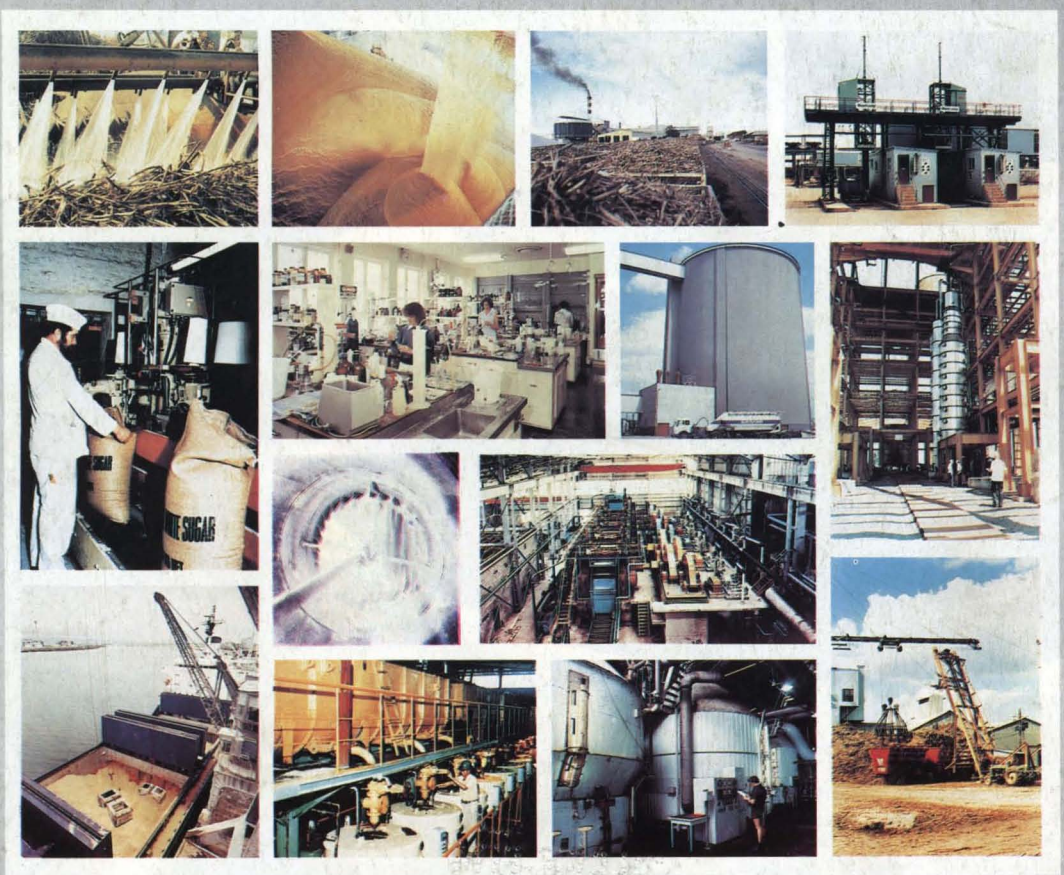
INTERNATIONAL SUGAR JOURNAL



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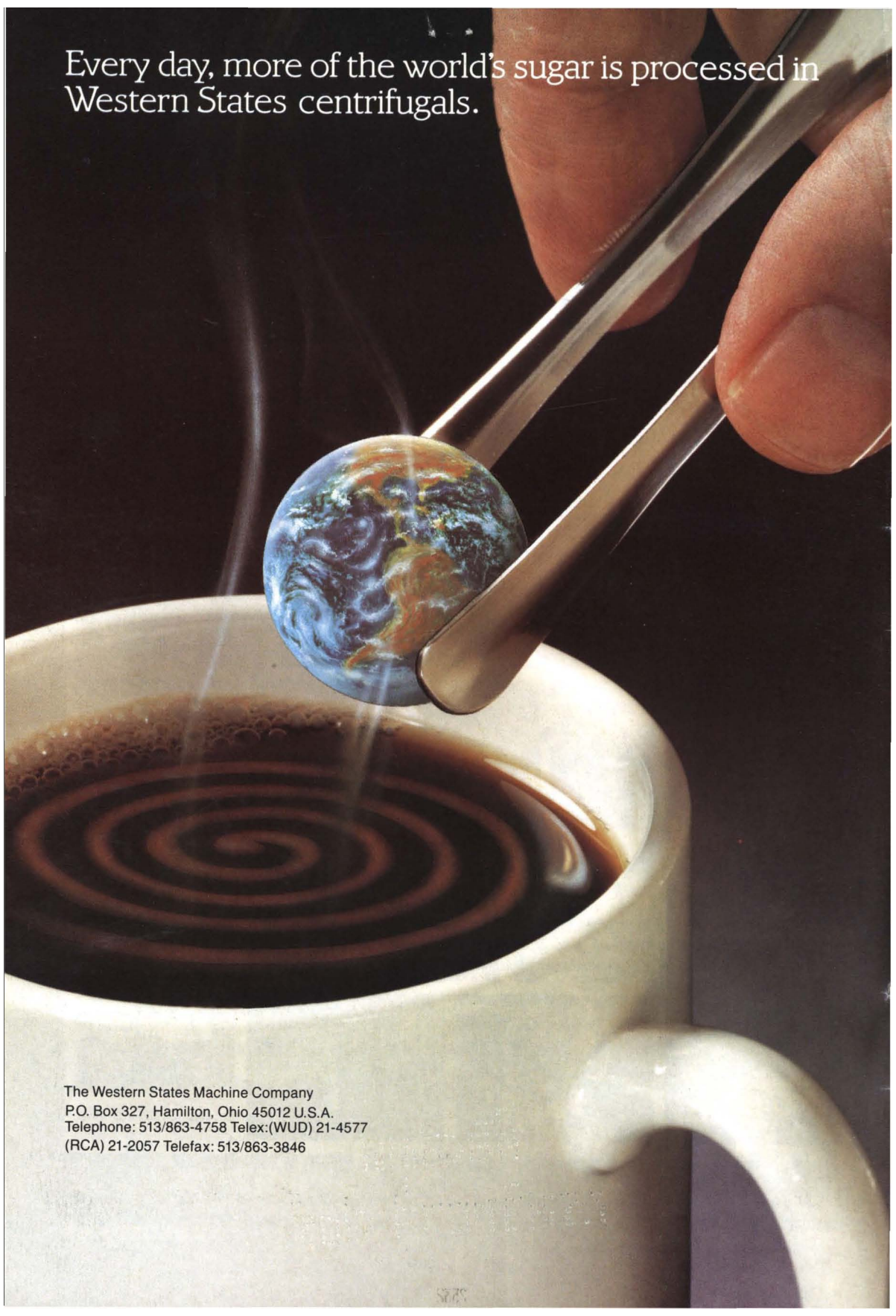
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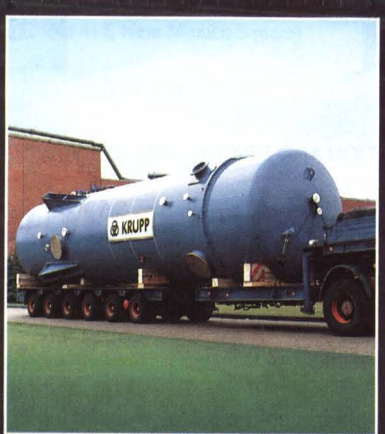

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ETHIOPIAN SUGAR CORPORATION

FINCHAA SUGAR PROJECT - DESIGN, SUPPLY, CONSTRUCTION AND COMMISSIONING OF SUGAR FACTORY AND ETHANOL PLANT (FP3)

The Ethiopian Sugar Corporation invites applications from suitably qualified and experienced Contractors wishing to be prequalified as Tenderers for the Design, Supply, Construction and Commissioning of a conventional Double Sulphitation Cane Sugar Factory, together with an Ethanol Plant producing Anhydrous Alcohol from Molasses. The initial capacity of the factory will be 4,000 tonnes of cane per day and should be capable of expansion to 6,000 tonnes of cane per day at a future date.

The Contract will be financed jointly by the African Development Bank and the Government of Australia. A selected supplier from Australia will supply the cane yard and mills component of the factory. This will be given as a free supply to the main contractor. Full technical and contractual details will be given at time of tender.

Applications for prequalification will be accepted from persons and companies acting either independently or in consortium.

The relevant prequalification document entitled:

Finchaa Sugar Project
Prequalification of Tenderers
Turnkey Responsibility for Design, Supply and Erection of a Sugar factory and Annexed Ethanol Plant

will be available on payment of a non-refundable fee of US$ 100, from:

The General Manager
Ethiopian Sugar Corporation
(Philips Building Room 412, Near Mexico Square)
PO Box 133
Addis Ababa
Ethiopia.

Tel	251 1 159700
Fax	251 1 513488
Tlx	21038

Formal applications for prequalification should be received in the manner prescribed in the said document not later than 30 August 1989, at the above address.

Those applicants who are prequalified will subsequently be invited to submit tenders.

PEOPLES DEMOCRATIC REPUBLIC OF ETHIOPIA

ETHIOPIAN SUGAR CORPORATION

FINCHAA SUGAR PROJECT - IRRIGATION CIVIL WORKS (FP4)

The Ethiopian Sugar Corporation invites interested contractors to tender for the construction of the Irrigation Civil Works for the Finchaa Sugar Project. The works, which will be financed jointly by the Government of Ethiopia, the African Development Fund and the African Development Bank, comprise:

(1) Mass concrete diversion weir across the Finchaa River and canal headworks — Concrete - 608 m^3

(2) 36 kilometres of concrete lined canal -

Earth Excavation	290,000 m^3
Embankment	277,000 m^3
Concrete	12,000 m^3

(3) 23 number inverted siphons - Concrete 2,000 m^3

(4) 44 number cross drainage culverts

(5) 5 number irrigation pump stations including side weirs in the canal and installation of pumps, delivery pipework, and manifolds (pumps and auxiliary fittings to be supplied by Owner)

(6) 3 number gravity offtakes to irrigation pipelines

(7) 4 number canal overflow weirs

(8) 270 kilometres of buried irrigation pressure mains and fittings (excluding supply of mains and fittings)

(9) A factory pump station including installation of pumps, discharge pipework, valves and manifold together with a gabion river weir (excluding supply of pumps, pipes, valves)

(10) 60 kilometres of road surfaced with granular material having 31 culverts

Joint ventures between Ethiopian and foreign contractors will be allowed.

Tender documents may be obtained from:

The General Manager
Ethiopian Sugar Corporation
Philips Building
Near Mexico Square
PO Box 133
Addis Ababa
Ethiopia

Tel 251 1 159700
Fax 251 1 513488
Tlx 21038

upon payment of a non-refundable fee of US $250.

The closing date for application will be 15th August 1989.

PEOPLES DEMOCRATIC REPUBLIC OF ETHIOPIA

ETHIOPIAN SUGAR CORPORATION

FINCHAA SUGAR PROJECT - SUPPLY C & F OF VEHICLES (FP23A)

The Ethiopian Sugar Corporation invites interested suppliers to tender for the Supply C & F of Vehicles for the Finchaa Sugar Project. The contract, which will be financed by the African Development Bank, comprises:

Description	Quantity
Tipper Truck	1
4 WD Senior Personnel Site Vehicle	4
4 WD General Purpose Site Vehicle	6
4 WD Pick-up	7
4 WD Pick-up	17
Saloon Car	7
2 WD Minibus	2

Tender documents may be obtained from:

The General Manager
Ethiopian Sugar Corporation
Philips Building
Near Mexico Square
PO Box 133
Addis Ababa
Ethiopia

Tel	251 1 159700
Fax	251 1 513488
Tlx	21038

upon payment of a non-refundable fee of US $100.

The closing date for application will be 30th August 1989.

News and views

World sugar prices

The decline in sugar prices during the latter part of May reversed during June. When it was disclosed that China had bought five cargoes of sugar world prices reacted immediately and the London Daily Price for raw sugar rose from $276.20 on June 1 to $288 the next day while that for white sugar rose from $344.50 to $353. This positive effect was soon counterbalanced by the political unrest in China, however, and the LDP fell back to $280.40 on June 6 and the LDP(W) to $350. Demand from Africa and the Middle East for white sugar, plus the belief that China would need to acquire more sugar, stopped the market from falling further, and belief that India would require up to 500,000 tonnes of white sugar helped to firm prices which rose steadily to $299 and $372, respectively, by June 14. Unexpectedly, the USSR purchased 140-150,000 tonnes of white sugar and sugar prices promptly rose. The head of the Soviet buying agency said that this would be all that was required, but he had made a similar statement earlier and so the market was not convinced that buying was complete. Prices continued to rise, especially for white sugar, the LDP(W) reaching $452 by June 29 before falling slightly to $450 on the last day of the month. The LDP was drawn up with the strong white sugar market and ended the month at $350.20. The tightness of white sugar supplies and strong demand thus brought the premium over raws from $68 at the start of the month to $100, and it seems likely that prices will go higher.

Sugar supplies for 1989/90[1]

It is no secret that sugar supplies are tight after four years of stock reductions. This has inevitably led to higher prices and supplies for both raws and whites are tight. The raw sugar market this year will be saved by Thailand's and Cuba's greater export availability, without which the market would be in real difficulties. Even though the raw sugar exports of these two countries are forecast to rise sharply this year, total availabilities will be just sufficient to cover demand. This shows how delicate the balance is and that the raws market is now entirely dependent on these two countries unless production in Brazil comes back.

At first the situation looks equally critical in the whites market. Even though the largest white sugar exporter, the EEC, produced 5% more in 1988/89, supplies could be very tight indeed unless India and Pakistan appear as exporters. However, large-scale diversion of cane to gur manufacture in Uttar Pradesh, where about 60% of India's gur output is produced, has meant that sugar mills in the area have stopped crushing prematurely. Hence production estimates for the whole of India have had to be scaled down. The situation in Pakistan is also far from clear and it remains to be seen whether the producers actually get permission to export.

The situation has been further complicated by the internal problems in Brazil, which caused difficulties when it came to formulating its sales strategy. From September 1988 to February 1989 white sugar exports were not more than 380,000 tonnes, raw value, 39% less than was exported in the same period a year before. Although exports may pick up, overall exports of white sugar will remain below the 950,000 tonnes exported in 1987/88.

The precarious situation in both markets shows that output will have to rise next year to prevent the possibility of a major disaster. World consumption will rise to 110 - 111 million tonnes in 1989/90 – an increase of 2 - 3 million tonnes. At present it is impossible to say whether output will rise sufficiently to prevent any further draw-down of stocks, but only a slight fall in stocks will be enough to send a sharp price signal and prices of 20 cents/lb are not unthinkable at least for a limited period of time. Such prices, of course, will lead to a sharp reaction on the import side and the whites market will be hit first as white sugar import demand is more price elastic than its raw sugar counterpart. At the same time, relatively high prices and the hope of even higher levels will stimulate production; the old boom and bust cycle. It can therefore only be hoped that good weather conditions will spare the sugar market another boom.

Reversal in Indian sugar supply prospects

The Indian government is now expecting only 9.0 million tonnes of white sugar to be produced from the current crop and possibly even less[2], against an earlier forecast of more than 10 million tonnes. Reports of cane diversion to gur manufacture have been received for some months but the effects of this have been masked by a healthy rate of sugar output which, at least until the end of March, was showing a substantial lead over progress in the corresponding months of the 1987/88 season. Production from the beginning of the season in October to the end of March reached 7,547,000 tonnes, white value, or just over 500,000 tonnes more than for October 1987/March 1988.

This was occurring side by side with keen bidding for cane by the gur manufacturers, mostly at higher prices than the factories could meet. Consequently cane supplies have run down rapidly and in more and more cases sugar factories have had to close early for lack of raw material. By the middle of May only 48 factories were still crushing against 157 in mid-May 1988. It seems that the cane crop may have slipped from 207/210 million to 200/205 million tonnes, and diversification to gur has cut the proportion delivered to factories from 47.75% last season to around 44/45%.

The boosted gur production will to some extent have helped to moderate requirements for white sugar to some 9.6/9.8 million tonnes but this still represents a shortfall which will reduce stocks. Earlier plans to export 100,000 tonnes of white sugar have now been abandoned but it may be some months

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 205 - 206.
2 *Czarnikow Sugar Review*, 1989, (1785), 69 - 70.

before the authorities allocate foreign exchange resources to the import of sugar. With the world market picture for white sugar already very strong, the appearance of another volume buyer during the second half of this year will further underpin prices at any sign of uneasiness.

GATT ruling on Australian complaint over US sugar policy

A special GATT panel has ruled in favour of an Australian complaint that the manner in which the United States has used certain tariff authority to operate its sugar import quota violates the GATT[3]. After the US and Australia reviewed the panel's finding, it was voted on and confirmed by the GATT Council on June 21.

Australian officials requested the panel last July after informal consultations with the US regarding the sugar quota failed to satisfy their concerns. The US derives authority to implement its annual sugar import quota from headnote two of the US tariff schedule and has maintained that its use of this authority is consistent with other GATT regulations. The panel's decision is sure to intensify a debate that has been going on for years about the operation of the US sugar program.

Depending on the findings, options open to the US in response to the GATT decision include compensating Australia or allowing Australia to retaliate against US products. Further, the US could begin using duties to regulate sugar imports; this could however pose problems for countries that receive preferential tariff treatments under the Caribbean Basin Initiative. In addition, the US could look into using its Section 22 of the Agricultural Adjustment Act of 1933 to set sugar imports; however, Australia has said it would likely challenge any US attempt to run its import quota through other means.

The US Sweeteners Users Association has told the Under-Secretary for International Affairs and Commodity Programs at the US Department of Agriculture that the sugar policy could cost the Administration millions of dollars in compensation suits[4]. Australia is only one of the many sugar exporting nations that have seen their share of the US import market decline rapidly in recent years owing to the largely protectionist nature of Washington's import policy.

The Secretary of Agriculture has also said[5] that the US should accept the panel's decision since to block the ruling would undermine US efforts to strengthen the GATT's dispute settlement mechanism. He said that "hysteria and consternation" had gripped the US sugar industry but emphasized that the US would have a "reasonable period of time" to bring its program into compliance with GATT rules, which will certainly require months, and changes might be able to await the 1990 Farm Bill.

World sugar balance, 1988/89[6]

F. O. Licht's third estimate of the world sugar balance for 1988/89 confirms that the situation is tighter than in any year since the last boom in 1980/81. In May 1980, the average daily price of the International Sugar Organization was already 30.8 cents/lb and it subsequently rose to a peak of 40.55 cents/lb in October. By contrast, in May this year, prices hardly exceeded 12 cents/lb.

Production rose sharply in 1981/82, but a similar rise appears unlikely for 1989/90. There are growing signs that production next year may not meet demand, which would imply another reduction in stocks. Against this background, current prices seem to be far too low; however, most market participants have become more cautious and regard even the modest rise in prices this year with great scepticism. First of all, there is the memory of the long period of low prices from 1984 to 1987, which makes it hard to believe that prices could rise again to 20 cents/lb or more. Second, it has become general knowledge that there have been significant structural changes on both the supply and demand side which will accelerate and strengthen the response to higher prices.

Owing to unexpected production problems in India and the scaling down of sugar production in Brazil in favour of alcohol output, the 1988/89 sugar balance has taken a change for the worse. 1989/90 will start with an extremely low level of stocks, which makes the market highly vulnerable to weather-induced supply shocks, while even without such a shock the situation will remain tight. The balance figures are as follows for the September/August crop years:

	1988/89	1987/88
	tonnes, raw value	
Initial stocks	32,562,000	36,032,000
Production	106,644,000	104,587,000
Imports	29,057,000	27,599,000
	168,263,000	168,218,000
Consumption	108,641,000	107,480,000
Exports	29,052,000	28,176,000
Final stocks	30,570,000	32,562,000
" "		
% Consumption	28.14	30.30

Thailand sugar output, 1988/89[7]

Final production for the 1988/89 season in Thailand was 3,898,519 tonnes, tel quel, from 36,666,934 tonnes of cane. This is calculated to be equivalent to 4,079,549 tonnes, raw value, and compares with production in 1987/88 of 2,704,408 tonnes. The final tel quel extraction rate of 10.632% represents a new record for the country and illustrates the effects of the almost perfect weather conditions enjoyed by the crop throughout the growing season. There have been suggestions that the area devoted to cane will be expanded by some 10% for the coming crop, but this is unlikely to be translated directly into potential sugar gains unless the weather repeats the optimum benefits of 1988/89. A drop in yields or extraction rates could easily counteract the suggested increase in cane area while, on the other hand, a modest improvement over this season's good results is possible.

