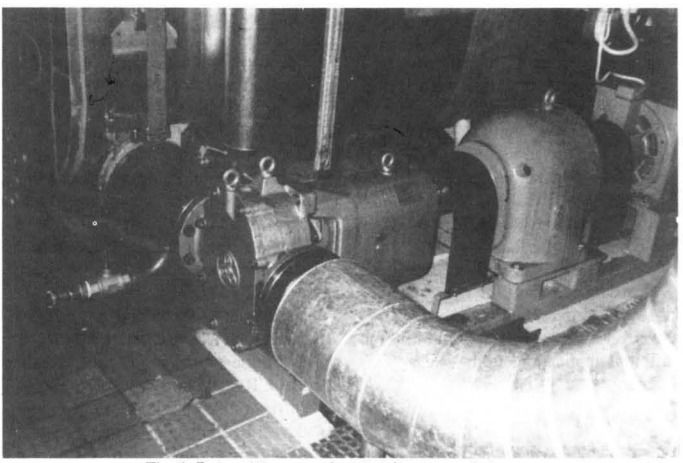

Fig. 1. Rotary lobe pump installed in a sugar factory

Sealing

The rotors are driven via external gears, providing the precision timing essential for optimum operation. A wide selection of seal types is available for sealing the twin drive shafts; these vary from packed glands to flushed packed glands or to mechanical seals. The GP pump is simple to clean and maintain; access to the pumping chamber is gained via a bolt-on front cover, and the pump is also ideal for cleaning-in-place procedures, essential where strict hygiene is critical. The compact dimensions for the GP pump ensure that, when it is mounted with a motor, either directly coupled or via a clutch or belt drive, the complete unit occupies a relatively small space.

Fig. 2. GP rotary lobe pump with rotor case cover removed

Facts and figures

New Zaire sugar factory[1]

Cuba is to participate in construction of a sugar factory in Bandundu in Zaire, which will have a yearly capacity of 30,000 tonnes of sugar and is estimated to cost between $100 and $110 million. It is to start production in the second half of this year. Cuba is also providing technical assistance in the control of cane diseases detected at the Lotokila sugar processing plant in Haute Zaire.

American Sugar Cane League relocation

The offices of the League, which is an association representing the interests of cane growers and millers in the continental United States, has moved from New Orleans to Thibodaux. The street location is 201 North Canal Boulevard, but the postal address will be P.O. Box 938, Thibodaux, LA 70302-0938, U.S.A. and telephone number (504) 448-3707. The move places the office within the industry and will provide for easier communication with growers and processors. Mr. J. Kelly Nix took office in January 1988 as the new General Manager of the League.

New body to represent all Australian sugar producers

A new company, the Australian Sugar Milling Council Pty. Ltd., has been formed to represent the interests of all the country's sugar factories. The new body will take over the functions of the Australian Sugar Producers Association Ltd., the Cooperative Sugar Millers' Association Ltd. and the Proprietary Sugar Millers' Association Ltd., all of which have been wound up. Chairman of the Council is Mr. J. A. Dixon, while the general manager is Mr. J. A. Desmarchelier, formerly general secretary of the Proprietary Sugar Millers' Association. The address of the new organization is G.P.O. Box 945, Brisbane, Queensland, Australia 4001.

continued from page 114

Conclusion

In this review of the pump types in common use in sugar manufacture, it can be seen that, of the many designs involved, relatively few are versatile enough to cope with the wide variety of demands made by the processing, especially in terms of high viscosities and high abrasion. The advantages to the engineer of having a common pump design for a wide range of applications are many. However, it is important that as little as possible compromise in performance is made in selecting a pump for a particular application. That such compromises do not have to be made is being more and more widely acknowledged throughout the sugar industry, when the merits of the twin rotary-lobe pump are considered.

New large cane transporter[2]

A prototype cane transport unit was undergoing trials during the recent crop at Maryborough in Queensland. It has two bins each of 13 tonnes capacity and these are separately discharged by coupling to a hydraulic hose at the receiving factory whereby the bins are tipped sideways to discharge the cane. A control on the trailer transfers hydraulic power to the ram of the second bin when the first has been emptied. The bins are filled in the field by means of high-lift side-tipping trailers which are the main type of infield cane transportation in the Maryborough district.

Increased sugar import quota for Portugal[3]

The EEC sugar management committee voted on February 10 in favour of a Commission proposal to increase the import quota of Portugal for raw sugar by 20,000 tonnes. This raises to 143,000 tonnes the amount which Portugal may import up to the end of June 1988 at a reduced levy.

