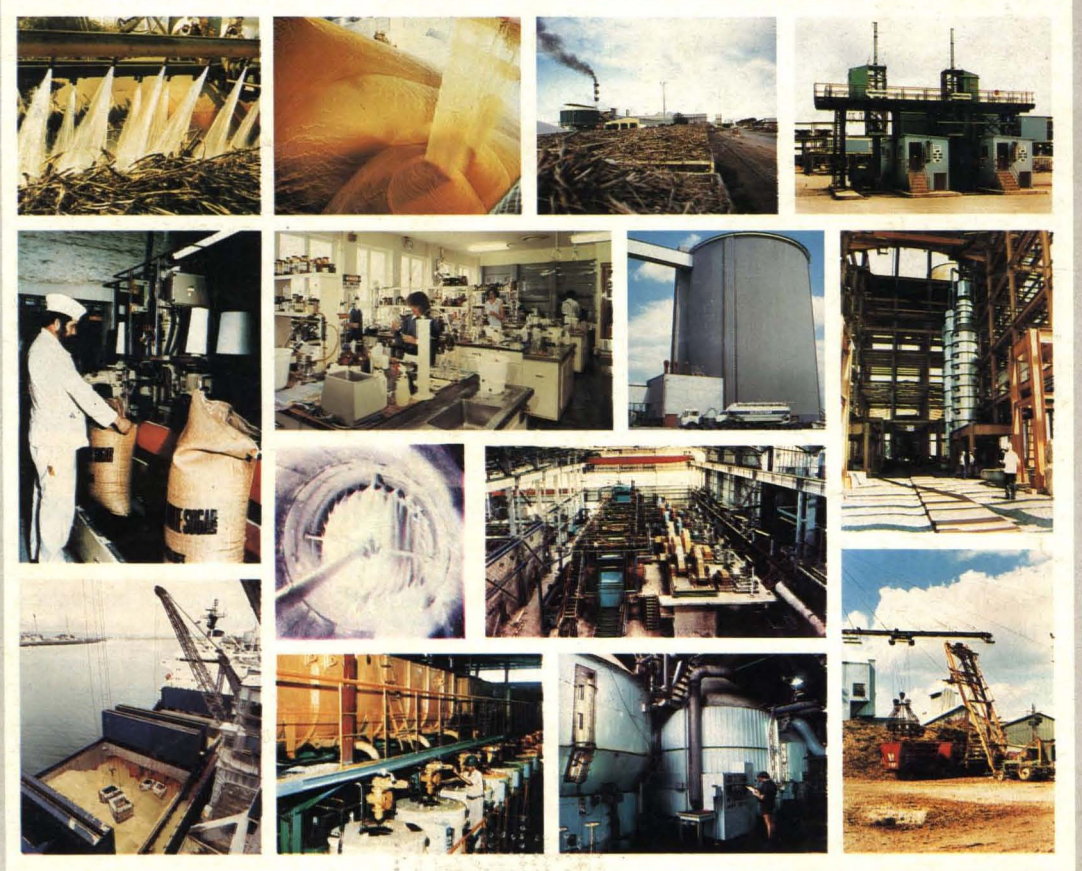
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXXII/ISSUE No.1104 DECEMBER 1990

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INTERNATIONAL SUGAR JOURNAL

UK ISSN 0020-8841
Volume 92
Issue No. 1104
December 1990

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Published by

International Media Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.
Telephone: +44-639-887498 *Telex:* 21792 REF 869 *Telefax:* +44-639-899830
US Office: 2790 Foster Avenue, Corning, CA 96021

Annual Subscription: £70.00 post free

Single Copies £7.00 post free

By Air: £35.00 extra

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News and views

World sugar prices

The situation in the Middle East, a weaker US dollar and continued rumours of purchases by China caused a strengthening of the London Daily Price for raw sugar during the first third of September and it rose from $268.20 on September 3 to $293.80 on September 11. Thereafter there was little news to affect the market and the LDP hovered around $285 until September 24 when it started to slide with liquidation of contracts, reinforced by a somewhat bearish assessment by F. O. Licht GmbH of sugar production prospects for 1990/91, to end the month at $271.20.