3 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 252.
4 *Public Ledger's Commodity Week*, May 13, 1989.
5 *ibid.*, June 10, 1989.
6 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 261 - 269.
7 *Czarnikow Sugar Review*, 1989, (1786), 87.

Product news

On-line control of sugar quality

Assens Sukkerfabrik is one of the five sugar factories of DDS (De Danske Sukkerfabrikker). Two years ago Assens Sukkerfabrik asked the Technological Institute of Denmark to review all methods for on-line monitoring of the function of centrifugals. In its report the Institute concluded that the Neltec colour control system was by far the best. The system was given a preliminary test in the final days of the 1987 campaign with promising results.

An investigation was performed in 1988 at Assens to find out if the Neltec colour controller was sufficiently sensitive to monitor sugar colour. The two measuring units were placed 1 metre above the sugar, as illustrated. The measurement area was 40 × 60 mm. Samples from the Braunschweig sugar institute were examined; these samples consisted of large crystals without sugar dust.

Type	Neltec purity
0	80 - 81
1	74 - 75
2	68
3	61 - 62
4	54 - 55
5	46
6	40

Sugar from factories were then examined; samples A and B were large crystals with little dust, while samples C and D were smaller crystals with some dust. The sugar colour was determined at the Nakskov sugar factory of DDS.

Sample	Sugar colour	Neltec purity
A	11	82
B	17	76
C	21	77
D	28	76

It is clear that smaller crystals and/or more dust reduces the sensitivity of the Neltec colour controller. The influence of variations in distance was examined using tests conducted on sugar of type 3. At a distance of 89 cm, Neltec purity was 57 - 58; at 100 cm 56 - 57; and at 113 cm 56. Thus it may be seen that variations in distance have little influence on the colour measurement.

The influence of sugar dust was examined by insertion of two polarization filters in the path of the light rays, one in the incident ray and one in the reflected ray. The filters cause a significant reduction in the amount of detected light. To compensate for this the distance between sugar and controller was reduced to 50 cm; this change shifted the purity level.

Sample	Sugar colour	Neltec purity without filters	Neltec purity with filters
A	11	83	63
B	17	76	54
C	21	77	53
D	28	76	50

It was concluded that the Neltec colour controller has sufficient sensitivity for on-line monitoring of variations in sugar colour, that sugar dust reduces the sensitivity of the controller, and that application of polarization filters counteracts this reduction.

Before the 1988 campaign the system was installed at Assens Sukkerfabrik. The system was placed over a grasshopper conveyor transporting sugar from the centrifugals. The measuring area was adjusted to match the width of the conveyor. The tests have shown that the system has a good sensitivity and stability. The system gives an immediate alarm when a loading valve is leaking or spray nozzles are plugged. As a result any brownish sugar is stopped before reaching storage.

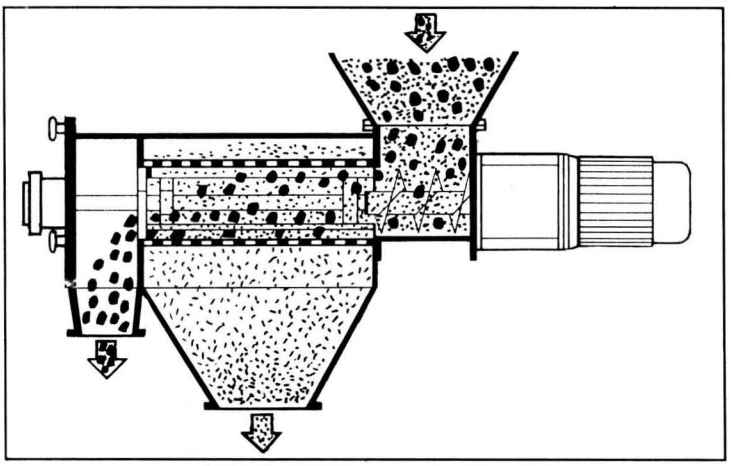
As a consequence of the tests and its experience Neltec is now offering a system for continuous monitoring of variations in sugar colour. This system can give information on essential changes in sugar colour in the periods between laboratory tests.

Further details:

Neltec,
Farvergarden 10,
DK-6541 Bevtoft,
Denmark.

Centrifugal sifting machines

A new generation of centrifugal sifting machines has been introduced by Powtek Ltd. The CSM range is built to food industry quality standards and is capable of sieving powder and granular sugar without damage to the screen. Feed material, transferred from the inlet into the sieving chamber by a feed worm (which can be metered to give restricted feed rate), is beaten against a sieve screen by a paddle assembly. Particles smaller than the screen apertures are discharged through the fines outlet chamber whilst oversize material is carried along the basket and discharged from the oversize end. Vibrations set up in the man-made fibre screen assist in preventing blinding and also enable the screens to be self-cleaning. The screens are quickly changed and tensioned without special tools and excessive wear is eliminated as the paddle assembly does



not come into contact with it. The CSM will operate size separation down to 100 microns, with no upper limit. It is suitable for sieving sugar on a 3 mm screen at around 100 tonnes/hour or icing sugar on a 125 micron screen at around 250 kg/hr. Powtek equipment is used in the sugar industry for milling and separation of different fractions: fine granulated, caster, icing, fine icing, etc. Only one size is separated per machine, although fractionation can be achieved using a number of them in series. The range includes ten standard models with capacities up to 300 cu. m./hr and with screen aperture sizes from 50 microns to 10 mm.

Further details:

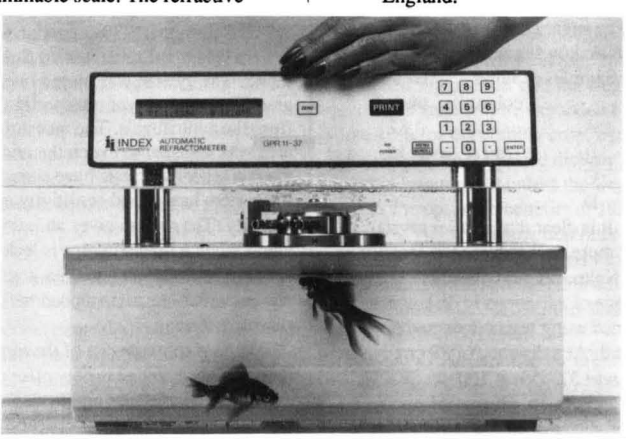
Powtek Ltd.,
Victoria House,
Cavendish Street,
Ashton-under-Lyne,
Lancs. OL6 7DJ, England.

New watertight refractometer

The need of many industries for a simple to use, accurate, and above all, watertight refractometer that can be used in factory or laboratory situations has been answered by Index Instruments Ltd. The new GPR11-37 refractometer has been specially developed for use in areas where equipment is likely to get wet frequently, for example, during general cleaning. The new machine has a fully sealed base unit and water resistant display. It can be immersed in water (up to the display panel) as shown in the photograph and still work perfectly. The GPR11-37 has been designed so that it can be used in production or laboratory areas, especially of sugar factories and refineries. Fully solid-state electronics and elimination of all moving parts ensure excellent reliability and low maintenance. Measurements are made with a virtually indestructable sapphire prism and results are on an LCD display. The machine has four measurement scales – refractive index (RI), Brix, temperature-corrected Brix and a user-programmable scale. The refractive index range is 1.32 to 1.70. This is much wider than most other automatic refractometers and ensures versatility. The sapphire prism is thermostatable to ensure long-term stability. Samples can be read at any temperature from 10°C to 70°C. The sample temperature is displayed automatically with each reading. Readings are made to an accuracy of 0.0001 RI (0.1°Brix). The built-in touch-sensitive keyboard is very easy to use. An automatic full self-check ensures correct operation, clear instructions and condition statements being given on the LCD display. Twin RS232 output ports allow connection to a printer and/or remote data collection facility. Readings can be taken "on command" from either the display panel or remotely. Alternatively, the system can be set to print automatically each time the reading changes. This allows the GPR11-37 to be connected, through a wide range of flow-through cells, to a continuous "on-line" process analysis system. For absolute safety, the GPR11-37 has a separate power supply. Only safe, low voltages within the unit ensure that it can be immersed in water with total safety.

Further details:

Index Instruments Ltd.,
Bury Road Industrial Estate,
Ramsey, Huntingdon,
Cambs. PE17 1NA,
England.



Flotation-clarification in sugar refining. Part I.

By Fok Hon-Jun
(Guangdong Cane Sugar & Paper Industries Corp., P.O. Box 801, Guangzhou, China)

Introduction

Since Williamson first created a system to combine phosphatation and flotation in 1919[1], which process was termed "phosflotation" by Saranin[2] many advances have been achieved and new flotation-clarification processes have been developed in the sugar industry. These processes have improved the quality of the sugar produced, and in some cases, increased the capacity of sugar plants. One important advance is the extensive application of highly efficient polyacrylamide flocculants, which greatly increased the velocity and the stability of the flotation-separation process. Another advance is the application of special cationic surfactants such as "Talofloc"[3], or dioctadecyl dimethyl ammonium chloride, which combines with the negatively charged colorants (the major portion of colour) as well as other anionic impurities, which then precipitate together. By this means, the efficiency of colour removal and clarification has been increased to a high level. However, these chemicals are still too expensive for many sugar plants, especially when the world price of sugar is low.

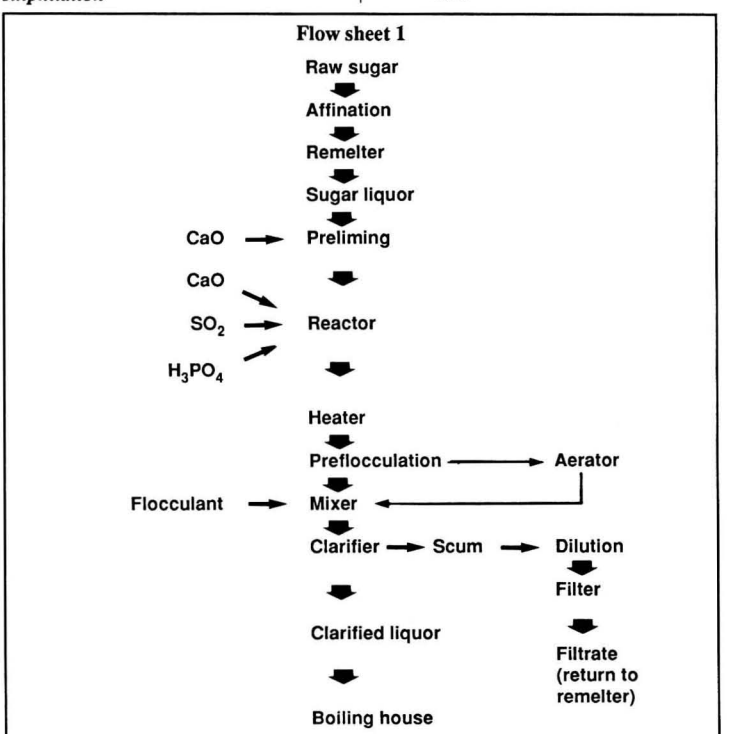
In China, most cane sugar factories produce plantation white sugar using a double sulphitation or double carbonatation process. After the grinding season, some of them play the role of a refinery and produce white sugar from imported raw sugar. Since the 1970's, intensive research on phosflotation and other methods of flotation-clarification have been carried out by the author and his colleagues. Based on this research, a new, highly efficient and low cost system has been developed and brought into use in several sugar factories in the Guangdong Province of China. It is a process which combines phosflotation with either sulphitation or carbonatation in which all of the precipitate is removed from the liquor by flotation. Compared with decolorization of about 30% for the simple phosflotation process, this new system has a colour removal of 50 to 70%, depending on the manner of combination and the working conditions of the process, which can be selected flexibly according to the quality of the raw sugar treated and the level of clarification efficiency desired.

There exists a special problem for this new system, as $CaSO_3$ and $CaCO_3$ precipitates are heavier and more difficult to float than calcium phosphate and, as the amount of these precipitates is much larger than that in the phosphatation process, it is quite difficult to make such heavy precipitate float steadily and quickly. To solve this problem, some new equipment for aerating the liquor and for creating good flocculation and flotation have been designed by the author. They have given satisfactory results and enabled this system to run smoothly.

Combination of phosflotation and sulphitation

When the phosflotation process was first applied in our sugar factories to clarify raw sugar liquor, SO_2 was not used. It has been proved in practice, however, that the quality of sugar produced can be improved by addition of small amount of SO_2 into the clarified liquor after phosflotation, and the effect is even better when a higher level of sulphitation is applied prior to phosflotation. In the latter method, the $CaSO_3$ precipitate forming in the liquor can be removed together with calcium phosphate by flotation, and both functions of colour removal – by SO_2 (mainly based on chemical reaction) and by $CaSO_3$ (mainly based on adsorption) – can be utilized, giving a higher decolorization of 50 to 65%, depending on the level of SO_2 added. The flowsheet of this combined process is shown below:

1 U.S. Patent 1,317,607.
2 *Sugar Technol. Rev.*, 1972, **2**, 1 - 72.
3 Bennett *et al.*: *Proc. 14th Congr. ISSCT*, 1973, 1569 - 1590.



The main operating conditions are:

(1) Melter liquor: 61 - 63°Bx, 60 - 65°C;
(2) pH of preliming: 8.2 - 8.8;
(3) Level of SO_2 added: 0.4 - 1.4 g/litre;
(4) Dosage of H_3PO_4: 300 - 500 ppm P_2O_5 on sugar solids;
(5) Heating temperature: 75 - 80°C;
(6) Dosage of flocculant: 10 - 15 ppm on solids;
(7) pH of clarified liquor: 6.6 to 6.8.

The efficiency of colour removal by the process increases with the amount of SO_2 added, and thus can be adjusted to the desired level according to requirement. When the raw sugars treated are of good quality, for instance, with a colour value below 4000 MAU, the addition of 0.4 to 0.8 g/l of SO_2 is sufficient to produce white sugar of normal quality (90 to 120 MAU); if it is increased to 1.0 or even 1.4 g/l, superior white sugar with a low colour of 80 or down to 60 MAU can be produced. On the other hand, when the raw sugars are poor in quality, such as with a high colour of over 8000 MAU, considerable problems would occur in the refining process, so a high level of sulphitation is necessary for these raws to keep the process running normally. For instance, in 1987, Mei-San sugar factory in Guangdong Province (with a crushing capacity of 6000 tonnes of cane per day) received imported raws with a dark brown colour. During the two months refining period, by controlling the level of SO_2 at 1.2 to 1.4 g/l, the quality of white sugar was kept normal. Some colour figures during this period were as follows:

Raw sugar:	7200 - 8500 MAU
Melter liquor:	2200 - 3200 MAU
Clarified liquor:	900 - 1300 MAU
Decolorization:	56 - 63%
White sugar:	100 - 120 MAU

During the milling season in our sugar factories, phosflotation is also used for syrup clarification, combined with juice clarification in which 1.2 to 1.4 g/l of SO_2 is added. Nevertheless, it has been proved that, when the clarified syrup absorbs a small amount of SO_2 of about 0.2 g/l again, the effect is even better. Superior white sugar with the following quality index has been produced in Zhong-San sugar factory by this process:

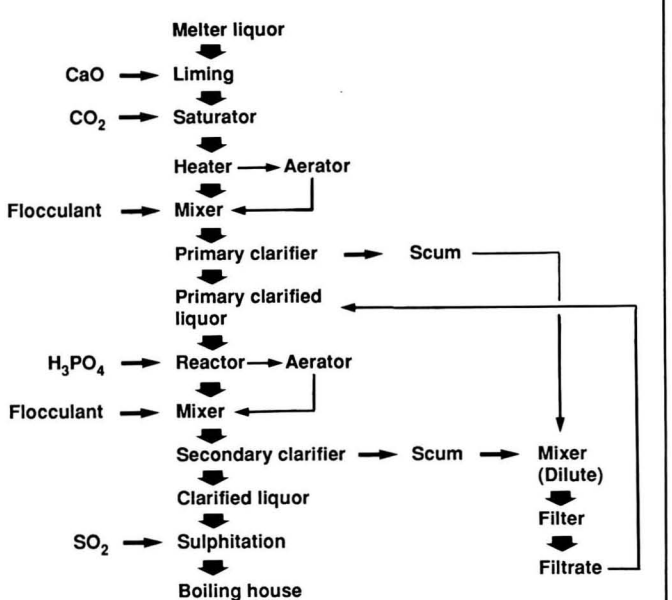
Pol:	99.8
Reducing sugars:	0.016%
Moisture:	0.036%
Ash content:	0.022%
Colour value:	64 MAU
Insoluble matter:	10.2 mg/kg
Residual SO_2:	7.5 mg/kg

Moreover, it is a significant phenomenon that these sugars are of good keeping quality. Some samples made in 1983 have been stored in white glass bottles, without sealing to make them air-tight. At the present time, although they have absorbed moisture from the air and have turned wet and sticky, they still remain quite white and bright, without apparent yellowing or darkening. In this process, both juice and syrup sulphitation are necessary. According to our experience over a long period of time, both sulphitation and phosphatation each has its own function of removing colorants and other impurities. They can complement each other, but the one cannot completely replace the other. This is also true of the juice and syrup clarification process.

The effectiveness of phosphatation has been studied in detail by many researchers[4] and has been accepted commonly in the sugar industry; but on the function of sulphitation, different evaluations exist. In 1984, based on a series of researches, Shore pointed out[5] "SO_2 is effective in inhibiting the colour forming reactions which occur during the storage of sugar as well as during the processing stages", and "The major role of SO_2 as used in the factory process is that of inhibiting the non-enzymic browning reactions", and "SO_2 also has a role in inhibiting colour formation by enzymic reactions". These conclusions are also confirmed by our experience.

It is worthwhile to mention the fact that, in most sugar factories in

Flow sheet 2



4 Bennett: *I.S.J.*, 1974, **76**, 40 - 44, 68 - 73.
5 Shore *et al.*: *Sugar Technol. Rev.*, 1984, **12**, 1 - 99.

Guangdong Province, both juice and syrup sulphitation are performed respectively using tubular reactors, which work under the condition of a slight vacuum created by juice or syrup injection. This equipment is of simple construction, having a high absorption efficiency of over 92% and with only a very short retention time of a few minutes.

Combination of phosflotation and carbonatation

The carbonatation process is well known to be more effective in removing colorants and other impurities than sulphitation; however, it requires a great deal of capital investment for equipment and produces a large amount of alkaline filter mud, the disposal of which is becoming increasingly difficult because of pollution problems.

To make use of the advantages of carbonatation but avoid its shortcomings a new system, consisting of low-level carbonatation and phosflotation, has been developed in Guangdong and put into use with satisfactory results. This process involves two steps of treatment and flotation as shown in Flow sheet 2:

The main operating conditions are as follows:

(1) Melter liquor: 61 - 63°Bx, 60 - 65°C
(2) Liming: 0.4 - 0.5% CaO
(3) Final pH of saturation: 8.0 - 8.5
(4) Heating temperature: 78 - 82°C
(5) Dosage of flocculant: primary, 20 ppm on solids; secondary, 10 ppm on solids
(6) Dosage of phosphoric acid: 200 ppm P_2O_5 on solids
(7) Level of sulphitation: 0.2 - 0.4 g SO_2 per litre
(8) Final pH of clarified liquor: 6.6 - 6.8

High efficiency of colour removal is obtained by this process. Some practical figures of colour were as follows:
Melter liquor: 3200 - 3800 MAU
Final clarified liquor: 1000 - 1200 MAU
Colour removal: 66 - 70%
White sugar: 60 - 80 MAU

Although the raw sugar is of a very dark colour, this process yields a white sugar of low colour and sparkling appearance.

In this process, the amount of lime added is reduced considerably and, hence, the amount of filter mud is also much less than with traditional carbonatation. Since the mud contains phosphate and is lower in alkalinity, it is a suitable fertilizer for acid soil, and the problem of pollution is decreased to a minimum.