Mauritius sugar production, 1987[4]

Harvesting of the 1987 sugar crop started on June 18 and ended on December 15, 1987. The 19 factories crushed a total of 6,231,127 tonnes of cane to produce 691,134 tonnes of sugar, tel quel (732,948 tonnes, raw value). Average cane yield per hectare was 80.6 tonnes and average sugar extraction was 11.09%. The outturn represented a fall from the previous season when 706,839 tonnes of sugar, tel quel, equivalent to 748,472 tonnes, raw value, was produced. Exports rose from 624,949 tonnes, tel quel, in 1986 to 656,317 tonnes in 1987 and domestic consumption was also slightly higher at 38,596 tonnes in 1987 against 37,731 tonnes, while the closing stocks were reduced slightly from 380,565 tonnes in 1986 to 377,541 tonnes at the end of 1987.

US beet sugar companies merger[5]

Holly Sugar Corporation has announced a major board and management restructuring related to its acquisition by Imperial Sugar Company which leaves Imperial with a majority of seats on the Board. Imperial has bought two-thirds of Holly's common shares outstanding for about $80.8 million and will acquire the remaining shares in exchange for a 25% stake in the new combined company, Imperial Holly Corporation, which will be the second largest publicly held sugar company in the US.

China sugar expansion[6]

Guangxi province in south-west China will increase cane crushing capacity to 180,000 tonnes a day by 1992 from the current 91,200 t.c.d.. to help make the area a major sugar producer, according to the *People's Daily*. China's outputs of beet, cane and sugar fell last year from those of 1986 and imports are at near-record levels. The paper said Guangxi will raise capacity by modernizing 62 sugar factories and building 20 new large-scale plants with materials and financial support from the central government. An official newspaper said that Guangxi plans to raise sugar output to two million tonnes by 1992 from 1.2 million now. To encourage sugar growing, the Guangxi government will be allowed to retain 20% of the sugar it produces above its quota requirements for the state. The regional government also hopes that sugar deficit areas, foreign consortia or individuals will invest in sugar factories. Areas where little sugar is grown are also welcome to make barter contracts or cultivate waste land to promote sugar production. Farmers in traditional sugar growing areas in Fujian and Guangdong have turned to more lucrative cash crops.

Canada sugar imports, 1987[7]

	1987	1986
	tonnes, tel quel	
Raw sugar		
Australia	312,649	542,610
Belize	21,971	0
Cuba	82,949	204,327
Guyana	20,431	20,003
Mauritius	74,643	29,743
South Africa	181,683	134,415
Swaziland	0	134,925
Zimbabwe	45,502	23,977
Other countries	153	48
	739,981	1,090,048
White sugar		
Denmark	2,724	3,114
Korea, South	1,348	486
USA	118,873	111,616
Other countries	5,883	2,030
	128,828	117,246

Guyana sugar exports, 1987[8]

	1987	1986
	tonnes, raw value	
Canada	21,331	20,896
EEC	161,306	160,591
Jamaica	0	106
Surinam	362	522
USA	10,104	4,989
USSR	0	27,866
Other countries	1,667	4,270
	194,770	219,240

Australian sugar company expansion[9]

Bundaberg Sugar Company Ltd., which owns three sugar factories and a refinery, announced that it has acquired the Mourilyan and Moreton factories in Queensland, which have daily cane processing capacities of 7500 and 5200 tonnes, respectively.

1 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 120.
2 *Australian Canegrower*, 1988, **10**, 18.
3 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 131.
4 *Mauritius Sugar News Bull.*, 1987, (12).
5 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 132.
6 *Reuter Sugar Newsletter*, March 1, 1988.
7 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, S97 - S98, S145 - S146.
8 *I.S.O. Stat. Bull.*, 1988, **47**, (2), 19.
9 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120**, 138.

Spanish beet sugar production, 1987/88[10]

According to Spain's Ministry of Agriculture, the area sown to sugar beet fell by 5.6% from 195,000 hectares in 1986 to 184,000 ha in 1987 but beet production increased from 7,629,000 tonnes to 7,638,000 tonnes. Total beet sugar production in 1987/88 was 1,072,000 tonnes, raw value, which compares with 1,093,000 tonnes the previous year and 965,000 tonnes in 1985/86. After a mild, wet winter, sugar yield prospects for the 1988/89 campaign are good.