The white sugar price started the month at $328 per tonne and stayed roughly constant during the first third of the month but then slipped to $305 on September 19, after which it recovered, to end the month at $313.70. The reduced premium over the raw sugar price reflected a lack of white sugar demand and was only $42.50 per tonne on September 28 against $61 on August 31 and almost $100 in May.

During the first half of October, the bearish trend continued in the raw sugar market and the LDP slid further. Selling by managed funds was largely responsible, reinforced by news that India was likely to export more than 200,000 tonnes in order to gain hard currency needed to pay for more expensive oil. Predicted purchases by China, Mexico and the USSR did not materialize and Licht's first estimate of the world sugar balance for 1990/91 indicated a small surplus. As the market fell, stop-loss orders resulted in more selling and even lower prices so that the LDP dropped to $241.70 per tonne on October 16, its lowest level since May 1988. The Soviet Union then confirmed that it had bought 100,000 tonnes and that more would be required; the LDP revived and rose to $264 on October 23 but this could not be sustained in the absence of more business, and it started to fall again, reaching $246 on October 29, after which a further small recovery brought it to $249.60 on October 31.

During this time the white sugar price remained much more stable, although it moved to some extent in parallel to that for raw sugar. Apart from a dip to $297.50 on October 16, it remained between $300 and $318 for the whole of the month, ending it at $308 per tonne, the premium rising from around $48 per tonne at the beginning of the month to near $60 at the end.

World sugar production estimates, 1990/91

F. O. Licht GmbH has recently published[1] estimates of world sugar production during the current season with a total of more than 111 million tonnes, raw value, or 2.8 million tonnes more than 1989/90. Global cane sugar output is forecast at 71 million tonnes, up by 2.4%, while beet sugar production is estimated to reach 40.2 million tonnes or 2.8% more than last season. The increase of 2.8 million tonnes is not considered dramatic, as there is significant pent-up demand which could bring demand growth back to the normal 2% average witnessed during the 1980's. However, it could mean a limited addition to stocks which would not be high enough to produce a market depression. Further, world stocks are not sufficiently high to provide a safety net should there be weather-induced production shortfalls. Hence the outlook is for stable prices but with a greater likelihood of upward than downward movements.

Sugar from beets is expected to provide 36% of the world total, somewhat higher than 1989/90, owing to higher West European and Asian crops. The EEC responded to higher prices and has expanded the beet area so that, in spite of a dry summer in places, a 3.9% increase of production is expected. Outside the EEC no drastic changes are forecast except for the 30% rise in Turkey's sugar production; this reflects more a poor campaign in 1989/90, however. In East Europe production is expected to fall slightly but, outside Europe, increases totalling 6.8% are forecast, including higher crops in the USA, China, Japan and Iran.

Asian cane sugar production is forecast to rise from 28.2 to 29.1 million tonnes in 1990/91. This will depend greatly on Indian sugar production; in recent years government incentives have led to more cane being delivered to the factories instead of to gur producers while good weather has also increased the cane crop. If output were to rise steeply a surplus could be produced which might have to be sold at a loss on the free market; in such circumstances the government might scrap the incentives, when production could be affected. China has been affected by drought, while in Thailand the drought last year could continue to affect 1990/91 production.

The Cuban crop is an uncertain factor because of political considerations and shortfalls in oil supplies from the USSR, but last year a surprisingly large crop of more than 8 million tonnes was produced despite a harvest plagued by bad weather and technical problems. US cane sugar production is expected to decrease following the effects of the freeze last December, while in South America production will be largely dependent on output in Brazil. This will be affected by how much cane is used for alcohol manufacture and will depend on the relative prices of sugar and oil.

Argentina can be expected to produce a normal crop, higher than that of 1989/90 which was affected by frost, while improved market conditions are likely to lead to a small increase in production in Colombia. Overall production in Africa is expected to be little changed but the Australian outturn is likely to be disappointing because of an extended drought followed by prolonged wet weather. Details of the estimates appear elsewhere in this issue.