The CO_2 used in this process may be obtained from either alcohol fermentation or flue gas, but the former is much better in this application. When fermentation gas is used, the equipment of this system can be considerably simplified because this gas is nearly pure CO_2. A tubular reactor used for CO_2 saturation of sugar liquor designed by the author has resulted in good performance and high efficiency of CO_2 absorption. The gas enters the tubular reactor and mixes with the liquor for only a few seconds, during which about 70% of the CO_2 is absorbed; the mixture then enters a small tank where CO_2 is further absorbed to approximately 90% in about ten minutes. This process is easy to control, the equipment and gas pipe are of small size and quite simple, and the power consumption is small. The greatest benefit is obtained when this process is applied in a plant which has adjacent alcohol production. Investment cost for this simplified carbonatation process is much lower than with traditional carbonatation. On the other hand, if flue gas is used to provide CO_2, the saturator, washing equipment and gas piping are larger and more complicated, and the power consumption is much bigger than when using fermentation gas.

The precipitated $CaCO_3$ formed in the liquor is around 10 g/l, and such an amount of heavy precipitate particles is very difficult to float. To solve this problem is of vital importance. In this area, some effective measures in aeration and flocculation have been applied which will be described below.
This system involves two stages of flotation, and the primary stage needs more flocculant and air bubbles for floating more precipitate. To serve the two stages of treatment, a newly designed double-layer clarifier of shallow type is used, and the retention time of each layer is 14 to 18 minutes, depending on the amount of liquor treated.

Usually, good and complete flocculation and flotation can be achieved in both steps of this process when running under normal conditions, and both clarified liquors are transparent. But if the working conditions of carbonatation are unstable or unsuitable, the first flotation would worsen and the primary clarified liquor would be turbid. However, this residual suspended matter can be removed at the secondary flotation, which works under more favorable conditions (with less precipitate mainly comprising calcium phosphate which is easier to flocculate and float); thus the final liquor is still clean and bright.

It appears that this process can be further simplified into one step of flotation, by prior addition of phosphoric acid, controlling the pH at around 8.0, and providing with automatic devices to maintain the temperature, pH and chemical dosage suitable and stable. Then the system will be more beneficial and economical.

Sierra Leone sugar project rehabilitation[1]

The Chinese-owned Magbass Sugar Complex at Tonkolili has launched a $3 million program to overhaul its machinery, vehicles and other equipment. The complex covers 1280 hectares of cane plantations on which it grows 60,000 tonnes of cane per year, from which is produced 6000 tonnes of sugar and alcohol.

Dutch sugar factory closure[2]

Two years after the closure of the CSM Suiker sugar factory in Sas van Gent, the Suiker Unie factory in the same town is to close at the end of this year.

1 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 212.
2 *Zuckerindustrie*, 1989, **114**, 440.

Integration of energy and by-products options with sugar factory operations

By Stephen J. Clarke
(Audubon Sugar Institute, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Centre, Baton Rouge, Louisiana, USA)

Introduction

Much information is available on by-products options for sugar cane but there has been a tendency to treat them in isolation. The purpose of this paper is to describe the impact of by-product processing upon the material and energy balances of the overall system, including sugar processing. A centralized system, based on bagasse, provides steam and power for all on-site processing. By-products, based on bagasse (e.g. furfural, paper and board) decrease the amount of fuel in the system and also require energy for processing and so may demand an external power source. Choice of variety may be critical under these conditions. Ethanol production as the major product has a different energy requirement from sugar production. By-products based on filter cake and molasses (e.g. ethanol and citric acid) require energy for processing but do not decrease the amount of fuel available. Fractionation of the cane, e.g. with a Tilby Separator, may provide a superior source of fibre but the material and energy balances become quite different from conventional processsing. Factors involved in each of these options will be discussed.

This paper may be considered as an extended appendix to a paper given at the 1986 Inter-American Sugar Cane Seminar[1]. The subjects of this earlier paper were the material and energy balances for a raw sugar factory and the choice of variety to maximize electric power production. The paper was based on a computer program which calculated the steam flows and requirements for each stage of the process and the electric power generated using a multistage extracting and condensing turbo-alternator. This turbine system provided intermediate pressure steam for prime movers (mills, etc.) and additional low pressure steam, above that available from the prime movers, necessary to meet process demands. Bagasse was the fuel for the system and modern, high pressure boilers were essential to the system.

By-products studies are usually made of the details of a particular process and often in isolation from the rest of the process and the source of the material. For the purpose of this paper, sugar production remains the dominant factor and primary demand for steam and power. This is neither a complete study of all the possibilities nor a detailed study of a single case. Its purpose is to illustrate the factors that need to be taken into acount when integrating by-product production with factory operation.

Each of the systems evaluated assumes modern steam generation practices since these provide flexibility for both power and process heat[2]. The economics of such operations are not considered since they are very much dictated by local circumstances. However, an economic follow-up could indicate the relative values of the various product options.

Calculation procedures

Details of all the calculations and assumptions are in the previous paper[1]. The conditions specific to the present paper are given in Table I. The major variables are the cane composition (either 12% fibre or 16% fibre) and the boiler pressures for the high pressure steam (either 8,360 kPa or 5,960 kPa). A flow diagram for steam production is given in Figure 1.

Paper presented to Inter-American Sugar Cane Seminar, 1987.

1 Clarke & Keenliside: *Proc. Inter-American Sugar Cane Seminar*, 1986, 102 - 115.
2 Paturau: *Proc. 19th Congr. ISSCT*, 1986, 1017.
3 *ibid.*, "By-products of the Cane Sugar Industry" 2nd Edn. (Elsevier, Amsterdam.) 1982.

Table I. Variety composition and processing conditions

	Variety 12	*Variety 16*
Cane composition		
Fibre % cane	12.0	16.0
Soluble solids % cane	16.0	16.0
Sucrose % cane	13.3	13.3
Reducing sugars % cane	1.0	1.0
Milling conditions	Intense preparation with five mill tandem	
Milling rate		
Tonnes cane per hour	240	185
Tonnes fibre per hour	28.8	29.6
Imbibition % cane	25	30
Mill extraction	96.0	94.5
Bagasse % moisture	50	50
Tonnes sugar per hour	28.2	21.4
Tonnes molasses per hour	10.9	8.3
Boiler efficiency	65%	
Steam pressure (kPa)		
High pressure	8360 or 5960	
Intermediate pressure	1850	
Low pressure	207	
Condenser pressure	8	
By-products demands[3]	kg steam per tonne material processed	kWh per tonne material processed
Fibre board	2600	400
Mechano-chemical pulp	1060	132
Acetic acid	2400	2
Citric acid	6,340	1270
Glycerol	2080	80
Yeast	550	280
Aconitic acid	1030	45

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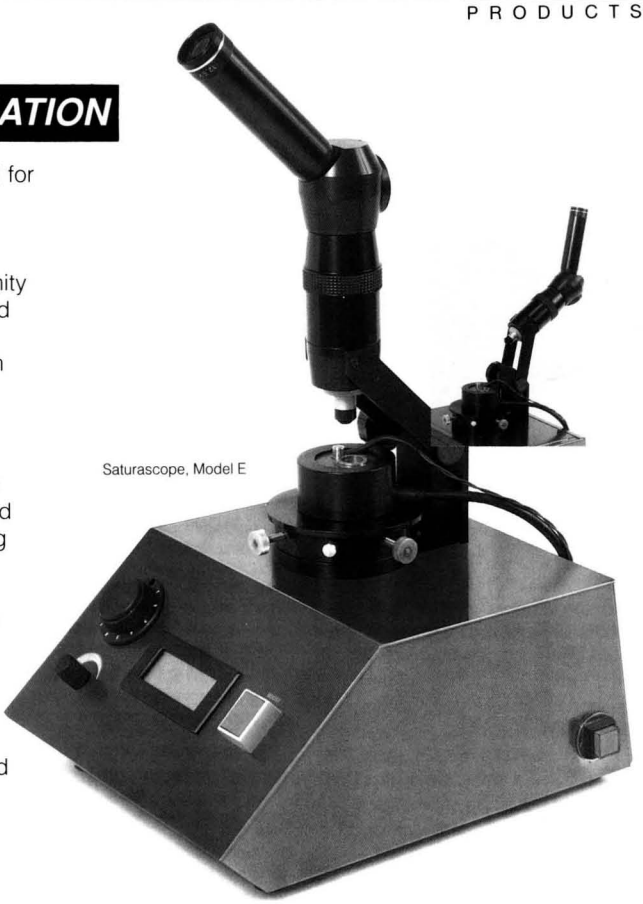

Saturascope, Model E

SUGAR COLOUR

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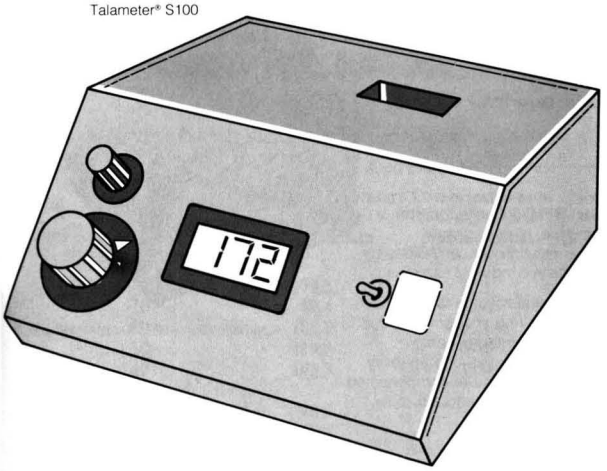

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This new instrument, developed by Tate & Lyle Process Technology Limited, has been licenced to 'Suma Products' to manufacture and market. It is based on the same principle of the original "8000 Series Talameter®" but with a simplified method, aimed strictly for repetitive colour determinations in dissolved sugar. Measurements in ICUMSA units or RBUs can be made in factory process streams from raw juice to final product sugar.

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BAGASSE ANALYSIS

The 500 gram sample size **Deerr Type Bagasse Digester** is fabricated entirely in stainless steel, and is designed for operation by a 220V, single-phase electric immersion heating system.

The outer vessel is lagged to prevent heat losses. The spiral conductor tube, surrounded by a water jacket with cooling water inlet and outlet, is permanently connected to the digester body top cover which in turn is fitted to the body by means of thumb screws and rubber gasket.

The inner perforated container is supplied with a lid to prevent the escape of bagasse particles during extraction. A handle for removing the inner basket is provided.

For the rapid and accurate determination of moisture in Bagasse (or suitably prepared Cane samples). Equal in accuracy to the oven drying method.

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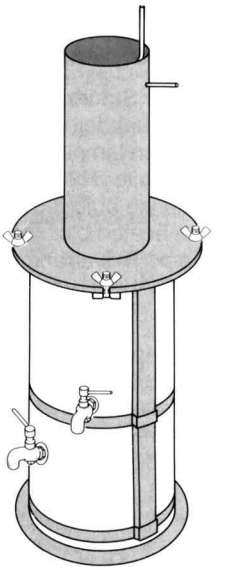
The quick action of the **Moisture Teller** is due to thermostatically controlled hot air being blown through a thin layer of Bagasse which is contained in the sample pan which has a woven wire base. The pan and sample are weighed before and after drying to give the moisture. A feature of this machine is that a large sample (1400 c.c.) is used, thus increasing the accuracy of the method.

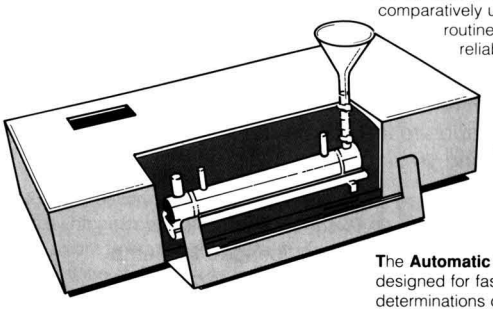
It has an automatic time switch from 0 - 60 minutes and a temperature range of 90 - 170°C.



Deerr Type Bagasse Digester

JUICE ANALYSIS

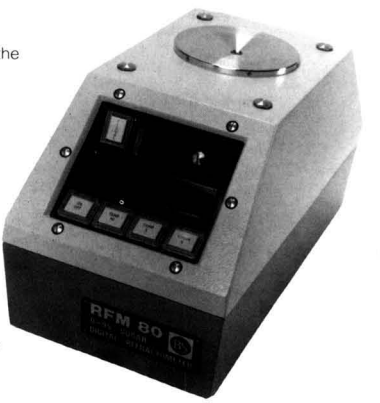
The **Automatic Digital Polarimeter** is a versatile instrument which is highly suited to both research work and routine daily quality control. It is very easy to use; the polarimeter does all the hard work involved in taking readings, leaving you time to concentrate on your samples and results. Also, comparatively unskilled technicians can carry out the routine work and obtain accurate and reliable results.



Automatic Digital Polarimeter

The **Automatic Digital RFM80 Refractometer** is designed for fast response, high accuracy determinations of Sugar solution concentrations by measurement of the refractive index of samples.

The RFM80 provides the ideal solution to the problem of accurately measuring concentrations in the range 0 - 95% Sugar w/w. Integral sample temperature sensing and compensation capability permits both ambient and temperature compensated results to be shown on the digital readout display, together with sample temperature.



Automatic Digital RFM80 Refractometer

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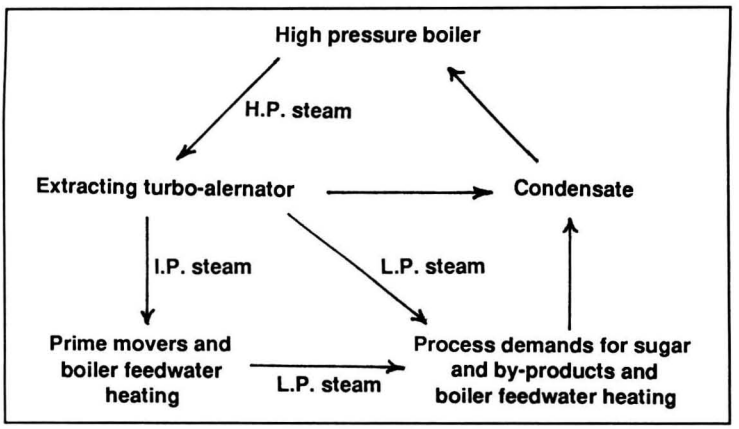

Figure 1. Steam flow diagram

The cane crushing rates are different for the two varieties to achieve roughly equal fibre grinding rates and therefore mill and boiler size. Extraction and sugar and molasses production data are also given in Table I. Steam and power requirements for by-product processing are taken from Paturau[3]. There are only limited data available on this subject and these used must be treated with caution. The data listed are per tonne of 50% moisture bagasse directly from the mill and for final molasses from the mill. The additional process steam and power requirements were calculated from the quantity of material to be processed and the tabulated demand per tonne of material. These total process steam and power requirements were calculated by addition of the by-product demand to the sugar processing demand. These data were used to calculate the overall steam and power balance for the system.

No data are available for the energy demands for processes based upon filter cake, e.g. wax production. Calorific value data for filter cake suggest it may be possible to use it as a fuel but this would require modern sludge boilers[4].

Bagasse based products

The use of bagasse as a raw material rather than as a fuel decreases the energy available for the sugar/by-product operation and increases its energy requirements. Three cases were chosen for evaluation, (i) bagasse being used off-site and therefore no processing required, (ii) fibre board production and (iii) mechano-chemical pulping. The latter two were chosen since they are in the middle of the ranges for steam and power demand for board and pulp processing. Fibre board has higher requirements since it is a finished rather than intermediate product. The results are given in Tables II, III and IV.

The major factor in bagasse

4 Clarke: "Calorific value of filter cake", Unpublished report, 1985.

Table II. Bagasse processed off-site

% bagasse diverted	Tonnes of bagasse diverted per hour	% low pressure steam required by by-product	High pressure steam production as % of zero by-product production
	Both varieties, both steam conditions		
0	0	0	100.0
10	6.1	0	88.9
20	12.1	0	77.7
30	18.2	0	66.6
40	24.3	0	55.4

% bagasse to by-product	8380 kPa case: Intermediate pressure as % of high pressure steam	8380 kPa case: Low pressure as % of available low pressure steam	8380 kPa case: Net power (MW)	5960 kPa case: Intermediate pressure as % of high pressure steam	5960 kPa case: Low pressure as % of available low pressure steam	5960 kPa case: Net power (MW)
Variety 12						
0	79.5	71.1	8.90	77.7	70.0	6.92
10	89.4	79.6	6.09	87.5	78.4	4.47
20	102.2	91.1	[3.29]	100.0	89.7	2.02
30	119.3	107.8	[0.48]	116.7	106.1	[–0.43]
40	143.3	133.9	[–2.32]	140.2	131.7	[–2.87]
Variety 16						
0	78.6	56.7	10.58	76.9	55.9	8.53
10	88.5	62.9	7.69	86.6	62.0	6.01
20	101.2	71.4	[4.81]	99.0	70.4	3.49
30	118.1	83.6	[1.92]	115.5	82.3	[0.97]
40	141.9	102.5	[–0.97]	138.7	100.9	[–1.55]

Table III. Mechano-chemical pulping of bagasse

Both varieties, both steam conditions

% Bagasse to pulp	Tonnes of bagasse to pulp per hour	% Low pressure steam required by by-product	High pressure steam production as % of zero by-product production
0	0	0	100.0
10	6.1	9.1	88.9
20	12.1	17.2	77.7
30	18.2	24.3	66.6

	8380 kPa case			5960 kPa case		
% Bagasse to by-product	Intermediate pressure as % of high pressure steam	Low pressure as % of available low pressure steam	Net power (MW)	Intermediate pressure as % of high pressure steam	Low pressure as % of available low pressure steam	Net power (MW)
Variety 12						
0	79.5	71.1	8.90	77.7	70.0	6.92
10	89.4	87.6	5.05	87.5	86.3	3.25
20	101.9	109.6	[1.37]	100.0	108.3	[–0.88]
30	119.3	142.4	[–3.62]	116.7	140.1	[–5.02]
Variety 16						
0	78.6	56.7	10.58	76.9	55.9	8.53
10	88.5	70.9	6.87	86.6	69.8	5.18
20	101.2	90.1	[3.16]	99.0	88.7	1.84
30	118.1	117.7	[–0.77]	115.5	115.8	[–1.90]

Table IV. Bagasse fibre board production

Both varieties, both steam conditions

% bagasse to board	Tonnes of bagasse to board per hour	% low pressure steam required by by-product	High pressure steam production as % of zero by-product production
0	0	0	100.0
5	3.0	10.9	94.4
10	6.1	19.8	88.9
15	9.1	27.4	83.3
20	12.1	27.4	77.7

	8380 kPa case			5960 kPa case		
% bagasse to by-products	Intermediate pressure as % of high pressure steam	Low pressure as % of available low pressure steam	Net power (MW)	Intermediate pressure as % of high pressure steam	Low pressure as % of available low pressure steam	Net power (MW)
Variety 12						
0	79.5	71.1	8.90	77.7	70.0	6.92
5	84.1	84.2	5.85	82.3	82.9	3.84
10	89.4	99.3	2.33	87.5	97.7	0.29
15	95.4	116.9	[–1.20]	93.3	115.0	[–3.25]
20	102.2	137.6	[–4.73]	100.0	135.0	[–6.80]
Variety 16						
0	78.6	56.7	10.58	76.9	55.9	8.53
5	83.3	68.7	7.89	81.5	67.7	6.02
10	88.5	82.4	5.19	86.6	81.2	3.51
15	94.4	98.5	1.72	92.3	97.0	–0.08
20	101.2	117.4	[–1.91]	99.0	115.5	[–3.73]

derived by-products is the loss of steam for process. Both the fuel quantity and the fuel quality are decreased. The former is more significant and the latter is due to the higher ash content of the pith recycled to the boilers after depithing of the useful fibre for pulp or board. The decrease in high pressure steam production is given in each table.

ISJ Abstracts

Cane sugar manufacture

Energy management with particular emphasis on steam raising - Gledhow sugar mill

P. Hamilton. *Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc.*, 1988, 85 - 86.

A practical method of monitoring coal-fired boiler performance is described that was applied to a 100 tonnes/hr unit which had been showing a fall in the steam:coal ratio and clinker formation on the furnace grate. The entire test was conducted over a 6-hour period and involved measurement of ash parameters (including unburnt carbon content), flue gas analysis, coal consumption and steam parameters. Sources of major loss were identified as unburnt carbon in coarse and fly ash (causes of which are listed) and stack losses attributed mainly to excess air volumes with resultant high energy loss in flue gas. Introduction of a number of modifications and changes in the type of coal led to an increase in boiler efficiency from 76.23% to 81.07%.