Mauritius sugar exports, 1987[11]

	1987	1986
	tonnes, tel quel	
Belgium	1,640	1,345
Canada	89,400	43,750
Egypt		10,800
Finland	0	13,300
France	70,955	69,410
Germany, West	628	163
Holland	4,613	3,060
India	0	12,485
Italy	2,744	0
Morocco	0	28,000
New Zealand	21,055	0
Portugal	18,000	0
Switzerland	562	0
UK	421,195	414,287
USA	9,559	12,556
USSR	15,750	14,700
Other countries	216	1,093
	656,317	624,949

Nicaragua sugar industry in difficulties[12]

Nicaragua's private and state sugar factories are facing serious production problems with only 50 - 60% of installed capacity being used, according to *Central America Report*. One of two basic problems is the lack of fuel and spare parts for machines and transport, which at times has paralysed production. The second is the prolonged drought which has affected the quality and quantity of cane and has caused yields to fall dramatically.

Australia sugar exports, 1987[13]

	1987	1986
	tonnes, raw value	
Canada	442,000	552,000
China	484,000	443,000
Japan	677,000	514,000
Korea, South	338,000	314,000
Malaysia	419,000	380,000
New Zealand	82,000	102,000
Singapore	109,000	135,000
USA	70,000	99,000
USSR	193,000	159,000
Other countries	13,000	12,000
	2,827,000	2,710,000

Philippines sugar exports in decline in 1987[14]

Philippine sugar exports in 1987 fell to 162,900 tonnes, 26.6% down from the year before. Earnings dropped to US $60.3 million, down 30.5% from the $86.7 million earned in 1986. The fall may be attributed to drought, smaller plantings and sugar producers shifting to more profitable enterprises. Most of the 1987 exports went to the US which reported imports of 132,500 tonnes, raw value.

Thailand sugar exports, 1987[15]

	1987	1986
	tonnes, raw value	
Bangladesh	13,031	60,935
Brunei	1,991	1,655
Bulgaria	0	62,725
China	837,858	307,191
Egypt	15,559	0
Hong Kong	14,467	819
India	13,685	78,064
Indonesia	0	15,630
Japan	440,699	377,342
Korea, South	343,882	483,672
Laos	3,157	0
Malaysia	95,427	171,608
Maldives	868	1,031
Nepal	0	16,257
New Zealand	16,901	20,810
Pakistan	15,730	54,905
Papua New Guinea	7,594	18,956
Philippines	456	0
Singapore	18,825	2,245
Sri Lanka	72,327	89,341
Syria	24,958	0
USA	11,642	21,910
USSR	108,053	250,143
Vietnam	14,564	12,520
Other countries and unknown	109	1,655
	2,071,783	2,049,414

Saudi Arabia sugar imports, 1987[16]

Imports of sugar by Saudi Arabia increased to 306,700 tonnes, raw value, up from 274,800 tonnes in 1986. The latter figure was lower than the 297,200 tonnes of 1985 and much lower than the 553,600 tonnes imported in 1984. Principal sources in 1987 were EEC countries (Belgium, France, Germany, Holland and the UK), all of which supplied white sugar.

New sugar factory in Burma[17]

A new sugar factory is under construction at Yedashe in the Pegu area of Burma, about 300 km north of Rangoon. Crushing capacity is 1500 t.c.d. and it will produce plantation white sugar by a double-sulphitation process. The main supplier is Tsukishima Kikai Co. Ltd. of Japan, while other Japanese companies will provide specialist plant.

Fiji sugar expansion[18]

Fiji is aiming to increase its sugar production in the coming years. Production in the 1988 seasson, which starts in May, is expected to exceed that of 1987 which, owing to political tension at the beginning of the crop and also to drought, was below the originally expected quantity, reaching only 401,000 tonnes, tel quel, against the record outturn of 500,000 tonnes in 1986. In 1989 production is expected to be 525,000 tonnes, according to the chief executive of the Fiji Sugar Corporation which has started measures to restore 1989 plantings to the levels before the 1987 drought. All except one cargo of 1987 production has been sold and industry earnings will exceed 215 million Fiji dollars. There is no shortage of markets for Fiji's sugar and, in addition to exports at preferential prices to the EEC, Fiji is currently exporting to China, Malaysia and New Zealand.

Malawi sugar exports, 1987[19]

	1987	1986
	tonnes, raw value	
Burundi	845	813
China	12,215	0
EEC	42,456	16,525
Mozambique	17,006	36,268
Portugal*	-	13,590
Rwanda	151	387
Sudan	482	0
Tanzania	310	0
USA	8,485	412
Zaire	26,083	25,359
Unknown	8,098	0
	116,131	93,354

*Included under EEC for 1987

Czechoslovakia beet crop, 1987[20]

A total of 6,893,000 tonnes of sugar beet was harvested in 1987, compared with 7,134,000 tonnes in 1986 and an average of 7,296,000 tonnes in 1981/85. The beet yield per hectare was 35.83 tonnes, against 36.71 tonnes in 1986 and an average of 34.79 tonnes in 1981/85. From these figures it is calculated that the beet area fell from 194,000 hectares in 1986 to 192,000 ha in 1987.