US tariff rate quota

As reported in a previous issue[2], the new tariff rate quota system was introduced on October 1. The sugar imports subject to the low duty of 0.625 cents/lb (or zero in the case of benefici-

1 *Int. Sugar Rpt.*, 1990, **122**, 495 - 501.
2 *I.S.J.*, 1990, **92**, 193.

aries of the Generalized System of Preferences or the Caribbean Basin Initiative) will continue to be determined on the basis of the estimated demand for sugar in the US market and domestic supplies. The US Dept. of Agriculture has announced that, for fiscal 1991 (the 12 months from October 1, 1990), the quota has been set at 1,725,000 tonnes (1.9 million short tons), raw value, an increase of 6.5% compared with 1989/90. Sugar may be imported above this amount but will be subject to a very high and variable second-tier duty, currently 16 cents/lb. This will have the same effect, i.e. excluding above-quota sugar, as the original quota system with an absolute limit, but is designed to comply with GATT requirements.

Country-by-country quotas are as follows, in tonnes, raw value:

Argentina	71,344
Australia	137,710
Barbados	11,614
Belize	18,251
Bolivia	13,273
Brazil	240,578
Colombia	39,820
Congo	7,730
Costa Rica	24,887
Dominican Republic	292,010
Ecuador	18,251
Fiji	14,932
Gabon	7,730
Guatemala	79,640
Guyana	19,910
Haiti	7,730
Honduras	16,592
India	13,273
Ivory Coast	7,730
Jamaica	18,251
Madagascar	7,730
Malawi	16,592
Mauritius	19,910
Mexico	7,730
Mozambique	21,569
Nicaragua	34,842
Panama	48,116
Papua New Guinea	7,730
Paraguay	7,730
Peru	68,026
Philippines	262,147
St. Kitts	7,730
El Salvador	43,138
Swaziland	26,547
Taiwan	19,910
Thailand	23,228
Trinidad	11,614
Uruguay	7,730
Zimbabwe	19,910

Chinese sugar expansion[3]

Guangxi is one of the provinces where the authorities in China have encouraged expansion in cane growing after the declines in areas in the traditional regions during the 1980's. Since August there has been a severe drought in Guangxi, however, with small rivers, ponds and reservoirs drying up, and some spontaneous cane fires have been reported.

The major beet growing area in China is Heilongjiang, where sugar production is of the order of 550,000 tonnes. However, there have been considerable investments in Xingjiang over the past two years and the region has now risen to be the second largest beet producer in the country. The State Council designated the region as a sugar beet producing centre in 1988, since when the beet harvest has almost doubled to 2 million tonnes of roots. The area has increased 41,300 ha to 66,600 hectares while investments of some 100 million yuan (about $27 million) have been used to increase the productivity of low and middle-yielding land. Since 1986 some 400 million yuan have been spent by the regional authorities building six new factories. This brings the total number of plants in the area to 11 with an overall production capacity of 330,000 tonnes.

Taiwan sugar imports[4]

Owing to falling domestic production and rising demand, Taiwan will have to import sugar for the first time ever and the government has given permission for imports of up to 50,000 tonnes. Taiwan's consumption in 1990 is estimated at 500,000 tonnes, up some 20,000 tonnes from 1989. Sugar production in 1989/90 was down by 140,000 tonnes from the previous season, however, owing to the flooding of cane plantations by several typhoons last year, and the production estimate for 1990/91 has been reduced to 480,000 tonnes. Another factor is that fewer farmers are willing to plant cane because of lower profits than from other crops. Taiwan is normally an exporter, although exports have been comparatively low in recent years.

South African sugar industry deregulation[5]

Sugar production in South Africa has been tightly regulated by laws controlling land use and sale of produce, introduced to protect farmers from the dual threat of bad weather and competition. The government has now relaxed the stringent rules governing price fixing and allocations of permits and land, and the effect will be to make more room for small growers and add about 300,000 tonnes to the country's current 2.1 million tonnes output of sugar. Up to 10,000 new growers are expected, many of them black and in the impoverished tribal homelands of KwaZulu and KaNgwane. Growers producing less than 250 tonnes of sucrose per year will be able to sell their cane at a favourable rate outside the quota system. Most of the extra sugar is expected to be sold abroad and, although Canada and the US put an embargo on South African sugar four years ago, the industry has had little difficulty finding buyers for its sugar without any price sacrifice. In the near term, however, revenue will be hit by a local winter drought and lower world prices.