A practical approach to energy management in a sugar factory

G. F. Mann. *Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc.*, 1988, 87 - 89.

In an energy management program which is described, attention is focused on means of minimizing controllable energy consumption. The areas involved include the boiler station (for which flue gas composition, unburnt carbon content in ash and the steam rate are important efficiency indicators) and those process stages where the amount of water can be optimized, including imbibition, evaporation (where the amount of make-up water should be minimal and the evaporation rate can be reduced by e.g. increasing the syrup Brix to 70°), filter washing (filtrate Brix being used as an indicator of water consumption), boiling (with monitoring of movement water and feeding of 70°Bx syrup to minimize the amount used), remelting (which should also be to 70°Bx) and sugar dryer dust separation (for which water consumption should be minimal). In a refinery, water consumption can be reduced by melting raw sugar to 70°Bx, minimizing the drop in Brix between melt and decolorized liquor, optimizing the Brix of fine liquor, minimizing evaporator make-up water and ensuring that amounts of sweet-water are not excessive (although the importance of the amount for energy saving is reduced where all sweet-water is used for melting or other process purposes and satisfactory Brix values are achieved). Equipment used for measuring boiler parameters and water flow is briefly discussed and a suitable report layout for energy management control indicated.

Improvement in the operation of the smuts and scrubber water system at Felixton

D. B. Wagner and G. T. Schumann. *Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc.*, 1988, 94 - 98.

Details are given of a system in which a mixture of factory effluent and smuts water from the boiler scrubbers is treated in two clarifiers the underflow from which is transferred to vacuum belt filters for dewatering while the clear overflow is recycled to the scrubbers and ash hoppers; the water separated by the belt filters is subsequently treated in a separate effluent treatment plant which also receives any overflow from the scrubber supply tank. Problems were caused by (i) the variable and often heavy loading of factory effluent on the scrubber circuit which led to poor clarification and filtration, and (ii) high Ca sulphate levels in the scrubber circulating water as a result of unsteady lime addition and high coal burning rates. A major improvement in performance of the system has followed the addition of lime to the clarifier underflow which has reduced the suspended solids content in the overflow to the effluent treatment plant and has reduced fouling of the scrubbers.

A pilot test on a sieve plate scrubber for a bagasse-fired boiler

C. J. Chang and J. T. Lee. *Taiwan Sugar*, 1988, **35**, (4), 9 - 11.

A simple sieve plate type of wet scrubber was developed for scrubbing bagasse-fired boiler flue gases. The gases enter radially at the bottom of the columnar vessel and then pass through a perforated plate and a target plate (both of which are immersed in water); the resultant bubbling ensures intimate contact between the water and the suspended particles, and the water is finally separated from the resultant droplets by a centrifugal mist eliminator at the top of the vessel. The fly ash removal efficiency is almost as good as that of a bag filter scheme.

Optimum relative humidity for raw sugar storage

G. Rasool, T. Hussain and M. Younis. *Pakistan Sugar J.*, 1988, **2**, (3), 3 - 6.

Studies of raw sugar storage for 60 days at room temperature (20 - 25°C) and a relative humidity in the range 40 - 90% (samples being taken at 10-day intervals for moisture determination) showed that 55% R.H. was optimum at which no change in the sugar moisture content was observed. The moisture content fell at lower R.H. and rose at higher values.

Some aspects relating to reduction in the moisture content of bagasse by efficient milling operations

P. K. Shewale and A. R. Patil. *Bharatiya Sugar*, 1987, **12**, (9), 9 - 11.

Hot water imbibition and arcing of mill rollers so as to increase squeezing are examined as means of reducing the moisture content of bagasse.

Faulty technique and equipment bottlenecks affecting crystal recovery and quality of sugar

D. S. Lande. *Bharatiya Sugar*, 1987, **12**, (9), 13 - 15.

Shortcomings in clarification, boiling, crystallization and curing and their adverse effect on crystal sugar recovery and quality are discussed.

Electronic weighing systems for sugar cane

T. K. Balwe. *Bharatiya Sugar*, 1987, **12**, (9), 33 - 35, 37, 39.

Computerized cane weighing systems used in Indian sugar factories are described and their performances and advantages examined.

Conservation of energy and modern milling techniques. Automatic cane feeding control

P. K. Shewale. *Bharatiya Sugar*, 1987, **12**, (9), 45 - 49.

An automatic cane feed control that is based on carrier speed is described.

Mill expansion with installation of a short-space TRPF system

G. D. Dasharath. *Bharatiya Sugar*, 1987, **12**, (10), 17 - 18.

Installation of a two-roller pressure feed system on one mill in a 6-mill tandem at an Indian sugar factory led to a reduction in bagasse moisture and pol and an increase in mill extraction, and it was decided to install the feeders on the remaining mills.

Sugar cane juice concentration by reverse osmosis

V. J. Shah *et al. Bharatiya Sugar*, 1988, **13**, (4), 19 - 20, 25 - 26.

Trials are reported in which reverse osmosis was used to concentrate juice from 15 - 17°Bx to 16 - 18°Bx or to 24 - 26°Bx (in recycling tests) using cellulose acetate in the form of spiral elements. Optimum parameters were established as: a feed pressure of 800 - 1000 psi, a flow rate of at least 10 litres/min and a feed temperature no higher than 60 - 65°C (since the membranes were subject to hydrolysis which rose with temperature).

New aspects of clarification of sugar cane juice

N. A. Ramaiah. *Bharatiya Sugar*, 1988, **13**, (4), 33 - 34.

The mechanism of clarification is briefly analysed, including the role of lime and its residual content in clear juice.

Bagasse storage problems covered up

Anon. *Australian Canegrower*, 1988, **10**, (10), 12.

At South Johnstone sugar factory, bagasse for use as fuel is now stored under Bagasse Guard blue PVC film manufactured by Abgal Pty. Ltd. and specially embossed to increase the life of the material and provide high resistance to ultra-violet degradation. The material is very strong and will stretch to more than four times its length before breaking, thus being less vulnerable to damage by wind and storms.

Vacuum pan computer system at Okeelanta

R. Valdes. *Sugar J.*, 1988, **51**, (3), 12.

The sequence control system used for the two pans (a third pan is being incorporated) at Okeelanta Corp. is outlined. Controller card data are transmitted via a multiplexer and a communications module to a programmable processor which updates graphic displays and data in the memory; a complete record of the strike is thus available once it is completed. Master sequence controllers make decisions on the type of strike, etc. while slave controllers are responsible for operational parameters. Advantages of the system are indicated.

Microprocessor control structures for raw sugar factories

W. Keenliside. *Sugar J.*, 1988, **51**, (3), 17 - 22.

The three basic control modes (sequencing or logic control, PID control and modelling control) and four control architectures (discrete, distributed, centralized and supervisory) are outlined and their application in the sugar factory discussed. Initial analysis of process operations suggests that a 5 - 8 cell distributed control system (in which a small area or cell is controlled through a single unit allowing communication between all elements in the cell) offers greatest flexibility and could be extended to provide supervisory control at a later stage if required. Advice is given on selecting suitable equipment and installing systems.

Automatic control in the sugar factory

Anon. *Ann. Rpt. Centre d'Essai de Recherche et de Formation* (Réunion), 1987, 17 - 20 *(French)*.

Clear juice pH control: At Le Gol sugar factory, the glass electrode used to maintain the pH of clarified juice constant at 6.9 - 7.0 became easily fouled; to reduce the problem, the juice should flow at a sufficient speed in the vicinity of the electrode, but a filter should also be installed before the electrode to prevent solid particles damaging its end. A small cooler was installed to reduce the temperature at which the electrode operated, but also reduced the juice flow rate. A circuit was to be introduced for cleaning the electrode with water.
Boiling control: Continuous boiling at Bois Rouge is controlled by electrodes that measure the massecuite conductivity at a radio frequency of 10 MHz; the part of the electrode (of Australian origin) in contact with the massecuite is made of PTFE (polytetrafluoroethylene) and so is not troubled by incrustation. The electrodes give a measure of the Brix and of crystal content and are also used to control dilution of *A*-syrups; they have proved satisfactory and are more stable than normal electrodes. Tests on measuring the Brix of syrup leaving the evaporator gave encouraging results, and further experiments were to be conducted to see if the new electrode could replace the current γ-ray densimeter at Grands Bois.
Mill turbine speed measurement: At Le

Gol factory, galvanometers used to indicate the speed of mill turbine drives as a function of voltage change have been replaced with digital indicators working on a frequency basis; the new indicators are of greater precision and are more robust.

Mill speed control: Tests on control of the speed of the last mill at Beaufonds as a function of the level in the Donnelly chute have shown a number of advantages: constant feed of the mill under normal conditions, an automatic fall in speed to the initial fixed level when feed stops, and a possible improvement in extraction and bagasse moisture content (although it was found that increased operation with a full chute resulted in a greater pool of juice above the rollers and caused re-imbibition of the bagasse on discharge).

Cane flow: A CERF sensor in a Donnelly chute which measures the conductivity at 10 points was found to control cane feed as well at the No.1 mill as at the last mill, but is not suitable where imbibition is carried out just above the chute; on the other hand, the various control modules in a Natronics system were damaged by oxidation, while the PID controller proved completely useless and had to be replaced by a much simpler but much more efficient limit module.

Sugar technology research in Réunion

Anon. *Ann. Rpt. Centre d'Essai de Recherche et de Formation* (Réunion), 1987, 21 - 48 *(French).*

Evaporation: Measurement of the pH and Brix of samples taken at the discharge port of each effect showed a major fall in pH across the 1st effect as observed at the SMRI in South Africa where a straight correlation was found between unknown losses and the dimensions of the 1st and 2nd effects; the large heat exchange surfaces in both vessels (a result of the considerable quantities of bled vapour recommended for reasons of energy saving) caused prolonged juice retention and hence degradation of sucrose and reducing sugars at the high temperatures (>118°C).

Recirculation of secondary juice before No.1 mill: Installation of an extra pressure roller before the 1st 3-roller mill in a 4-mill tandem at Beaufonds provided pre-imbibition with secondary juice extracted from the prepared cane; although it was feared that this imbibition in the Donnelly chute of the 1st mill could create feed problems because of the considerable amount of liquid in the mixture of prepared cane and secondary juice, no difficulties arose and there was even a slight increase in the hourly throughput of the (4-roller) 1st mill. The feed:discharge ratio was adjusted to allow extraction of the major part of juice by the new roller. Details are also given of a new shredder identical in design to that installed at Ookala factory in Hawaii, of a stone and trash separation system which has given promising results and of an inclined stone separator which has also provided encouraging results. Diagrams are also presented of various performance parameters at Réunion factories.

Clarification of cane juice and its control in India

J. C. Bhargava. *Bharatiya Sugar*, 1988, **13**, (5), 9 - 13, 15 - 17, 19 - 20.

The clarification process and the various individual and groups of non-sugars it removes are discussed generally and descriptions given of the methods used in India, particularly continuous sulphitation. Automatic control is briefly discussed.

Cane juice clarification - process options

M. Singh and S. N. Shah. *Bharatiya Sugar*, 1988, **13**, (5), 51, 53 - 56.

Features and major drawbacks of the double sulphitation method used in white sugar manufacture are listed and details with flow diagrams given of the Talodura and Fabcon juice/syrup clarification processes.

Reduction in steam consumption in the boiling house

D. S. Lande and S. Y. Jadhav. *Bharatiya Sugar*, 1988, **13**, (5), 57, 59 - 60.

A number of measures are examined that will contribute to a reduction in steam consumption in the various process stations.

Practical approach to an ultimate thermal economy and bagasse saving in the sugar factory

A. R. Patil. *Bharatiya Sugar*, 1988, **13**, (5), 65 - 66.

Means of reducing steam and power consumption in the sugar factory and thereby cutting bagasse consumption are considered.

A study on the use of Indion 8102 anti-scalant chemical to reduce the scale formation in evaporators and pans - a boon to the sugar industry

S. Srinivasan. *Proc. 51st Ann. Conv. Sugar Tech. Assoc. India*, 1988, M.1 - M.14.

Addition of a total 20 ppm of Indion 8102 to juice entering the evaporator, to the 3rd and 4th effects and to the pan syrup supply tank at the author's factory resulted in a reduction in scale formation and to monetary savings which are calculated.

Syrup bleaching by hydrogen peroxide for the production of white sugar

R. D. Jadhav *et al. Proc. 51st Ann. Conv. Sugar Tech. Assoc. India*, 1988, M.53 - M.61.

Addition of 20 ppm hydrogen peroxide to syrup instead of sulphitation reduced the white sugar colour content by 46% and the sulphated ash by 20% while saving foreign exchange (virtually all the sulphur used in the Indian sugar industry being imported) and preventing environmental pollution by SO_2 gas.

Beet sugar manufacture

Possibilities of improving the quality of purified juice

V. A. Golybin, A. I. Gromkovskii, Yu. I. Zelepukin and I. L. Shramko. *Rpt. Voronezh Tekh. Inst.*, 1988, 7 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs.19 R435.

The questions are discussed of reducing the colour and Ca salts content in purified juice by means of intermediate carbonatation during progressive preliming and holding 2nd carbonatation juice in ripening vessels after introduction of a reagent (sodium triphosphate or soda) into the juice. The intermediate carbonatation is conducted at pH_{20} 8.1 - 8.2 for 2 min with addition of 0.20 - 0.25% CaO on beet and ripening is carried out at 83 - 85°C for 10 - 15 min.

The outlook for energy and processing technology in sugar manufacture

K. E. Austmeyer. *Zuckerind.*, 1988, **113**, 855 - 859 *(German)*.

After a brief discussion of energy consumption by the West German sugar, brewing and dairy industries in 1981/85, the author examines the energy situation within the sugar factory. A rise in electricity consumption in the early 1980's, partially associated with measures to cut fuel consumption, was followed by a fall in 1985/86 to 270 Wh/kg white sugar as a result of conversion from aerobic to anerobic treatment of effluent, reduction in beet pile ventilation and in water circulation, etc. An average specific energy input of 10 MJ/kg sugar in 1985 compared with 16 MJ/kg in 1978. A typical energy balance flow diagram for a sugar factory is presented, and the benefits of mechanical vapour compression and of pulp drying by modern energy-saving processes such as low-temperature treatment indicated. Means of reducing steam consumption are discussed, including a 2-stage expansion cooling-crystallization scheme with or without vapour compression to yield two grades of white sugar. A combined gas turbine/waste heat boiler scheme is also described, use of which would contribute to a possible reduction in energy consumption to 4 MJ/kg.

Power-heat coupling and energy link-up in the sugar manufacturing and pulp drying process

P. Valentin. *Zuckerind.*, 1988, **113**, 860 - 867 *(German)*.

The input ratio of electrical power to useful heat is used to evaluate the energy efficiency of processes and thermal power plant performance against the backcloth of the situation over the last 12 years in factories of Süddeutsche Zucker-AG. The increasing effect on energy costs of the link-up between factory and electricity supply utilities is indicated. Examples are given of energy savings by process optimization, by the use of vapour compression in evaporation and pan boiling and by application of greater interconnexion between sugar manufacture and pulp drying. These measures and the adoption of modern drying techniques will reduce primary energy consumption and the amount of noxious substances by more than 25%. The use of auxiliary gas turbines would also provide a balanced power and heat coupling.

Incrustation in sucrose-water solutions

S. K. Heffels and E. J. de Jong. *Zuckerind.*, 1988, **113**, 873 - 877.

The shape and growth of incrustations formed in sucrose solutions in a tubular heat exchanger were studied under varying conditions. Results showed that, in the presence of small crystals, incrustation formed at a supersaturation well below 1.2 (the critical level for secondary nucleation). Incrustation in crystallizers was found to start with the adherence of nuclei to surfaces (as observed by van Wijk & Wienk for NaCl solutions), suggesting that it is markedly dependent on the degree of crystal abrasion at the wall as well as on the adhesion forces; the least incrustation was found on hydrophobic surfaces such as PTFE (polytetrafluoroethylene).

Protection of beet against frost

J. P. Vandergeten and M. Vanstallen. *Le Betteravier*, 1988, **22**, (234), 14 - 15 *(French)*.

While beet stored under normal conditions in clamps may lose about 300 g of sugar per tonne/day, the losses may rise to 1 kg/tonne/day and processing problems occur if the beets are exposed to frost. Although a frosty period cannot be predicted by long-term weather forecasts, data from past years will show when there are likely to be frosts. If there is no immediate risk of frost, it is recommended to allow 48 hours to elapse between harvesting and covering clamps with plastic sheeting; this interval allows the high respiration rate and increased temperature of the beets to fall and become stable. If a frost is imminent, immediate protection is necessary and the base of the pile should be protected first. Tests have shown much greater losses in unprotected beets than in the upper part of a plastic-covered clamp, while protection against rain ensures that soil adhering to the beets becomes dry and is easily detached, thus reducing the dirt tare. It is not necessary to remove the cover if the air temperature rises.

Improve loss calculation

A. N. Goloshchapov and S. A. Gorlanov. *Sakhar. Svekla*, 1988, (5), 46 - 47 *(Russian)*.

It is shown how the official Soviet formula for calculation of losses in stored beet over a given period provides values based on constant daily losses and hence gives the differences between the initial and final weight and sugar content without allowing for the progressive fall in these values that occurs each day, so that both losses are underestimated. A more precise method of calculation is explained and its importance for the sugar industry in its conversion to self-financing indicated.

Improving the condensate scheme for diffusers

V. K. Marchukovskii and N. D. Khomenko. *Sakhar. Svekla*, 1988, (5), 47 - 49 *(Russian)*.

The condensate extraction scheme used on the inclined trough diffuser at a Soviet sugar factory was replaced with a different system after it failed to maintain a constant temperature and caused higher sugar losses. Condensate from the steam chests in the prescalder section is extracted via a steam trap to one of four liquid seals in a tank; the condensate from the chests in the three other diffuser sections is fed directly to the other seals, and the contents of the tank discharged through a control valve to be pumped to a holding tank or to the preliming tank. The system has operated reliably for three campaigns.

Hypochlorites from ion exchanger regeneration effluent

G. M. Solovets, R.I. Fesenko, T. N. Galkina and T. I. Sysoeva. *Sakhar. Svekla*, 1988, (5), 49 - 52 *(Russian)*.

Since electrolysis of NaCl to provide Na hypochlorite for use as a bactericide in the treatment of recycled waste water has the disadvantage of increasing the amount of salt consumed and ultimately entering the waste water treatment plant, tests were conducted on hypochlorite production by electrolysis of regeneration effluent from an anion exchange plant used for syrup treatment and effluent from a cation exchange process for water treatment on a Na^+ and NH_4^+ cycle. The test conditions and results are reported in detail and showed that the most suitable as electrolyte was a 1:1 mixture of the two types of effluent; undiluted eluate from syrup treatment would not be suitable on its own because of the high electricity consumption. The storage of the hypochlorite solutions obtained was also investigated.

Tuning and operation of an automatic control system for FiLS filters

G. P. Konev and P. V. Naryshkov. *Sakhar. Svekla*, 1988, (5), 52 - 53 *(Russian)*.

With automatic control of a battery of FiLS filter-thickeners based on filtrate output, treatment of poor juice having a high filtration coefficient (>6) may lead to a weakening of the signal from the flowmeter and hence to fouling and reduced throughput. A more suitable control parameter would be filter cloth dirtiness as indicated by flow resistance in the form of H/Q^2 where H = filtration pressure and Q = flow rate (m^3/hr); however, since the use of this ratio would complicate the calculations involved in setting up the system, it is considered adequate to use the difference H – Q. A scheme based on this is outlined.

Operational evaluation of heating and power plant performance

V. N. Filonenko. *Sakhar. Svekla*, 1988, (5), 53 - 56 *(Russian)*.

Nomograms are presented showing nominal fuel consumption as a function of the heat and power output of the appropriate plant and the mathematics used as basis for their construction explained. The relative error is ±1.5%.