Cane alcohol study in South Africa[21]

The government of South Africa has appointed a committee to investigate the feasibility of a plant to produce alcohol from sugar cane and also to determine whether it would be a viable economic proposition to blend it with petrol. In the event that the government approves, it is proposed to set up a 70 million rand alcohol plant that would use more than 10% of Natal's cane crop. The plant would be operational by 1989 and would eventually produce 1250 million litres of alcohol.

Poland campaign results, 1987/88[22]

In the 1987/88 campaign 1,675,000 tonnes of sugar was produced from 13.6 million tonnes of beets. This result is poorer than that of 1986/87, when 1,770,000 tonnes of sugar was produced.

10 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120,** 147.
11 *Mauritius Sugar News Bull.*, 1987, (12).
12 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120,** 151.
13 *Czarnikow Sugar Review*, 1988, (1771), 45.
14 *Czarnikow Sugar Review*, 1988, (1771), 45.
15 *I.S.O. Stat. Bull.*, 1988, **47,** (2), 35 - 36.
16 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120,** S123.
17 *Sugar y Azúcar*, 1988, **83,** (3), 11 - 12, 14.
18 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120,** 191.
19 *I.S.O. Stat. Bull.*, 1988, **47,** (2), 24 - 25.
20 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120,** 185.
21 F. O. Licht, *Int. Sugar Rpt.*, 1988, **120,** 153.
22 *Zuckerindustrie*, 1988, **113,** 255.

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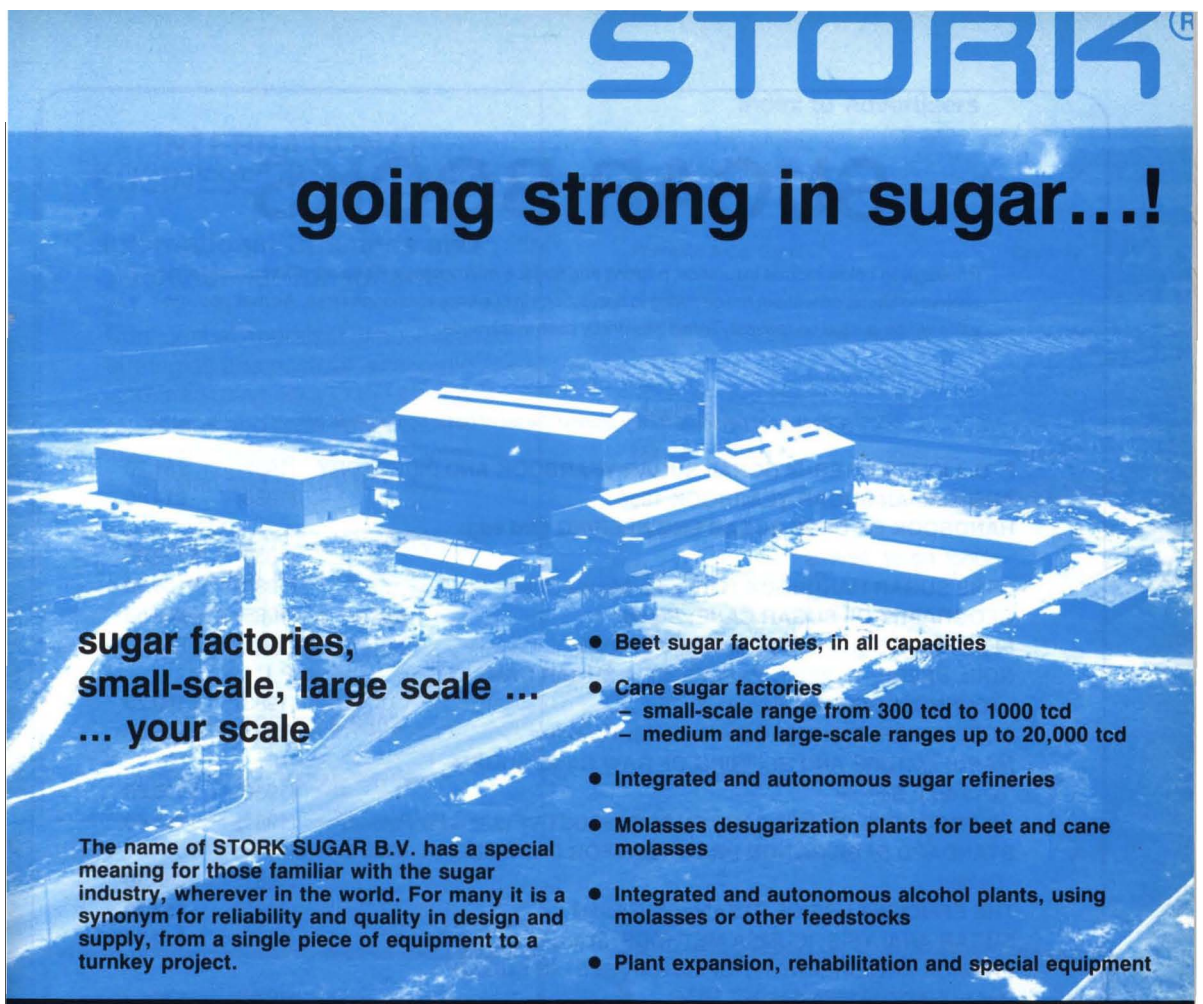