The South African Sugar Association is looking at the possibility of securing a new southern Africa regional market for sugar now that Pretoria's reforms are easing relations with neighbouring states. But for the industry as a whole, the main benefit of apartheid reform is the chance that the World Bank might eventually help fund a multi-million rand irrigation project in the Komati River basin in the Eastern Transvaal.

Jamaica sugar industry situation[6]

The Jamaica sugar industry produced some 215,600 long tons of 96°

continued on page 257

3 *Czarnikow Sugar Review*, 1990, (1801), 148.
4 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 492.
5 *Public Ledger's Commodity Week*, October 6, 1990.
6 *Sugar Assoc. of the Caribbean XXIV Conf. Newsletter*, 1990, (2).

Laser-cut screens for continuous centrifugals

By P. G. Atherton*, M. Brandt**, K. C. A. Crane*** and A. G. Noble*

Introduction

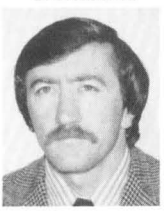
The introduction of continuous centrifugals to the raw sugar industry some thirty years ago resulted in a reduction of the problems encountered while handling low-grade materials in batch machines, and reduced the capital outlay per unit of capacity.

However, the thin layer of massecuite flowing up the screen of a continuous machine does not form its own filtering medium, as does the thick bed in a batch machine. Fine screens had to be developed, to avoid excessive losses of crystal to molasses, before these machines could come into factory use.

Screen apertures of some 40 to 60 microns were required for this service, smaller than could be produced by conventional punching techniques. Among the alternative methods for screen production were chemical etching and electro-deposition. Chemical etching has the problems that the configuration of the hole leaves very thin, weak edges, and the minimum hole size will be no smaller than the thickness of the material used. Material of 40 to 60 microns thickness would be too low in strength to be used for this application.

P. G. Atherton

M. Brandt



K. C. A. Crane

A. G. Noble

Screens manufactured by electrodeposition were developed and have been in use for many years. The screens are normally made from a base of nickel, electrodeposited on a former, and subsequently chromium plated. The screens used in Australia have commonly 6% open area, with slots 60 microns wide and 1500 to 2000 microns long.

While these chrome-nickel screens have served the industry well, they have at least one serious disadvantage. A chromium plated surface is rarely continuous, having cracks at frequent intervals. These cracks allow molasses to penetrate through to the nickel substrate, exposing it to the corrosive action of the molasses. Particularly in places like Australia, where the molasses is very corrosive in nature (potassium content up to 40,000 ppm, chloride content up to 30,000 ppm), rapid corrosion of the nickel below the chromium plating can occur, as shown in Figure 1. This corrosion results in detachment of areas of the chromium, as shown in Figure 2, exposing the relatively soft nickel to the corrosive action of the molasses and the abrasive action of the sugar crystals. Widening of the slots in the screen then occurs rapidly, causing increased losses of sugar to molasses.

This matter has been studied in some detail in Australia and is fully reported in papers by Greig *et al.*[1,2], Kelly *et al.*[3], and White *et al.*[4]. Staff of the Bureau of Sugar Experiment Stations (BSES) have for some years been seeking an alternative for Cr-Ni screens because of the serious losses of sugar to final molasses caused by the rapid deterioration of these screens, and have investigated a number of possible replacements.