Increasing the heat exchange rate and reducing scale formation

A. V. Savostin, E. A. Vdovenko and E. Yu. Viktorova. *Sakhar. Svekla*, 1988, (5), 56 - 57 *(Russian)*.

Laboratory experiments showed that the presence of 0.01 - 0.02% perlite on beet gave reductions in the rate of scale formation by 30 - 70%, and in the time of evaporation to give a Brix of 60° by 6 - 15%, as well as in juice colour content. Active carbon was also effective but is much more costly than perlite and would also necessitate plant to remove it from the thick juice, whereas perlite could remain in the juice and serve as precoat in subsequent filtration.

New sectioned heaters

A. A. Pochechun, B. M. Yanchuk, Yu. S. Razladin and P. P. Moskalenko. *Sakhar. Svekla*, 1988, (5), 57 - 61 *(Russian)*.

The performances of the new sectioned, vertical tube juice heaters introduced in the Soviet sugar industry over the last 2 - 3 years to replace shell-and-tube heaters are discussed.

Minimization of sugar losses during sugar beet storage and processing by optimum distribution of materials flow in the sugar factory

S. P. Gol'denberg and A. Z. Morev. *Rpt. Mosk. Tekhnol. Inst. Pishch. Prom.*, 1988, 10 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (20), Abs. 20 R372.

A mathematical model is proposed for the storage/factory system. The effect of storage and processing time on sugar losses was investigated and the possibility indicated of minimizing them overall.

Mathematical modelling on microcomputers of the kinetics of the diffusion process

S. P. Gol'denberg and A. Z. Morev. *Rpt. Mosk. Inst. Pishch. Prom.*, 1988, 13 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (20), Abs. 20 R373.

A model is proposed which allows investigation of the dynamic and static processes in diffusion, and the effect of various factors on sugar losses and process time is evaluated. A formula is presented for calculation of diffusion losses.

Examination of a model of flow in a battery of low-grade crystallizers

A. I. Gromkovskii, V. F. Dobromirova and S. P. Savchenko. *Rpt. Voronezh Technol. Inst.*, 1988, 4 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (20), Abs. 20 R374.

A mathematical description of the heat and mass transfer processes in a battery

of low-grade crystallizers requires a flow model. An investigation was conducted in which the response curve describing pulse disturbance caused by the introduction of NaCl tracer into the first crystallizer was determined. The crystallizers were linked by gutters between their upper sections or in staggered formation with alternate upper and lower chutes. Statistical analysis of the curves obtained for each crystallizer showed that the optimum model was one of ideal displacement when the massecuite retention time was the same in all crystallizers. The staggered formation of the chutes is better in regard to the flow model.

The mechanism of sucrose crystallization in the presence of pectic substances

V. M. Kharin and V. F. Dobromirova. *Rpt. Voronezh Technol. Inst.*, 1988, 2 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (20), Abs. 20 R376.

The mechanism of sucrose crystal growth is made clearer if the viscosity of supersaturated syrups is determined at the same time. The effect was determined of pectic substances on syrup viscosity and on the mass transfer coefficient characterizing sucrose crystal growth at syrup concentrations in the range 65 - 79% and at 30, 40 and 50 °C. Results showed that the rate of approach of sucrose molecules to the crystal faces did not vary significantly which could be attributed to the formation of a network structure of polymers in the solutions.

Restoration of worn steam chests in trough-type diffusers

A. E. Mil'man and Yu. R. Semchuk. *Gaz. Cukr.*, 1988, **96**, 148 *(Polish)*.

See *I.S.J.*, 1988, **90**, 54A.

Cukroprojekt predefecation and cold main liming

S. Ginal. *Gaz. Cukr.*, 1988, **96**, 149 - 151 *(Polish)*.

The 7 compartments of a circular vessel that make up the preliming section increase in depth in a clockwise pattern around the central main liming section so as to provide a continuous downward sloping bottom. The vertical partition between each compartment has an orifice at the bottom to allow the juice to flow into the next compartment. A circulation pipe extending from before the orifice towards the top of the preceding partition houses a circulation pump which draws up some of the juice that is about to leave the compartment; the juice strikes a servo-controlled flap that separates the stream into a forward and backward flowing component so that some of the juice in the last compartment will pass right back to compartment 1. Raw juice and 2nd carbonatation mud are fed into compartment 1, compartment 3 receives 1st carbonatation mud while milk-of-lime is fed to compartment 7. Two transfer plates in compartment 4 allow juice to return from compartment 5 to compartment 3 and bypass compartment 4 when the plates are in one position, whereas in another position the plates restrict the juice to circulation within compartment 4 at the same pH as in compartment 3 (creating a pause in the pH progression). From compartment 7 the juice enters the main limer which is provided with a conical bottom and a central mixer rotating at 300 rpm. Details are given of the automatic control of the system and of the prototype installed at Tuczno sugar factory. Comparison of its performance with the average performance of conventional trough-type limers at 5 other factories demonstrates its superiority particularly in the reduced colour formation in thick juice, standard liquor and sugar.

Lime consumption and sugar quality at Kruszwica sugar factory as example

F. Nowak. *Gaz. Cukr.*, 1988, **96**, 152 - 153 *(Polish)*.

Although the processes and equipment used at Kruszwica are the same as used generally throughout the Polish sugar industry, for some years the factory has produced a good quality sugar (having a colour content of 0.58°St) at a lower-than-average lime consumption (1.32% on beet) in juice purification. Among the factors considered responsible for the better performance are: a relatively high consumption of SO_2 (100 ppm on beet) for treatment of diffusion water and thin juice, a comparatively low juice draft of 117% (which, however, helps to raise molasses losses) and a smooth processing pattern. Pretreatment of raw juice with 2nd carbonatation mud and recycling of limed juice and 1st carbonatation mud to preliming probably contribute to the overall reduced lime consumption.

Optimization of anaerobic fermentation of sugar industry effluents

B. Polec. *Gaz. Cukr.*, 1988, **96**, 163 - 167 *(Polish)*.

Investigations and the mathematical theory of waste water fermentation are discussed that were aimed at establishing optimum conditions under which the COD and BOD_5 of highly concentrated waste could be reduced by >70% at maximum use of the effective volume of the reaction vessel and minimum retention time.

Control of the density of sugar house juices using a process refractometer

F. Buja and P. E. M. Cavicchioli. *Ind. Sacc. Ital.*, 1988, **81**, 174 - 177 *(Italian)*.

A PR-01 process refractometer provided with an infra-red light source, digital sensor and temperature compensation is described and its advantages as a means of controlling the Brix of e.g. green syrup from a Quentin plant, of massecuite in continuous boiling and of thick juice intended for storage are discussed. During crystal growth it is the only source of information on supersaturation. The problem of incrustation in pans is mentioned. The refractometer is considered a promising alternative to radiometric Brix meters which are not allowed in Italy.

Laboratory studies

HPLC determination of anions in sugar factory products

S. Foissac. *Ind. Alim. Agric.*, 1988, **105**, 643 - 648 *(French)*.

HPLC determination of inorganic anions in sugar factory products is described in which Chrompack strongly basic silica exchange resin was used as stationary phase in a 25 cm × 4.6 mm or 10 cm × 3 mm column with conductimetric detection using salicylic acid or K phthalate as solvent or with spectrophotometric detection using a benzenepolycarboxylate buffer or pyromellitic acid. For organic anion determination, only conductimetric detection was used with Biorad Aminex HPX 87 H as stationary phase in a 30 cm × 7.8 mm column and the best separation being given by dilute sulphuric acid at pH 1.1 as eluent. Chromatograms and tabulated results are discussed.

Determination of K, Na and alpha-amino nitrogen in the sugar factory. Technological and agronomic implications

S. Bertuzzi and M. Zavanella. *Ind. Sacc. Ital.*, 1988, **81**, 135 - 138 *(Italian)*.

When a laboratory unit was installed for K, Na and α-amino-N analysis in beet at Minerbio sugar factory in 1984, none of the existing formulae for calculation of thick juice purity and molasses formation as a function of the three components was valid under Italian conditions. However, suitable formulae were developed during 1984 and 1985, and the results for the period 1984/87 are indicated. The significance of the findings for both the farmer and processor is also discussed.

Polarimetry and the International Sugar Scale

A. Emmerich and K. Zander. *Sugar Tech. Rev.*, 1988, **14**, 275 - 330.

Development of the sugar scale from the work of Ventzke and the problems created by the introduction of photoelectric polarimeters, leading to the need for a new scale, are discussed. The need for new basic measurements is examined and the new scale adopted by ICUMSA at its 19th Session in 1986 is defined. The fundamentals of polarimetry and the various types of instrument are described, with an explanation of techniques used for their calibration and sources of error that can arise in this. The effect of sugar solution colour on measuring error is discussed and correcting for temperature described.

The latest on colorants in beet sugar manufacture

L. D. Bobrovnik and V. N. Rudenko. *Pishch. Prom.*, 1988, (2), 47 - 48; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs.19 R440.

The interaction of glucose, dihydroxy acetone, glyceraldehyde, acetaldehyde, reducing matter alkaline degradation products and caramels with glutamic acid was studied and the elementary composition of the isolated colorants determined and their ultraviolet and infrared spectra examined. The investigation showed that products of beet sugar manufacture contain neither reducing matter alkaline degradation products nor caramels. All colorants formed in the presence of amino-acids and peptides under true conditions of sugar manufacture are inevitably the result of interaction between sugar degradation products and nitrogenous compounds.

A thermophysical method for determining traces of carbohydrates in aqueous solutions

V. D. Tsyutsyura. *Rpt. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1988, 8 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs.19 R444.

The method described for determination of e.g. sugar traces in condensate used as boiler feed in sugar factories involves initial heat treatment of the test sample to convert the carbohydrates to organic acids followed by measurement of the electrical conductivity or pH. Investigations have permitted determination of the optimum heat treatment temperature and time and of the effect of initial alkalinity on the physical parameters. The lowest limit of detection is 10 ppm.

Determination of the dry solids content of beet pulp by an electrometric method

D. G. Komanyuk, S. N. Kalina and V. A. Knyazev. *Pishch. Prom.*, 1988, (2), 34; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs.19 R449.

The possibility is demonstrated of rapidly determining pulp dry solids from its conductivity, and a nomogram is presented for a dry solids range of 10 - 50%.

Near-infrared analysis of cane

Anon. *Ann. Rpt. S. African Sugar Assoc. Expt. Sta.*, 1987/88, 23.

The suitability of near-infrared (NIR) reflectance analysis for rapid estimation of cane quality was investigated, with calibration and validation of the instrument in three stages: (1) initial calibration with standard sugar solutions of known sucrose content (1 - 20%) and with a series of juice samples (including prepared diluted extracts and 1st expressed juice) of known Brix and pol; (2) calibration with almost 100 juice samples that had already been analysed for Brix and pol as well as (by GLC) for sucrose, fructose and glucose; and (3) determination of sucrose, dry matter and fibre in shredded cane, with separate calibrations being developed for both fresh and dried samples. Except for glucose and fructose, significant correlations were obtained between the concentrations of the various constituents as found by NIR and values given by conventional methods. In terms of the correlation coefficients NIR appeared to be more reliable for cane juice than for shredded cane, but in terms of the coefficient of variation there was little difference between the Brix and pol values found by NIR in cane and juice samples. In >70% of cases, the differ-

ences between Brix, pol and sucrose values obtained by NIR and GLC were within 0.40 units; even for shredded cane samples, the differences were <0.55 units for Brix and <0.60 units for pol in 70% of the samples. It is concluded that, although NIR is not sufficiently reliable to replace standard methods of analysis, it does have potential for rapid assessment of cane quality and does have the advantage over polarimetry of requiring only simple filtration of juice samples instead of clarification with lead acetate, providing a measurement within <30 sec. For determination of organic matter, clay and total N in soil samples as well as for soil classification in terms of N mineralization, NIR has given very satisfactory results and has largely replaced visual rating of samples.

Rapid analysis of cane juice by near infra-red reflectance

J. H. Meyer and R. A. Wood. *Proc. 62nd Ann. Congr. S. African Sugar Tech. Assoc.*, 1988, 203 - 207.

See previous abstract.

Fluorescence photometric determination of the coenzyme F_{420} for the monitoring of anaerobic waste water treatment

G. Kaiser, S. Frenzel and W. Mauch. *Zuckerind.*, 1988, **113**, 868 - 872 *(German).*

Factor 420 is a fluorescent coenzyme found by Cheeseman *et al.*[1] in Strain M.o.H. of a *Methanobacterium* sp. Using a slightly modified photometer or nephelometer, a centrifuge and a membrane filter, it is possible to monitor anaerobic treatment of effluent by determining the relative fluorescence. The specificity of the method was determined by measuring the fluorescence intensity at 470 nm over a wide range of exciter wavelengths (340 - 450 nm) and establishing optimum reaction conditions. A decrease in fluorescence indicates a disturbance in the fermentation process and allows prompt remedial action to be taken.

The selection of deproteinizing agents for determination of sucrose and reducing sugars by the Hanes method

S. Yoshiaki and K. Tokinobu. *Rpts. Central Customs Lab.*, 1986, (26), 101 - 106; through *Food Sci. Technol. Abs.*, 1988, **20**, Abs. 3 A 27.

In solutions where proteins interfere with the determination of sugars, a deproteinizing agent is required. In the determination of sugars by the Hanes method with a ferricyanide reagent, tungstate is normally used, but it requires a slightly acidic pH which causes partial inversion of sucrose. Various possible deproteinizing reagents were examined. A 1:1 mixture of $ZnSO_4$ and $Ba(OH)_2$ was effective with several solutions containing sugars and gave no problems with inversion.

Determination of dextran in raw cane sugar by Roberts copper method: collaborative study

M. A. Clarke and M. A. Godshall. *J. Assoc. Off. Anal. Chem.*, 1988, **71**, (2), 276 - 279.

A collaborative study involving 13 laboratories was conducted on dextran determination in cane raw sugar using a modification of the colorimetric method of Roberts[1] in which the dextran was separated from the copper complex by filtration instead of centrifuging. Four samples from different countries representing the range of dextran concentrations normally found in raw sugar were analysed in duplicate. Recovery of added dextran was in the range 97 - 102%, and the coefficients of variation for overall repeatability and reproducibility were 4.3 and 13.2%, respectively.

Robot gets on the juice at North Eton

Anon. *Australian Canegrower*, 1988, **10**, (11), 6.

A Kawasaki robot is used at North Eton to measure juice Brix and pol; it can analyse up to 14 samples at a time and record data in its control computer, and carries out most of the routine functions involved, including pouring, testing, washing and drying. Advantages of the use of a robot include reductions in labour costs, in human contact with lead subacetate, in variability of sampling results and in the need for supervision, while disadvantages include the higher basic costs by comparison with a continuous-flow measurement system, the retention of lead clarifying agents, the possibility of slight change in Brix measurements depending on how the juice is handled, and dependence on a single piece of equipment subject to occasional breakdown. At Mossman, membrane filtration is used to clarify juices for pol and Brix measurement.

Flow-injection determination of sugars with immobilized enzyme reactors and chemiluminescence detection

C. A. Swindlehurst and T. A. Nieman. *Anal. Chim. Acta*, 1988, **205**, (1/2), 195 - 205; through *Anal. Abs.*, 1988, **50**, Abs. 12D143.

In the determination of glucose, the sample (80 µlitres) was injected into a carrier stream of 1 mM phosphate buffer (pH 6.5) which was passed through a reactor (5.6 cm × 3 mm) containing glucose oxidase and aldose 1-epimerase, immobilized on controlled-pore glass; the hydrogen peroxide produced was determined via its chemiluminescence reaction with luminol in the presence of peroxidase at pH 11.6. Sucrose, maltose, lactose and fructose were determined similarly after their enzymic conversion to glucose (with β-fructofuranosidase and aldose 1-epimerase, glucan 1,4-α-glucosidase, β-galactosidase and glucose isomerase, respectively). Calibration graphs were rectilinear from 0.2 µM to 1 mM glucose, sucrose and maltose (limit of detection 0.1 µM) and 3 µM to 1 mM lactose and fructose (limit of detection 1 µM). Analysis time was approx. 2 min.

1 *J. Bacteriol.*, 1972, **112**, 527 - 531.

By-products

Promising methods for obtaining pectic substances

N. P. Shelukhina. *Pishch. Prom.*, 1988, (5), 11 - 12; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (19), Abs. 19 R456.

A method is described for obtaining pectic substances from beet pulp using *Trichoderma koningi*. Treatment of the initial material with the fungal culture before extraction yields mainly cellulolytic enzymes. In one variant of the method, the fungal pretreatment is followed by treatment with HCl solution, while in another variant the sterilized material is treated with a complex of enzymes from *Geotrichum candidum* cultured on a medium free from pectin. Rapid nephelometric, turbidimetric, volumetric, conductimetric, etc. methods for quantitative analysis have been developed as macro- and micro-modifications to monitor the pectin content in the raw material, intermediate products and final product, as well as a rapid method to determine the moment at which pectization of the protopectin commences.

Soil amelioration with molasses meal and filter cake

Anon. *Ann. Rpt. S. African Sugar Assoc. Expt. Sta.*, 1987/88, 28.

Various soil treatments were tested for their effect on crusting and soil loss by erosion. Results showed that trash blanketing was the most effective, followed by molasses meal at 25 tonnes/ha, phosphogypsum, polyvinyl alcohol and filter cake at 50 tonnes/ha, all of which reduced soil loss; however, filter cake failed to reduce crusting. Because of its stickiness, molasses meal was very effective in reducing crust formation, although it appeared to retard germination and cane growth.

Desalting of molasses by counter-diffusion in the fermentation industry

R. A. Johnson and M. S. Lefebvre. *Abstr. Pap. 194th Nat. Meeting Amer. Chem. Soc.*, 1987, 36 *(Abstract only)*.

A counter-diffusion method has been developed for the desalting of molasses used in ethanol production by fermentation. Tests conducted on an industrial yeast fermentation unit, using both desalted molasses and molasses clarified by the normal method, showed that ethanol yield rose from 2.4 to 4.1 g/litre/hr with a 20 - 25% fall in the molasses salts content. Fermentation of the desalted molasses was complete after 18 hours by comparison with 27 hours for clarified molasses. Process efficiency rose by 10% when desalted molasses was used.

Effect of sulphitation and carbonatation mud on the yield and quality of sugar cane

R. S. Kanwar, N. Singh and J. Kapur. *Indian Sugar Crops J.*, 1987, **13**, (2/3), 17 - 20.

Application as fertilizer of sulphitation or carbonatation mud at 20 tonnes/ha plus N at 100 kg/ha gave cane and sugar yields comparable to those given by 150 kg/ha urea alone and thus allowed replacement of 50 kg/ha urea while having less adverse effect on pol and juice purity.

A review of some aspects of distillery spent wash (vinasse) utilization in sugar cane

J. D. Patil, S. V. Arbatti and D. G. Hapase. *Bharatiya Sugar*, 1987, **12**, (7), 9 - 11, 13, 15.

Characteristics of vinasse, the nature of pollution it can cause and methods for its treatment and disposal are reviewed and its potential value as a cane fertilizer is analysed.

Effluent treatment processes for distillery spent wash

K. K. Johri. *Bharatiya Sugar*, 1987, **12**, (7), 23 - 25, 27 - 28.

Aerobic lagooning is dismissed as unsuitable for vinasse treatment in India because of the strong odour produced and possible pollution of ground water by seepage and overflowing of lagoons during the rainy seasons, while anaerobic treatment consumes electricity and large quantities of dilution water; disposal of the large volume of effluent still poses problems and systems have to be modified to burn the resultant biogas. Incineration is seen as the only suitable system, especially where water is scarce, and provides the opportunity for self-sufficiency in steam and power.

Fertilizers from spent wash - a review

A. D. Kulkarni, H. M. Modak and S. J. Jadhav. *Bharatiya Sugar*, 1987, **12**, (9), 17 - 20.

The production of fertilizer by fermentation or composting of vinasse or its mixtures (including those containing bagasse and/or filter cake) or by other specified processes (such as one developed by Kyowa Hakko Kogyo Co. Ltd. for humus production) is discussed.

Continuous fermentation of sugar cane molasses to ethanol using immobilized yeast

R. B. Natu, S. D. Borwawake, S. V. Patil, A. D. Sawant and S. J. Jadhav. *Bharatiya Sugar*, 1987, **12**, (9), 23 - 25, 27, 29 - 30.

The literature describing various systems for continuous alcoholic fermentation of cane molasses using immobilized yeasts is reviewed.