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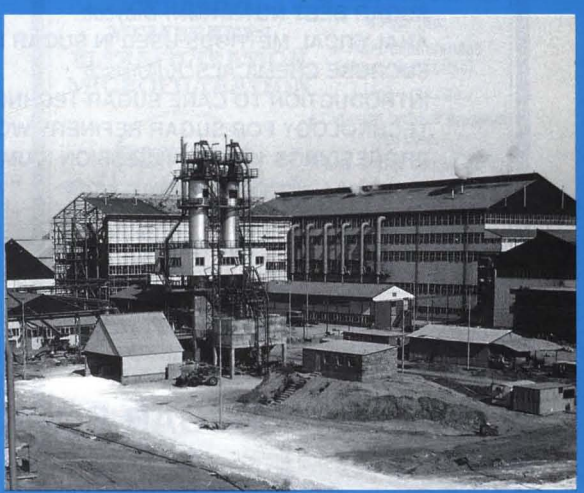

△ Small scale sugar factory at Kyauk Taw-Burma. The factory has a capacity of 350 tonnes of cane per day, and has a Stork distillery producing 5000 liters of alcohol per day from molasses.

Stork Sugar

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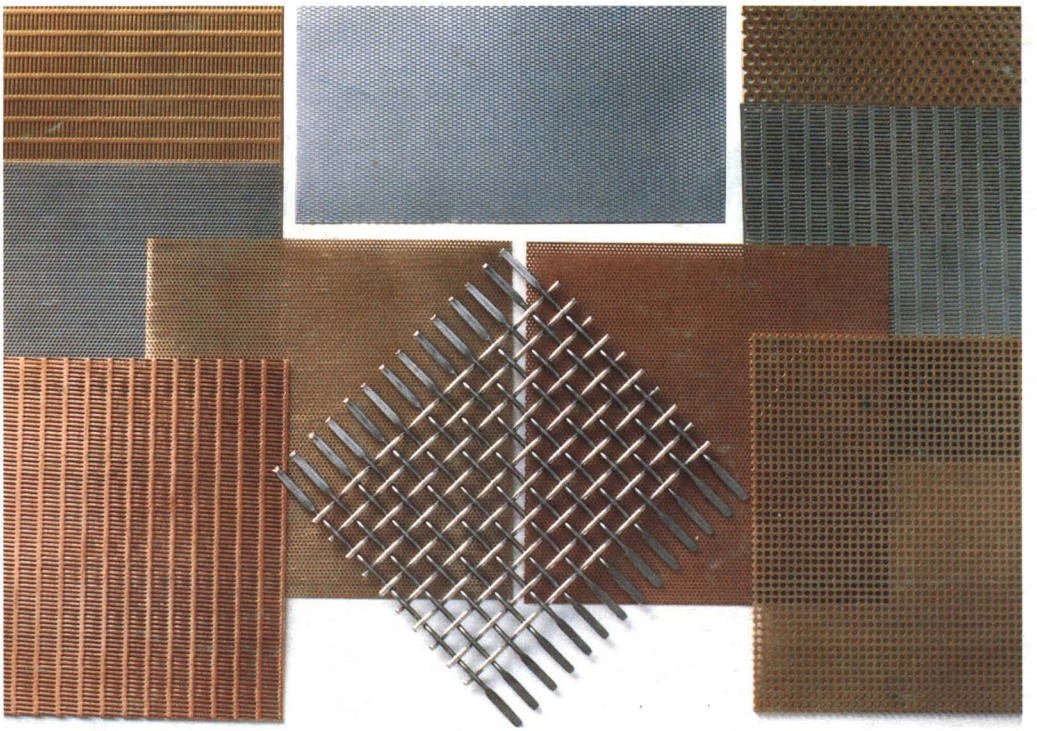

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