In 1986 BSES became aware of the expertise in laser technology residing within the Commonwealth Scientific and Industrial Research Organisation (CSIRO), which is the official research body of the Commonwealth Government of Australia. Contact was made with

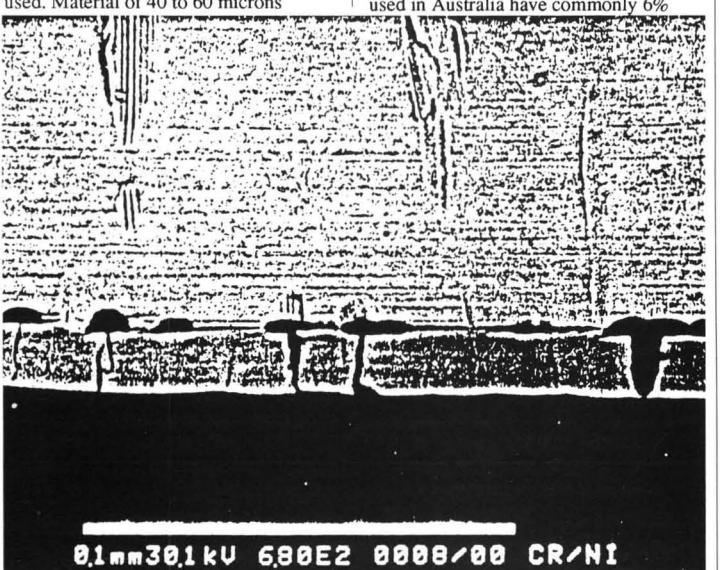


Fig. 1. Cross section of unworn screen removed from a centrifugal. Cracks in the chromium layer and corrosion under the layer can be readily observed. The white bar indicates 100 microns

Paper presented to Sugar Industry Technologists, 1990.

* Bureau of Sugar Experiments Station.
** Commonwealth Scientific and Industrial Research Organisation.
*** ActionLaser Pty. Ltd.

1 *Proc. Australian Soc. Sugar Cane Tech.*, 1984, 243 - 249.
2 *ibid.*, 1985, 179 - 188.
3 *ibid.*, 161 - 168.
4 *ibid.*, 1987, 207 - 213.

staff of the Division of Manufacturing Technology of CSIRO and discussions were held on the prospects for making screens from stainless steel using laser techniques.

CSIRO agreed to investigate the matter and subsequently undertook, under the sponsorship of BSES, to produce screens for testing in a small laboratory centrifugal. CSIRO have patented the process for the manufacture of these screens.

Laboratory testing

Two screens were produced for the 200 mm conical basket laboratory centrifugal at Queensland University. These were made from 300 μm thick sheet of 302 stainless steel, one screen with round holes approximately 70 μm diameter, and one with slots approximately 50 μm × 550 μm.

The performance of these screens was evaluated by testing in the laboratory centrifugal, as well as by carrying out static flow tests, and comparing the results with those obtained from a chrome-nickel screen of similar open area. It was found there was no significant difference in capacity and performance between the three screens.

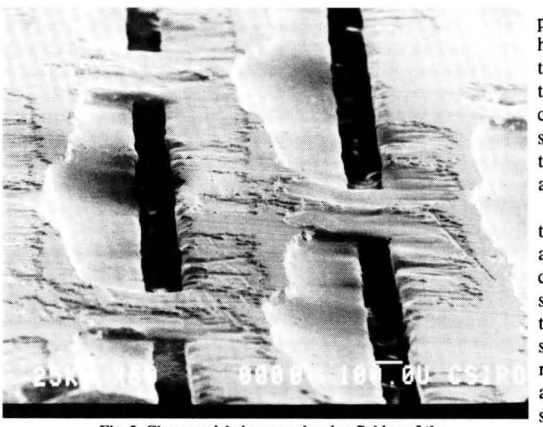


Fig. 2. Chrome-nickel screen showing flaking of the chromium layer and abrasion of the soft nickel base to enlarge slot widths from 60 to more than 100 microns

Strength testing, and corrosion testing using final molasses, were also carried out on samples of stainless steel, titanium and chrome-nickel screens.

The salient points of the results were: (a) *Corrosion testing*
As expected, titanium was the most corrosion resistant material, while 316 stainless steel was markedly superior to 302.

(b) *Strength testing*
The stainless steel screens showed superior strength characteristics, both parallel to the slots (2 times higher) and perpendicular to the slots (7 - 10 times higher), to those exhibited by the chrome-nickel screens. Current stainless steel screens are of a temper stronger than these annealed samples.