Direct and residual effects of sulphitation and carbonatation mud on the yield, quality and nutrition of sugar cane

R. S. Kanwar and J. Kapur. *Indian Sugar Crops J.*, 1987, **13**, (4), 1 - 5.

In field trials, sulphitation or carbonatation mud at 20 tonnes/ha plus N at 100 kg/ha gave the same plant cane yields but higher ratoon crop yields by comparison with N applied alone at 150 kg/ha, although juice quality and cane nutrient

status were unaffected.

Treatment of distillery effluents: a challenge

S. V. Arbatti and D. G. Hapase. *Bharatiya Sugar*, 1987, **12**, (10), 9 - 13.

Of various systems of vinasse treatment analysed, the most promising for large distilleries is considered to be its concentration and incineration, while fermentation followed by aerobic treatment or composting could be suitable for small plants.

Correct ensilage of pressed pulp

J. P. Vandergeten and M. Vanstallen. *Le Betteravier*, 1988, **22**, (234), 15 - 16 *(French)*.

Tests conducted over a 10-year period have shown that properly ensilaged beet pulp has a pH of 4.04, contains 9.12 g of acetic acid per kg dry matter, 1.12 g butyric acid per kg and 38.57 g/kg lactic acid as well as 2.39% of the total N in the form of ammonia. The fermentation process responsible for lactic acid formation causes a rapid fall in pH to 4.2 after an average of 5 days, at which level other fermentation processes are blocked and the growth of mould prevented. Basic rules for efficient ensilage are listed.

Sugar cane bagasse - available raw material for paper

B. S. Gurumurthy. *Indian Sugar*, 1988, **38**, 251 - 263.

The value of bagasse as raw material for paper is discussed and the possibility expressed of erecting a paper mill and a sugar factory at the same site (preferably under the same management) so as to effect savings in steam, power and costs and provide sufficient bagasse for both plants.

Press mud enrichment by micro-organisms

Anon. *Sugarcane Breeding Inst. Newsletter* (Coimbatore), 1988, **7**, (3), 2, 4.

Fungi, actinomycetes and bacteria inoculated into filter cake samples were found to improve their bulk and particle density, porosity and water-holding capacity and increase the total N, P, Ca and Mg contents by comparison with naturally degraded filter cake. The treated material thus acted as an effective fertilizer and soil conditioner and increased the shoot and root lengths and weight of cane setts; it had no toxic effect on tomato, mustard and cucumber plants in trials.

Supplementing a pulp-based ration for bull calves

L. Istasse. *Le Betteravier*, 1988, **22**, (235), 6 - 7 *(French)*.

Trials are reported in which bull calves were fed on (i) a ration containing a beet pulp mix (95% pressed pulp and 5% of a mixture of urea-treated molasses with minerals and vitamins) supplemented with barley and bran, and (ii) a dried pulp ration supplemented with fats. In (i) the supplements improved on the daily weight gain obtained with the pulp ration alone, whereas in (ii) the fats had little positive effect.

Improving beet pulp pressing methods and processes

A. A. Romanov, E. G. Stepanova and N. A. Lyusyi. *Obz. Inf. Gosagroprom SSSR. Nauch.-Issled. Inst. Inf. i Tekhn.-Ekon. Issled. Pishch. Prom., Sakhar. Prom.*, 1988, (6), 1 - 27; through *Ref. Zhurn. AN SSSR (Khim.)*, 1988, (20), Abs. 20 R379.

The authors demonstrate the need to intensify the pressing process of raw pulp so as to preserve its feed value and save fuel and energy. Data are presented on the composition and chemical properties of pulp as a compressible material together with an examination of pressing equipment and details of new designs. Results are given of factory-scale and laboratory investigations on intensive thin-layer pressing of pulp and the effect of diffusion and chemical pretreatment on intensive pressing is discussed.

Bagasse-based laminated particle board

M. Mahajan. *Bharatiya Sugar*, 1988, **13**, (4), 9 - 13.

The uses, properties and manufacture of bagasse-based laminated board are described and production costs estimated.

By-products of the sugar industry

D. G. Hapase. *Bharatiya Sugar*, 1988, **13**, (4), 15 - 18.

A survey is presented of the potential uses of cane tops and trash, bagasse, filter cake, molasses and sucrose as starting materials for various by-products; also mentioned is the manufacture of propionic acid from fermentation alcohol and vinasse treatment methods.

Distillery effluent treatment - a technological challenge

K. K. Johri. *Bharatiya Sugar*, 1988, **13**, (4), 81 - 85.

Vinasse treatment processes are described and their suitability discussed as a function of various factors.

Wet dust removal from a beet pulp dryer

S. Canossa. *Ind. Sacc. Ital.*, 1988, **81**, 171 - 173 *(Italian)*.

After giving reasons for the rejection of other types of dust separator, the author describes the wet dust separation plant installed at Molinella sugar factory for treatment of flue gas from the pulp dryer. At an efficiency of about 94%, the unit reduces the dust content from 165 to 10 mg/m^3. Electricity consumption is 270 kWh and 10 - 15 litres/hr of a 48% NaOH solution is consumed in alkalizing the wet mixture.

Utilization of bagasse and final molasses as cattle feeds

S. A. Hasan. *Pakistan Sugar J.*, 1988, **2**, (1), 24 - 30.

Bagasse depithing methods are described and details given of the chemical composition of whole and depithed bagasse and of cane molasses. Various feedstock rations are suggested that contain molasses and bagasse pith, and ration supplements are indicated. A number of important points are made regarding molasses and bagasse as animal fodder components.

Reassessment and improvement of continuous cultivation of yeast

C. H. Lin, L. H. Wang, Y. C. Kuo and C. Y. Chang. *Rpt. Taiwan Sugar Research Inst.*, 1987, (117), 43 - 54.

Continuous cultivation of *Candida utilis* NRRL Y-900 on clarified cane molasses was investigated with the aim of evaluating the kinetic data and reassessing operating conditions such as the mixing speed and aeration rate currently used at Hsinying by-products factory. The dissolved oxygen level, oxygen transfer rate and mixing characteristics were monitored to yield the optimum dilution rate and the optimum time at which to change from batch to continuous operation. Optimum operating strategies to provide maximum productivity using the avail-able production facility are suggested. The kinetic data are to be used as a basis for future scale-up of the operations.

Vinasse as fertilizer

Anon. *Rpt. Zimbabwe Sugar Assoc. Expt. Sta.*, 1986/87, 35 - 36, 65 - 68.

Investigations were conducted on application of vinasse in irrigation water to ratoon crops at dilution ratios of 1:50, 1:100, 1:200 and 1:400. In the first 3 crops only the 1:50 concentration showed evidence of any yield benefit which became significant in the 4th and 5th ratoons, with increases of 25% and 27% over the untreated control and respective sugar yield increases of 18% and 9.6% (cane pol falling with increase in vinasse concentration). Significant yield interactions between the vinasse and applied nitrogen were recorded in all but the 3rd ratoons; in the first 3 crops the nitrogen in the vinasse boosted yields in the absence of applied N but had no significant effect when N was applied, whereas the 1:50 concentration raised yields of the 4th and 5th ratoons by 74%; 22% and 10% when 0, 60 and 120 kg/ha N was applied, but had no effect in the presence of 180 kg/ha N. Trials showed a highly significant negative correlation between smut incidence and vinasse concentration, an effect which was most pronounced in the 2nd and 3rd ratoons when high levels of the disease were recorded; laboratory studies showed that the high nutritive content of the vinasse enhanced spore germination and thus reduced the numbers of viable spores in the soil available for infection of subsequent ratoons.

Mill mud and dunder: valuable sources of cane crop nutrients

G. Turner. *BSES Bull.*, 1988, (24), 10 - 11.

Application of filter cake or filter cake/ash mixture to fallow fields at 150 tonnes/ha provides sufficient nutrients to allow a full crop of cane to be grown and requires only 60 kg/ha nitrogen as supplement at planting. In ratoon or replant cane, more additional N is required, although some is still available from the filter cake in the 2nd year after application. P, Ca and Mg are available in the 2nd and subsequent years after filter cake application because of their slow breakdown and retention in the soil. Assessing the value of filter cake is briefly discussed. Vinasse as a major source of K is applied by growers within 60 km of Sarina alcohol distillery in Queensland; where soil contain large reserves of P, only N and vinasse are needed for optimum sugar yields.

Silage effluent and molassed sugar beet feed - a profitable opportunity

G. Macleod. *British Sugar Beet Rev.*, 1988, **56**, (4), 10 - 13.

Effluent from grass silage contains protein, Ca, P, K and Mg and is therefore of potential value as an animal feed; it is the second strongest pollutant produced on farms in the UK (and is much worse in this respect than untreated domestic sewage), so that its incorporation in animal fodder by absorption is of major interest. Investigations have shown that the absorbency rate and resultant silage metabolizable energy vary with the materials used; however, molassed beet pulp has high absorption properties (as a rule, 1 tonne of pulp absorbing 3 - 4 tonnes of effluent in silage clamps) and increases the quality and palatability of the resultant silage by fermentation of its sugar which also contributes to a high metabolizable energy level. Trials with beef cattle have demonstrated the value of the mix in terms of daily liveweight gain and feed efficiency.

Isolation and characterization of bacterial contaminants from molasses fermentation vats

-. Greatal, D. P. Singh and D. S. Dahiya. *Proc. 51st Ann. Conv. Sugar Tech. Assoc. India*, 1988, G.33 - G.39.

Five bacteria isolated from fermented dilute molasses samples from different distilleries and also found in the fermenters were identified as three *Lactobacillus* spp., *Streptococcus thermophilus* and *Leuconostoc mesenteroides* (the most dominant of the five at the yeast propagation stage). The possible sources of the contamination are briefly discussed.

Effect of some environmental factors on the cellulolytic activity of Basidiomycetes spp. moulds in submerged fermentation of bagasse

A. Dixit and K. A. Prabhu. *Proc. 51st Ann. Conv. Sugar Tech. Assoc. India*, 1988, G.51 - G.58.

A study of the cellulolytic properties of two Basidiomycetes strains, BH_1 and BW_1, isolated from fermented bagasse is reported and their value in bagasse hydrolysis assessed.

Table V. Molasses based production

By-product	8380 kPa case			5960 kPa case		
	% of low pressure steam for by-product	Required low pressure as % of available	Net power (MW)	% of low pressure steam for by-product	Required low pressure as % of available	Net power (MW)
Variety 12						
None	0	71.1	8.90	0	70.0	6.92
Ethanol	15.5	84.1	7.98	15.5	82.8	5.68
Acetic acid	28.5	99.4	6.30	28.4	97.8	3.64
Citric acid	51.2	145.7	[–12.50]	51.2	143.4	[–16.25]
Glycerol	25.6	95.6	5.86	25.6	94.1	3.29
Yeast	8.3	77.5	5.64	8.3	76.3	3.49
Aconitic acid	14.5	83.1	7.59	14.5	81.8	5.31
Variety 16						
None	0	56.7	10.58	0	55.9	8.53
Ethanol	14.3	66.2	10.58	14.3	65.2	8.55
Acetic acid	26.7	77.4	10.27	26.7	76.2	8.03
Citric acid	49.0	111.2	[–3.99]	49.0	109.5	[–7.06]
Glycerol	24.0	74.6	9.92	24.0	73.5	7.77
Yeast	7.6	61.4	8.27	7.6	60.5	6.21
Aconitic acid	13.4	65.5	10.21	13.4	64.5	8.16

Steam requirements for mill, boiler and boiling house operation must be maintained and any case that does not do this is not considered viable. The intermediate and low pressure steam required for the two-stage boiler feed-water heating must be taken into account. The percentage of total low pressure (process) steam required by the by-product process is given for each case. Use of 10% bagasse to produce pulp requires only about 9% of total process steam and for board almost 20% of the process steam.

For each variety and steam condition, the intermediate pressure steam required to operate the mill, etc., is calculated as percentage of the total high pressure steam since this passes through the turbo-alternator and is then available as intermediate pressure steam. Demand exceeds supply at diversion of about 20% of the bagasse.

Low pressure steam requirement as a percentage of that available from the prime movers and turbo-alternator are given for each case. The variety makes a significant difference in this case. With Variety 12, only about 12 - 15% of the bagasse can be processed to pulp without exceeding the steam supply, but this can be increased to 22 - 25% for Variety 16. Without exceeding the steam supply, only about 10% of the bagasse can be converted to board with Variety 12 and 16% with Variety 16.

Net power production (after all internal power requirements are met) are also tabulated. In some cases the data are given in square brackets to indicate that they are not sensible since there is insufficient steam available for the system. A negative value for power production, as long as sufficient prime mover and process steam is available, suggests that the system could function if an outside source of electric power were available.

An interesting alternative route to fibrous cane by-products involves the use of the Tilby separator which allows the cane to be fractionated into high and low quality fibrous components. The material and energy balances become quite different from conventional processing, but there is a paucity of data on the subject.

Molasses based products

The data for several molasses derived by-products are given in Table V. In each case the data are for conversion of all the molasses produced to the product indicated. The quantities of molasses involved are given in Table I. The ethanol case was calculated as described in the previous paper and the rest using the published data on steam and power requirements[3]. Positive energy balances are shown in each case except citric acid. This product requires extensive processing and purification and product recovery by crystallization. Ethanol, acetic acid and glycerol are recovered by distillation and yeast and aconitic acid by centrifugation and washing, all simple processes.

Summary

Bagasse based by-products may only be feasible at low levels unless additional fuel sources are available. The loss of fuel is a more important factor than the increased process steam demands.

Molasses derived by-products can be produced on-site, using all the molasses and producing surplus electric power, without additional fuel sources, if simple processing steps are involved.

Integración de las alternativas de energía y subproductos con la operación de los ingenios

Los subproductos derivados del bagazo

continued on page 157

Temperature control system for desuperheated steam

By S. M. Sharma and Hausila Singh
(Electronic Systems Area, Central Electronics Engineering Research Institute, Pilani, Rajasthan, India 333031)

Introduction

There are about 386 sugar factories in India with a total annual white sugar production of the order of 8.9 million tonnes. No less than 25,000,000 cane growers, 300,000 industrial workers and many others are directly or indirectly dependent on this industry, which is consequently of high importance to this country. Traditional methods of production are still used, however, which entail inefficient utilization of energy and low productivity. In this scientific age the importance of instrumentation for monitoring and controlling process parameters has been realised in various industries. Gains can be most profitably made in the sugar industry by modernizing and reaping the full benefits it can offer in terms of byproducts utilization such as for paper, fertilizers, chemicals and electricity generation[1] and providing better opportunities of employment in villages leading generally to betterment of life in rural areas.

S. M. Sharma

An example of such modernization is described in this paper which concerns a microprocessor-based stepper motor drive system. This has been used to control indirectly the generation of desuperheated steam by controlling the injection of condensates. The results of field trials of the controller at a sugar factory are also given.

Microprocessor-based stepper motor drive system

Stepper motors form part of a steadily growing market for advanced motion control with most sophisticated control being available now at significantly lower prices. This is due to the availability of low-cost microprocessors, memories and power semiconductors, coupled with complementary advances in metallurgy and motor technology.

For controlling the stepper motor with a microcomputer, the driver stage is connected directly to the output port whereas the motor and its driver stage are connected through a control signal cable having five wires, as shown in Figure 1. By varying the time intervals between the steps, one obtains a very accurate speed regulation. Also, counting of steps makes it possible to follow the position of the driven object.

As there are large distances between the motor and microprocessor the current in the motor windings must flow through a long cable (typical resistance 0.1 ohm/meter) and thus the total motor winding current is reduced owing to the voltage drop which takes place because of the large ratio of cable resistance to that of the motor. To compensate for this, the power supply of the driver stage is increased to a value such that the motor winding receives the rated current during operation. Thus the driver power supply becomes dependent on the resistance of the signal transmission cable. The loss of power in the signal transmission cable is found to be much greater in some cases when the resistance of the motor winding is much below the resistance of the signal transmission cable. In addition to this, the microcomputer in this method remains busy until all the steps are completed by the motor. To overcome these problems a method has been designed, developed and field-tested; it is discussed below.

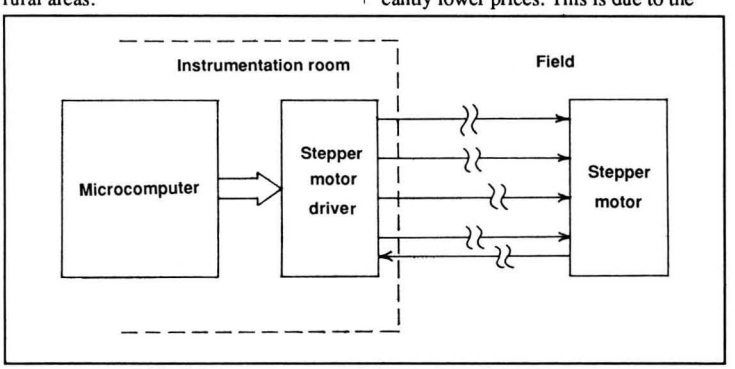

Fig. 1. Microprocessor-based stepped motor drive system

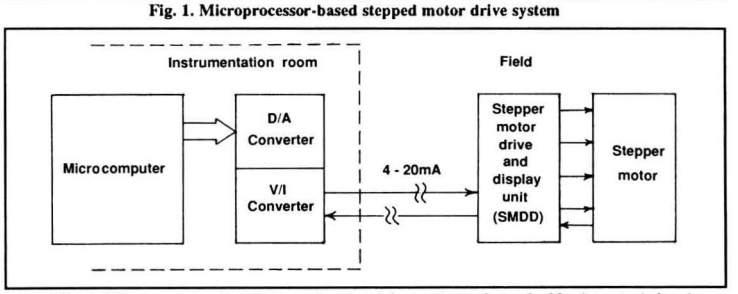

Fig. 2. Microprocessor-based stepped motor drive system using a 4 - 20mA control signal

Drive system using a 4 - 20mA control signal

A block diagram of the stepper motor drive system[2] is shown in Figure 2. The same drive system has been used for controlling the temperature of desuperheated steam and is shown in Figure 3. Its sub-systems are discussed

1 Baikow: "Manufacturing and refining of raw cane sugar", (Elsevier, Amsterdam) 1982.
2 Sharma & Singh: *Paper presented at National Seminar on Modernization of Sugar an Allied Industries* (IIT, Kanpur, India), March 26 - 27, 1988.