Following these initial tests it was decided to produce a set of screens for a full size commercial machine, using a slot configuration similar to that used in chrome-nickel screens. A collaborative agreement was entered into by BSES and CSIRO to develop these screens, and a set was manufactured by CSIRO for a BMA K1000 centrifugal.

Testing in a K1000 machine – 1987 season

The screen produced was installed on the low grade centrifugal station of a sugar factory equipped with five BMA K1000 machines. The program was designed to test the performance of the machine fitted with the laser-cut stainless steel screen compared with that of an identical machine fed with massecuite from the same source, and fitted with a conventional chrome-nickel screen.

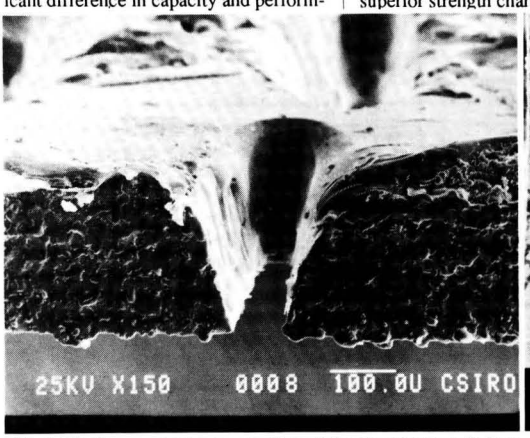


Fig. 3. SSL slot cross section showing high relief angle and extremely sharp edges (Magnification × 150)

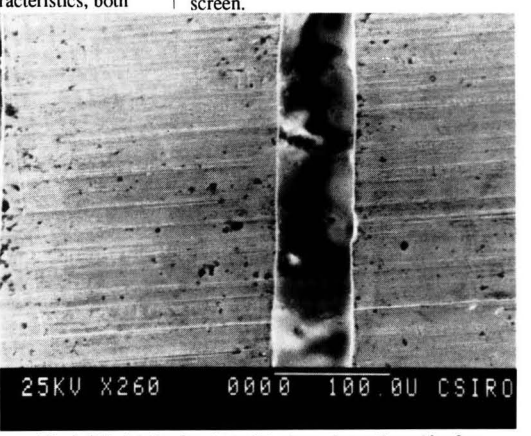


Fig. 4. SSL slot showing sharp slot edge and smooth working face (Magnification × 260)

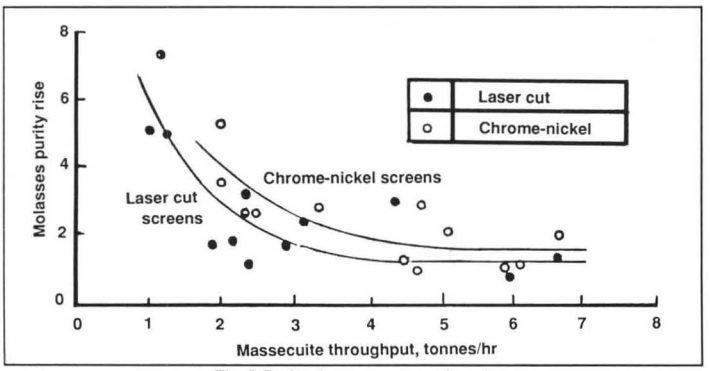


Fig. 5. Purity rise *versus* massecuite rate

The laser-cut screen had the same nominal area (6%) as the chrome-nickel screen and the slots were 60 μm × 750 μm, cut in 200 μm thick 316 stainless steel. Figures 3 and 4 show a typical slot cross-section and a typical slot width profile for the laser-cut screen. The cross section illustrates the sharp edges of the inlet side of the slot and the good relief angle provided by this method of perforation, while the slot profile shows the consistent slot width, sharp slot edge and the smooth working face of the screen.

The procedure involved the running of trials at intervals throughout the test period, to compare capacity figures and sugar and molasses analyses. The general approach was to set the machines' feed rates to give the same sugar purity, and to do three trials at different sugar purity levels on each run. A comprehensive log of temperatures, pressures and water flows was taken. Molasses flow rate was measured by timing the collection of a known volume; samples of massecuite, sugar and molasses were taken and analysed. A pressure-filtered sample of mother liquor was taken from a sub-sample of massecuite, and analysed so that the purity rise through the machine could be determined. From the molasses rate and the analysis results the massecuite rate was calculated.