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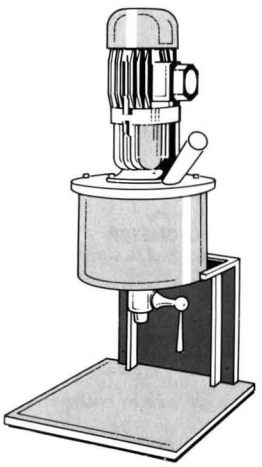

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This mill will produce after 5 hours grinding about 95% nuclei of below 10 micron.[1]

1. Report of Crystallographic Laboratory University of Utrecht, Holland.

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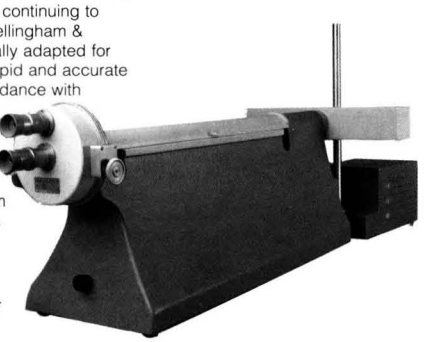

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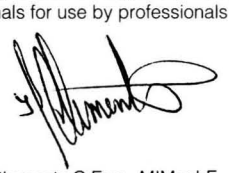

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12 **CUTEX**
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13 **ABBE 60/95 REFRACTOMETER**
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15 **SALOMETER**
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16 **ROTARY DISSOLVING MACHINE**
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17 **HYDROMETERS**
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2. E. Hugot - Handbook of Cane Sugar Engineering. 1960. p. 517

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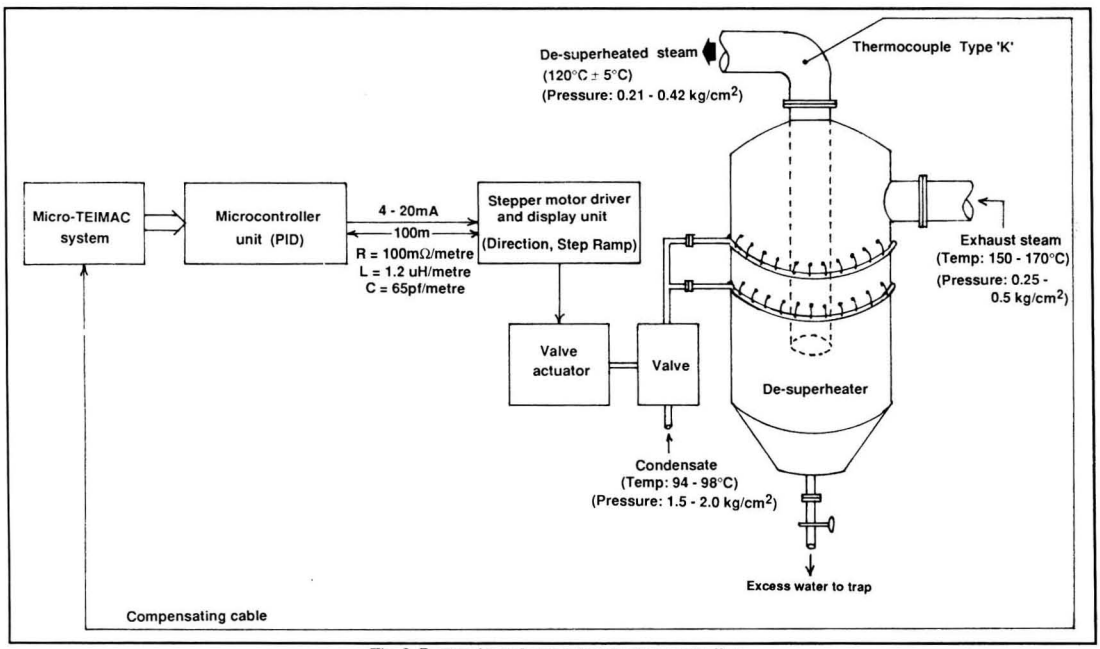

Fig. 3. Desuperheated steam temperature controller

below; they are:
(a) a microprocessor-based temperature indicating and monitoring (Micro-TEIMAC) system,
(b) a stepper motor drive and display unit, and
(c) a needle valve actuator.
Each sub-system is an independent instrument or a piece of equipment but they have been interfaced together to work as an integrated controller. High quality discrete components and integrated circuits have been used for achieving high accuracy and reliability of the system in the sugar industry

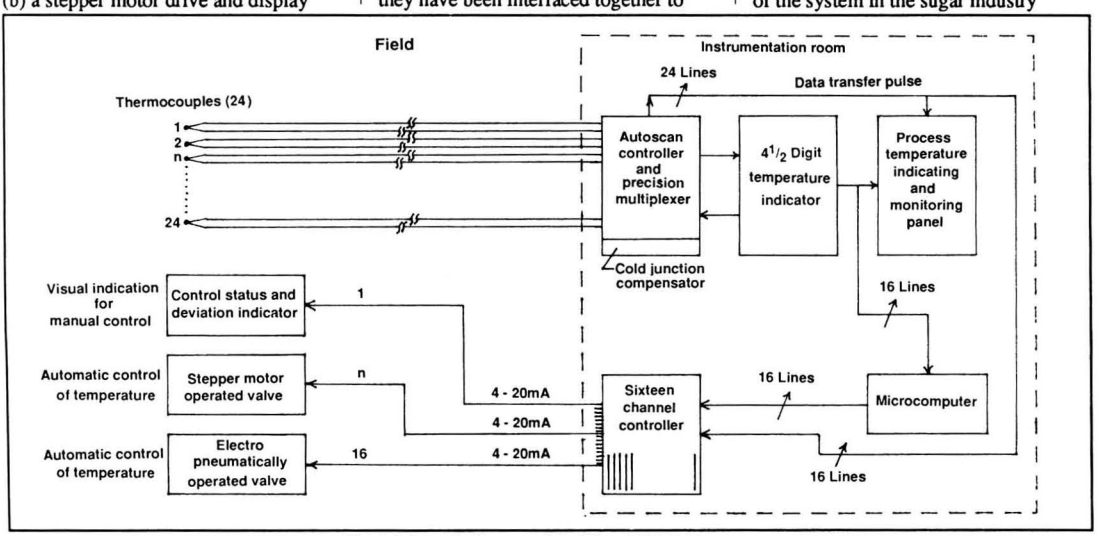

Fig. 4. Schematic diagram of the Micro-TEIMAC system

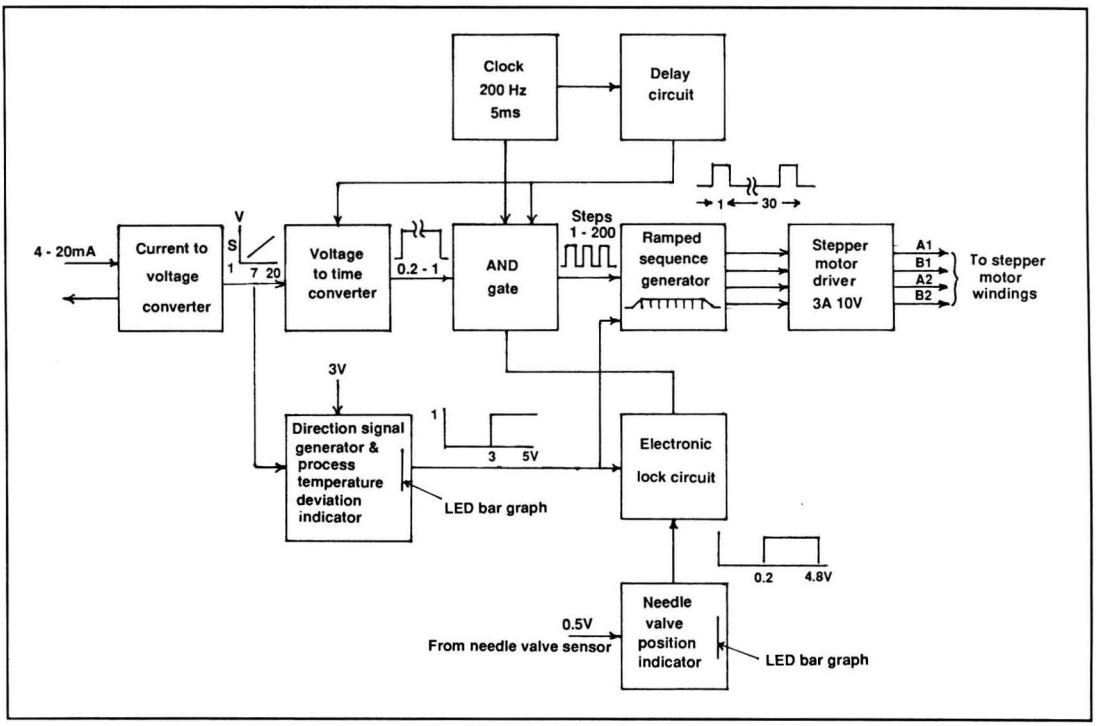

Fig. 5. Schematic diagram of the stepper motor drive and display unit (SMDD)

environment.

In addition to the above units, the system needs thermocouples, compensating cable, multicore cable and needle valve. A brief description of the subsystems is given below:

Micro-TEIMAC system

The Micro-TEIMAC system, shown in Figure 4, consists of (a) a digital temperature indicator (DTI); (b) an auto-scan controller and precision multiplexer (ASCPM); (c) a microcomputer; (d) a process temperature indicating and monitoring panel, and (e) a 16-channel controller. All these units are accommodated in a console and placed in the instrumentation room.

The temperature data from twenty-four processes are acquired from thermocouples via the compensating cable and 24 low-offset reed ASCPM relays. The DTI measures temperature accurately in the range 0°C to 1260°C with 0.1°C resolution and ±1°C accuracy. The microcomputer stores these data in a memory location, compares them with set points and generates PID error signals in binary form for sixteen channels. At the same time it transfers the data to a process temperature indicating and monitoring panel. The data acquisition channels and controller channels can be extended depending upon the user requirements. Moreover the controller can easily be extended to 24 channels in the present setup by incorporating another 8-channel controller. A 16-channel controller unit which consists of D/A converter and V/I converter receives the PID signal and generates a 4 - 20mA control signal for onward transmission to a remotely located stepper motor drive and other controllers. Two wires are needed per controller for signal transmission. The 16mA span between 4mA to 20mA carries the information.

If the transmitted signal is zero this indicates failure of the control signal circuit or power supply. The power source and the transmitter combine to give a current which appears from a high impedance source and which can feed a load or loads connected in series. The system described in this text can feed a maximum load of 500 ohms which can further be increased to 1000 ohms by using a power supply across a V/I converter to a maximum voltage of 30V.

Stepper motor drive and display (SMDD) unit

A block diagram of the stepper motor drive and display unit is shown in Figure 5. The unit receives a 4 - 20mA control signal from the 16-channel controller unit and generates the proper sequence with the help of a high per-

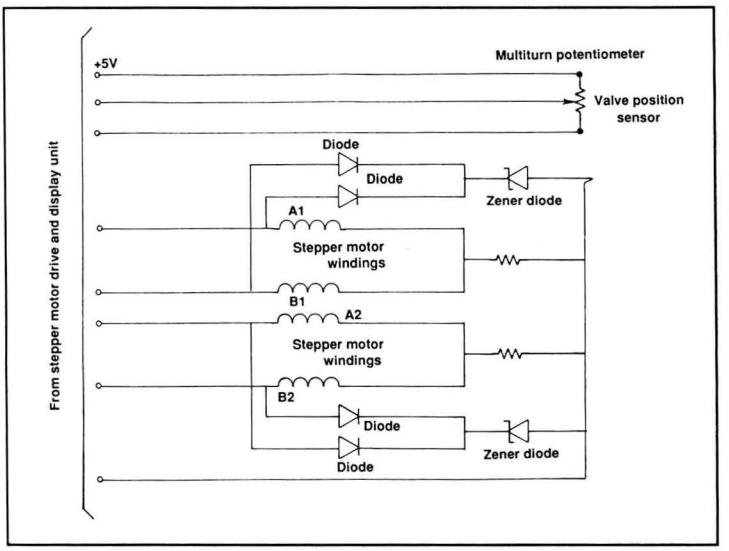

Fig. 6. Circuit diagram of the needle valve actuator

formance translator[3] for the stepper motor in ramping mode to rotate it in the desired direction by the number of steps proportional to amplitude of the control signal. The final speed, at which the stepper motor rotates without losing steps under existing load condition in the sugar factory, is 250 steps per second.

The SMDD actuates the stepper motor after a predetermined interval to allow sufficient time for the reaction to take place in the process. This interval may be adjusted as necessary. In addition to this, the SMDD generates a signal to stop the stepper motor from rotating further in the same direction whenever an extreme end position (fully open/closed) of the valve is reached during the automatic mode and saves the valve from getting damaged. This unit also provides information about the temperature status of the process and the number of turns by which the needle valve has been opened, by means of the bar graphs mounted on its front panel.

Needle valve actuator (NVA)

This consists of a STM 902 stepper motor and a multi-turn potentiometer. The circuit diagram of the NVA is shown in Figure 6. The multi-turn potentiometer is on one side of the shaft of the stepper motor, and the needle valve is connected on its other side through a flexible coupling. The multi-turn potentiometer provides the signal for the bar graph displaying the position of the needle valve. The sequence of pulses is transmitted from the SMDD to the windings of the stepper motor through a multi-core cable.

Principle of operation

The microcomputer accepts a BCD signal from the digital temperature indicator and compares this with the set point which is software-programmed. The PID error signal generated by the microcomputer is fed to a D/A converter (AD558) whose analogue output signal is maximum, i.e. 10 volts, when the D/A converter receives a binary signal equal to FFH and minimum i.e. zero volts when the D/A converter receives a binary signal equal to OOH. The 2B20 V/I converter converts the output voltage of the D/A converter into a 4 - 20mA control signal. Thus, the PID control signal, which varies between 4mA and 20mA, is transmitted over a 2-wire cable from the instrumentation room in the factory to the stepper motor site where the SMDD is mounted.

The stepper motor drive and display unit receives the 4 - 20mA control signal and converts it into a control voltage signal with the help of a metal film resistance. This control voltage signal is used for generating the direction and step signal for the sequence generator. In the ramping mode, the motor is accelerated and decelerated with a fixed load. As the stepper motor moves in a clockwise or anticlockwise direction, the needle valve closes or opens. The temperature status of the process is displayed as a bar graph mounted on the front panel of the SMDD.

Major specifications of the SMDD and NVA are as follows:

(a) Input 4 - 20mA control signal
(b) Stepper motor
  (i) Type: Permanent magnet DC stepping motor, two phase, bifilar wound.
  (ii) Step angle: 1.8° + 5% non-cumulative
  (iii) Steps per revolution 200
  (iv) Holding torque
    (1) One phase energized 14 kg.cm
    (2) Two phase energized 19.8 kg. cm
  (v) Maximum dynamic torque 14 kg.cm
  (vi) Residual torque 1 kg.cm
  (vii) Rotor inertia 0.3 kg.cm^2
(c) Valve position display : Bar graph having 20 LED's.
(d) Process temperature status display: Bar graph having 20 LED's.
(e) Accuracy of bar graph display: 2%
(f) Auto/manual mode of operation: Yes
(g) Stepping rate 200 steps/sec (adjustable)
(h) Dimensions
  (1) Stepper motor drive and display unit: 5.23 in (L) × 8.75 in (H) × 15.7 in (D)
  (2) Needle valve actuator: 3.5 in (L) × 17.5 in (H) 4.25 in (D)

Results of field trials of the stepper motor controller

The system was field-tested over

3 Athani & Mundhada: *IEEE Trans. on Industrial Electronics & Controls Instrumentation*, 1978, IECI-25, (4), 343 - 346.

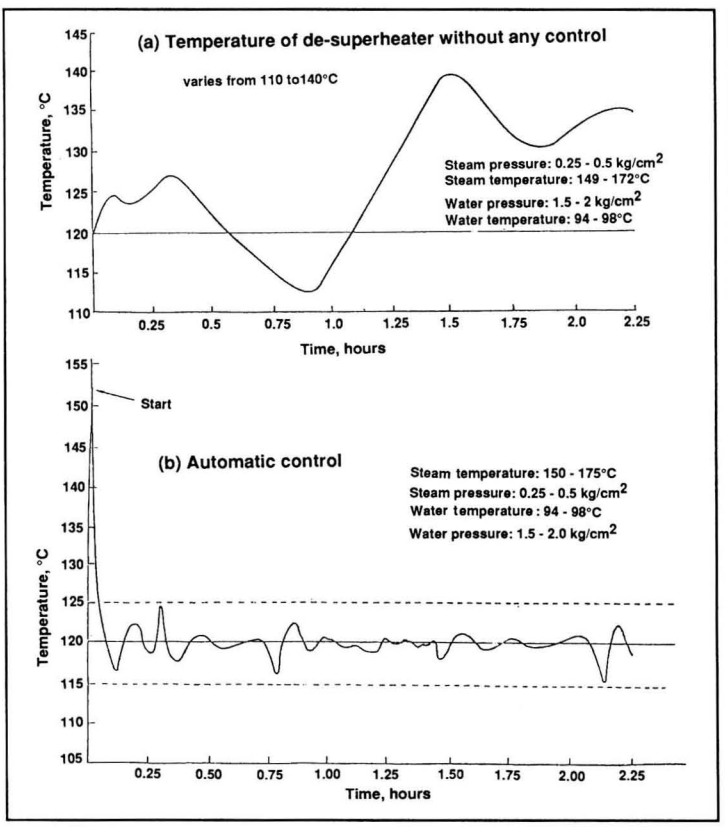

Fig. 7. Temperature variation of desuperheated steam (a) without control and (b) with automatic control

a complete crushing season at the Kisan Sahakari Chini Mills Ltd., Anoopshahar, for indirectly controlling the generation of desuperheated steam. The results are discussed below.

A block diagram of the controller is shown in Figure 3. The exhaust steam received after the power turbines, mill turbines and turbo feed pump has a pressure of around 0.5 kg/cm^2 and a temperature around 200°C. It is used in the boiling house for heating juice from 60°C to 100°C in different stages. For transferring latent heat effectively in the evaporator and pans, the temperature of exhaust steam is brought down to 120° ±10°C by cooling it with condensate (temperature 97°C approx.) The stepper motor operated valve is opened as required to allow sufficient condensate to flow through sprays in the desuperheater. The liquid absorbs heat from the exhaust steam and is itself converted into steam. The temperature of the combined steam is lower than that of original exhaust steam so that it is desuperheated.

The temperature in the desuperheater is measured by the digital temperature indicator with the help of a Type 'K' thermocouple and compensating cable. The uP-based controller unit generates a 4 - 20mA current signal which is transmitted over two-wire cable to the SMDD. The valve is opened or closed according to the control signal.

The results are shown in Figure 7. The top curve shows the temperature variation of the desuperheater without any control, between 110°C and 140°C. The valve has been opened to provide sufficient water to flow into the desuperheater at the start of the experiment.

The bottom curve shows temperature variation of the desuperheater with automatic control; this is limited to between 115.5°C and 124°C, i.e. within ±5°C of the set point (120°C). The ripple in the controller output is mainly due to delay.

It is worthwhile to note that the SMDD and NVA were located within the sugar factory where the ambient temperature rose to about 50°C in summer and where severe electrical disturbances and mechanical vibrations were present. In spite of such adverse environmental conditions there was no deterioration in performance of the SMDD and NVA. Not a single failure occurred in the entire system, including the Micro-TEIMAC system, during field trials in the sugar factory.

It has been observed that, by maintaining the temperature of the desuperheater within limits, the inversion of sucrose into glucose and fructose was reduced, which helped to increase sugar production and decrease losses. In addition to this, the transfer of latent heat in the evaporators and pans was more effective, resulting in reduced consumption of steam in the boiling house.

Conclusion

The stepper motor controller which was used for controlling the temperature of the desuperheater could maintain a temperature within ±5°C of the set point. It worked reliably in a sugar factory environment. Maintenance of the temperature of desuperheated steam allowed heating of the juice to the required temperature at different stages within the expected time, and consumption of steam was also optimized.

The control signal is transmitted from the instrumentation room as a 4 - 20mA current through a two-wire cable (resistance 0.1 ohm/metre), so that

energy loss in transmission to the remotely located stepper motor site is negligible. Moreover, the electrical noise present in the sugar factory environment has negligible effect on the control signal owing to its current form. High quality discrete components and integrated circuits have been used to achieve precision in positioning the control valve by the stepper motor. The temperature control system helps achieve higher sugar recovery, economic use of steam energy and efficient running of the factory.

Acknowledgements

The authors are grateful to Dr. G. N. Acharya, Director, CEERI, Pilani, for his guidance and encouragement from time to time during the course of development of this controller. They also thank their team members C. R. K. Prasad, K. Sivadasan, D. P. Sharma, H. R. Singhal, Bharat Singh and B. L. Saini, who provided help in the field trials, etc. The authors are grateful to the management and staff of the Kisan Sahakari Chini Mills Ltd., Anoopshahar, for providing the facilities for conducting the field trials of the controller unit.

Summary

Development of a microprocessor-based drive system for a remotely located stepper motor is reported in this paper. The 4 - 20mA control signal is generated centrally and transmitted over a two-wire cable to a remote station where the motor is located. For generating the proper drive sequence, the step and direction signals are decoded from the control signal at the remote location. The microprocessor-based stepper motor drive system has been field-tested for controlling the temperature of desuperheated steam in a sugar factory. The results of this field trial are discussed. By applying this type of controller in the sugar and allied industries, the operation of many processes can be automated.

Sistema de control de temperatura para vapor de-supercalentado

En este trabajo se informa del desarrollo de un sistema impulsor basado en un microprocesador para un motor de avance gradual ubicado remotamente. La señal de control de 4 - 20 mA es generada centralmente y es transmitida a lo largo de un cable de dos alambres a una estación remota donde está ubicado el motor. Para generar la secuencia impulsora apropriada, el avance y la dirección de las señales son decodificadas desde la señal control en el lugar remoto. El sistema impulsor del motor de avance, basado en un microprocesador, ha sido probado en el control de temperatura de vapor de-supercalentado en una fábrica azucarera. Se discuten los resultados de estas pruebas. Con el uso de este tipo de controlador se puede automatizar la operación de muchos procesos en la industria del azúcar e industrias similares.

Système de contrôle de température pour la vapeur désurchauffée

Cet article décrit le développement d'un système à base de microprocesseur qui règle la mise en marche à distance d'un moteur à fonctionnement par marche-arrêt. Un signal de contrôle de 4 à 20 mA est généré à la centrale de contrôle et est transmis au moyen d'un câble à deux conducteurs vers une station éloigné où se trouve le moteur. Afin de générer la séquence correcte de fonctionnement, les signaux de marche-arrêt et du sens de marche y sont décodés aux dépens du signal de contrôle. Ce système a été essayé en installation industrielle pour contrôler la température de la vapeur désurchauffée dans une sucrerie. On discute des résultats de ces essais. L'application de ce type de contrôleur dans l'industrie sucrière ou similaire permet l'automation de plusieurs opérations.

Temperaturregelungssystem für entüberhitztem Dampf

Berichtet wird über die Entwicklung eines mikroprozessorgeregelten Antriebssystems eines ferngesteurten Schrittmotors. Das zentral erzeugte Steuersignal von 4 - 20 mA wird über Zweidrahtkabel einer Distanzstation übermittelt, wo der Motor montiert ist. Zur Erzeugung der richtigen Antriebsequenz werden die Schritt- und Richtungssignale vom Steuersignal an der Distanzlage dekodiert. Das mikroprozessorgeregelte System des Schrittmotorantriebs wurde im Felde geprüft zur Steuerung der Temperatur von entüberhitztem Dampf in einer Zuckerfabrik. Die Ergebnisse dieses Feldversuchs werden diskutiert. Durch Anwendung dieser Art Steuergerät in der Zucker- und verbundenen Industrien kann man manche Verfahren automatisieren.

Integration of energy and by-products options with sugar factory operations

continued from page 151

solamente pueden ser factibles a niveles bajos, a menos que haya disponibilidad de otras fuentes de energía. La pérdida de combustible es un factor más importante que la mayor demanda de vapor del proceso. Los subproductos derivados de la melaza pueden ser obtenidos en el lugar, usando toda la melaza y produciendo un exceso de energía eléctrica, sin necesidad de fuentes adicionales de combustible, si se usan métodos sencillos de elaboración.

L'integration des options énergétiques et des sous-produits dans la sucrerie industrielle

On ne peut produire que de faibles quantités de sous-produits aux dépens de la bagasse, sauf si on dispose de sources supplémentaires de combustible. La perte de combustible est un facteur plus important que l'augmentation des demandes en vapeur. Lorsqu'on fait appel à de simples méthodes de fabrication, des sous-produits dérivés de la mélasse peuvent être fabriquées au sein de l'usine en utilisant toutes les mélasses et en augmentant la production de courant électrique.

Finnsugar diversification into enzymes, etc.

The Finnish Sugar Company has seen some fundamental changes in its business activities in recent years. From its formation in 1918, when six small sugar refineries in Finland joined together, until 1980, Finnsugar was virtually a 100% sugar refining company. Today, however, the company's sugar activities have declined dramatically as a proportion of its turnover. In 1978 only 22% of its turnover came from sugar; the rest was from its more recently-acquired business activities[1].

Quotas on beet sugar production in Finland, together with low crop yields and high production costs, forced the company to look elsewhere for growth. During the past eight years Finnsugar has been diversifying into a number of new and very profitable areas, including the food industry, fish and animal feed industries as well as a biochemistry and biotechnology. The watershed was reached in the mid-1960's when the company began to invest in research which led to new methods of producing speciality sugars like fructose and xylitol, and in the early 1970's large-scale production began. In order to market its new products world-wide, Finnsugar joined forces with Hoffman-La Roche to form a 50:50 joint venture company Xyrofin. Unfortunately, Xyrofin hit problems early on when, in the 1970's, research in the UK indicated that xylitol caused illness in rats. This virtually destroyed the market for xylitol in the US, despite later research which showed that only abnormal amounts would produce adverse effects. Research showed that xylitol has a preventative effect against tooth decay, a feature which Finnsugar has since been using to promote its use in chewing gum, now the biggest selling product on the Finnish confectionery market. Finnsugar, which now owns all of Xyrofin, is strengthening its marketing efforts, especially in the US.

Special sweeteners such as xylitol, fructose, glucose and sorbitol are produced by the company's Biochem Division, which also develops, produces and markets biochemicals, starch and feed enzymes for the food, animal feed and pharmaceutical industries. This international part of Finnsugar's activities accounts for about one-eighth of its turnover. Its Feed Division produces and markets compound feeds, molasses, molassed beet pulp and grass meal, as well as bone meal and feed fat for feeds. Finnsugar has 40% of the animal feed market in Finland and its turnover is equal to that of the Sugar Division. While the bulk feeds are sold mainly to the domestic market, the company is selling some products overseas, for example Clampzyme, a cocktail of enzymes which is used to preserve farm silage, reducing its pH without the need for acids. Clampzyme removes oxygen, releases glucose as a substrate for lactic acid producing bacteria and predigests the fibre of the cell walls, so increasing the feed value of the silage.

Enzymes are also being used to solve problems in the paper and pulp industries and in the food packaging industry. One enzyme system detoxifies the debarking effluent while another reduces the amount of chlorine-based chemicals needed for pulp bleaching. Glucose oxidase consumes oxygen so that, incorporated in the cap of a beer bottle, it absorbs the oxygen in the head space. It can reduce harmful oxidation of other food products, thus increasing shelf-life of certain products such as meat, fish and grated cheeses from 4 to 30 days.

Finnsugar's researchers have developed a method for accelerating the maturation process in beer, using a high-density immobilized yeast, which accelerates the production rate significantly. A major success has been Finnstim, a fish food additive which improves its conversion; it incorporates betaine, which is detected by the fish in its mixture with other amino-acids and they are stimulated to eat. Betaine also appears to protect the fish against osmotic shock when they move from fresh to salt water. As fish consumption increases and fish farming expands, prospects for Finnsugar sales look promising.

Finnsugar recently took over two companies in the US producing starch-processing enzymes; this and other acquisitions in the UK and elsewhere are part of a program intended to raise the proportion of its turnover abroad from 25% of the total to 50% in 3 - 5 years, a goal which looks achievable.

Facts and figures

New distillery in Peru

A distillery with a capacity to produce for export an initial 20,000 litres of alcohol per day is to be built at the Paramonga sugar complex, 150 km north of the Peruvian capital Lima. Cane cultivation will be expanded to provide raw material and the total investment will be $17 million; $3 million for the distillery and $14 million for the additional cane cultivation costs.

Azurca project revival[2]

Colombia and Venezuela have agreed to revive the Azurca project which was started in the 1970's. Initially it was planned that Colombia would grow sugar cane to be processed in Venezuela; the raw sugar would then be returned to Colombia for refining. A sugar factory was built in Venezuela but with a capacity only 40,000 tonnes of cane per year. Construction of the refinery in Colombia was started but never completed. Venezuela has now agreed to expand the raw sugar factory while Colombia will increase cane plantings and will finish the refinery, at an estimated cost of $5 million.

Czech sugar factory orders[3]

In 1989 cane sugar factories built by Skoda Corporation of Plzen, Czechoslovakia, are to be delivered to the Philippines and Thailand.

1 *Chemistry in Britain*, 1989, **25**, 124.
2 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 233.
3 *Skoda News*, May 1989, 2.

Drought damage to cane in Argentina[4]

Reports from Argentina say that, owing to drought, nearly half the sugar cane crop has been lost in Tucumán, the country's major cane growing province. A decrease of 3.9 million tonnes of cane is expected and this will result in a reduced sugar output from the 1989/90 season which started in June.

Cane alcohol economics in Australia[5]

According to a report by the Australian Minerals and Energy Council on the place of alternative fuels in Australia's future, alcohol is not regarded as a serious contender as it is likely to be so much more expensive than other fuel alternatives. Any significant use appears far in the future for the country since, although the technology is well-established, the economics appear poor.

Cyclone damage in Mauritius[6]

The estimate of sugar production in Mauritius this season has been sharply reduced from 680,000 to 600,000 tonnes as a result of damage caused by a cyclone in early April which destroyed between 15 and 25% of the crop in the south and east of the island and more than 30% in some areas. Losses in the north and west should not exceed 10%, however, and some of the loss may be recovered if there is good weather between now and harvesting at the end of the year. Mauritius should not have any difficulty in meeting its priority export commitments.

Colombia sugar exports, 1988[7]

	1988	1987
	tonnes, raw value	
Bulgaria	21,000	145,155
China	60,950	0
Dutch Antilles	1,280	0
EEC	12,000	0
Japan	0	4,025
Morocco	56,000	0
Peru	2,506	0
Trinidad	0	4,924
USA	76,647	54,372
USSR	12,000	12,000
Other countries	600	0
Total	242,983	220,476

Rise in Madagascar sugar exports[8]

Madagascar's sugar exports in 1989 are estimated at 57,000 tonnes, owing to a sharp increase of sugar production in the 1988/89 crop. This will be the first time that the country has exported more than 25,000 tonnes in one year, and exports from the current crop will fall again to 40,000 tonnes.

UK drought and aphid damage[9]

The beet crop in the United Kingdom is suffering badly from the combined impact of drought and aphid infestation. Dry weather in March allowed sowing of 60% of the 1989 beet crop but heavy rain delayed sowing of the rest until May. The earlier sown crops have progressed well but the later ones have emerged erratically and all are in need of rain. There will be a virus yellows

4 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 196.
5 *Australian Canegrower*, 1989, **11**, (5), 2.
6 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 197.
7 *I.S.O. Stat. Bull.*, 1989, **48**, (4), 8.
8 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 211.
9 *British Sugar Beet Review*, 1989, **57**, (2), 1, 4 - 6.

Irish sugar conference

An international sugar technical conference took place at the Hotel Europe, in Killarney, Ireland during June 5 - 8, under the auspices of Irish Sugar PLC. Participants gathered at the hotel during June 5 and were entertained to a reception in the evening by the host company. The Conference opened on the following morning, under the chairmanship of E. Olden of Thurles factory and included presentation of three papers, "Experiences of a full falling film evaporator station" by K. L. Carter and P. D. Thompson of British Sugar plc, "Refinery developments in the white sugar station at Carlow including pan seeding and MET vacuum cooling crystallization" by M. E. Buckley of Irish Sugar PLC, and "Modern technical trends in sugar crystallization" by D. Schliephake of the Braunschweig Sugar Institute. The afternoon sessions, under the chairmanship of E. Collins of Carlow factory, included two papers: "Experiences with an interesting arrangement of a falling film evaporator and continuous crystallization at Minerbio sugar factory in the 1988 campaign" by C. F. Buja of Minerbio sugar factory, Italy, and "Possibilities and practical results of continuous pan boiling" by E. D. Bosse, of Braunschweigische Maschinenbau Anstalt AG.

The third session, chaired by S. Gannon, of Marlow factory was held on the following morning and included papers on "Eemshaven sugar terminal: Facts and figures of a 100,000 tonne horizontal sugar silo constructed in 1988" by J. R. Boersma, of Suiker Unie, "Beet sugar colorant: recent studies" by Margaret A. Clark and colleagues of Sugar Processing Research Inc., New Orleans, and "The utility of a factory sugar loss identification program reflecting variable sugar beet quality" by S. E. Bichsel and L. Batterman of American Crystal Sugar Co.

The afternoon was free for golf, scenic tours, etc., and the Conference resumed for its fourth session on Thursday morning under the chairmanship of M. J. Brennan of Irish Sugar's head office in Dublin; it included papers on "Purification of waste water treatment in a sugar factory – anaerobic and aerobic treatment and N elimination" by C. Nähle, of Süddeutsche Zucker -AG, "Further developments in extraction efficiency with a DDS diffuser" by A. F. Johnsen, of A.S. De Danske Sukkerfabrikker, and "Experience with cathodic corrosion protection in diffusion" by R. Rosenqvist and H. Hallanoro of Finnsugar and M. Ainali of Savcor-Consulting Oy., Finland. The Conference was then closed and the participants, who included 41 Irish Sugar personnel and 35 foreign guests from 11 countries, dispersed. Abstracts or shortened versions of the papers will appear in this Journal in due course.

problem this year owing to the large numbers of green aphids in all areas, and the spread of these insects which are resistant to insecticides is causing concern, as in the presence of weed beet in up to a third of the crop area.

Malaysia sugar imports, 1988[10]

	1988	1987
	tonnes, raw value	
Australia	534,869	427,960
Brazil	33,390	0
Cuba	54,644	15,498
Fiji	68,452	119,790
Swaziland	12,702	0
Thailand	37,010	101,798
	741,067	665,046

Costa Rica sugar crop reduction[11]

The 1988/89 sugar harvest could be 20,000 tonnes lower than the previous one because of factory shutdowns (because of low domestic sugar prices) and to farmers' switching to other crops such as coffee. Exports are likely to fall to 37,000 tonnes, down from the average 80,000 tonnes of the past ten years.

Tanzania sugar shortfall[12]

Sugar production in Tanzania is expected to be some 100,000 tonnes, or 250,000 tonnes short of the country's annual demand. The shortfall is attributed to a number of factors including old machinery. The ailing industry needs to establish new and modern factories and big sugar cane plantations in various parts of the country. At the moment, Tanzania depends on three factories and imports limited quantities, mainly from Zambia and EEC countries. It exports some 11,000 tonnes annually to the EEC under its ACP preferential price quota.

Molasses in animal fodder

The GEPLACEA/UNDP Diversification Program has concluded publication of a book "Molasses as an ingredient in animal feed", which comprises the *Proceedings* of the Seminar/Workshop organized by the International Foundation for Science, in cooperation with the University of Camagüey, Cuba, and held in July 1987. Information may be obtained from GEPLACEA, Av. Ejército Nacional - 1er piso, 11520 México, D.F., México.

Bagasse utilization study in Mexico[13]

A pilot plant for the production of hydrolysed bagasse and pith by vacuum treatment was recently put into operation at the Casasano "La Abeja" sugar factory in Cuautla, Morelos. Production will be batchwise at first but facilities will later be adapted to continuous operation.

New Indian sugar factories[14]

Two new sugar factories started operations in Tamil Nadu recently. The Sakthi Sugars Ltd. factory at Sivaganga has computerized controls and it will be possible to ensure higher recovery as well as savings in energy consumption. Dharani Sugar Mills, a non-resident Indian venture, has completed its plant near Vasudevanallur in Tirunelveli district and is the first to come into operation in the current plan period with a capacity of 2500 tcd. Full capacity will be reached shortly and cane supplies are more than adequate in the factory area.

Further Mexican sugar imports[15]

Mexico will import 400,000 tonnes of white sugar in 1989 to offset an expected poor 1988/89 harvest, now set at between 3.43 and 3.45 million tonnes, down from 3,593,000 tonnes in 1987/88. Poor weather in the south-east sugar producing region is blamed for low production. The new imports are in addition to 270,000 tonnes imported earlier[16]. Mexico will, however, export about 200,000 tonnes of raw sugar in 1989; in 1988 exports amounted to 950,000 tonnes.

Guyana sugar workers strike[17]

In protest against the increase in cost of staple foods caused by a 70% currency devaluation on April 1, workers in the Guiana sugar and bauxite industries went on strike. The latter remain on strike but the sugar workers have ended their protest. The consequence of the interrupted Spring crop (now estimated at 75,000 tonnes against 90,000 tonnes before the strike), together with arson in some of the cane fields, has been that with no hope of fulfilling its EEC supply quota of 167,000 tonnes by the end of June Guyana has had to declare *force majeure* over the 40,000-tonnes shortfall. In 1988 low sugar production prevented fulfillment of the US supply quota, which was redistributed to other Caribbean producers.

Cyclone damage in Queensland[18]

The cyclone which hit the Queensland coast on April 4 destroyed about 10% of the cane crop in the Burdekin River delta – some 400 - 450,000 tonnes – but the loss of revenue to growers and millers is less than initially feared and seems likely to have negligible impact on the world market. Because much of the cane in the area was already wet and standing in soft ground, it was simply flattened by the strong winds. Had the area been dry, the cane might have snapped, wrecking it altogether.

Dominican Republic sugar exports, 1988[19]

	1988	1987
	tonnes, raw value	
Algeria	19,870	27,810
Bahamas	0	659
Bulgaria	0	12,628
EEC	10,712	0
Finland	12,875	0
Haiti	8,164	3,913
Korea, South	0	515
Morocco	16,480	70,040
Tunisia	0	11,742
USA	228,900	302,800
USSR	219,560	146,315
Other countries	11,045	10,936
	527,606	587,358

10 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, S193.
11 *Reuter Sugar Newsletter*, March 1, 1989.
12 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 235.
13 *GEPLACEA Bull.*, 1989, **6**, (4), Sugar Inf.-1.
14 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 237 - 238.
15 *S. African Sugar J.*, 1989, **73**, 110.
16 *I.S.J.*, 1989, **91**, 99.
17 F. O. Licht, *Int. Sugar Rpt.*, 1989, **121**, 258, 275.
18 *Financial Times*, April 6, 1989.
19 *I.S.O. Stat. Bull.*, 1989, **48**, (6), 10.

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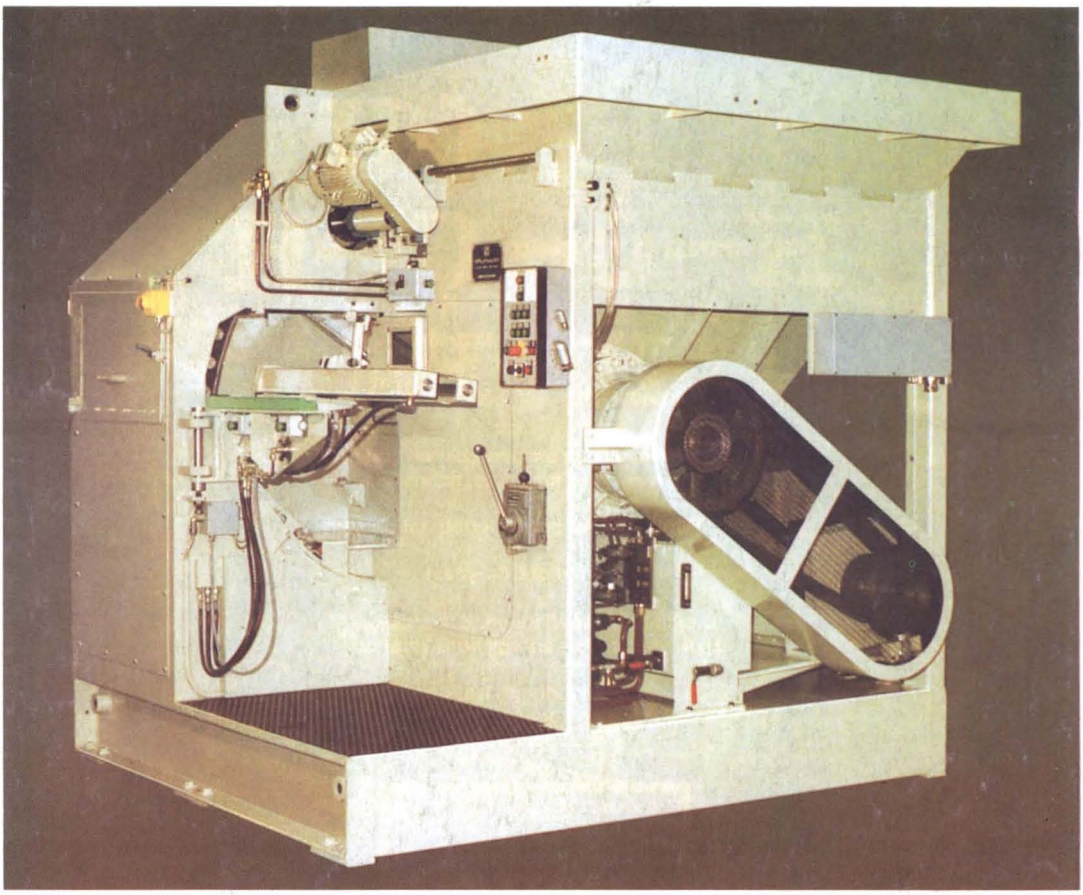

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