The results from these tests showed that there was no significant difference in performance between the two types of screen with regard to either machine capacity or purging efficiency, and that the machine fitted with the stainless steel screen showed a lower purity rise. This is illustrated in Figure 5, which shows the relationship between purity rise and massecuite rate for the two machines. Lines of best fit have been determined from a regression program, and are shown below. As expected, purity rise decreases to a minimum as massecuite rate is increased.

The equations for the two lines are:

Laser-cut

$$P = 4.561 + 1.354M - 6.277 \log_e M \quad (r^2 = 0.687, n = 12)$$

Chrome-nickel

$$P = 6.103 + 1.083M - 6.154 \log_e M \quad (r^2 = 0.650, n = 12)$$

where P = purity rise and M = massecuite rate (tonnes/hr)

The benefit ranges from 0.5 units at 5 tonnes/hr to about 1.0 units at 2 to 3 tonnes/hr, so at normal feed rates an average gain of some 0.75 units would be expected.

Screen wear and slot widening were significantly less with the stainless steel screen. Figures 6 and 7 show the comparison between a 60 μm slot stainless steel laser-cut screen and a 60 μm slot chrome-nickel screen after 1300 hours of operation.

There was markedly less blinding with the stainless steel screen. Examin-

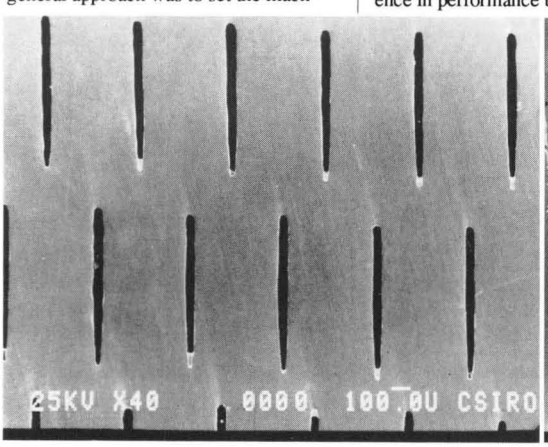


Fig. 6.

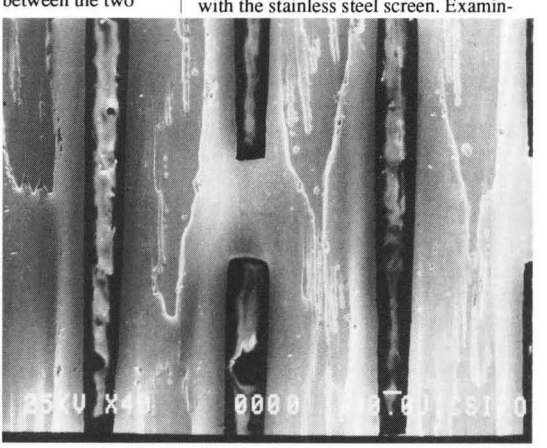


Fig. 7.

ation of the screens after removal showed significant slot blinding in the chrome-nickel screen, and an insignificant amount in the stainless steel laser-cut screen.

The greater strength of the stainless steel screen resulted in less distortion of the working screen over the backing screen. A typical example of the distortion experienced with chrome-nickel screens is shown in Figure 8. Such distortion can lead to a significant loss of crystal, and can be a serious problem with chrome-nickel screens.

Fig. 8. Chrome-nickel screen showing slot distortion over the backing screen (Magnification × 30)

Further testing in factory machines – 1988 season

Following this successful test in a single K1000 machine in one sugar producing district in Australia, it was decided to produce for Australian mills a limited number of screens, on a cost basis, for trial purposes. Some ten screens were produced and distributed to mills throughout a wide geographical spread.

These screens were produced in the laboratories of the Division of Manufacturing Technology of CSIRO, using the same laser equipment that was used for the production of the screen for the K1000 machine. Unfortunately, supplies of the requisite size of 316 sheet were not available and 304 stainless steel had to be used, except for some loading pot screens which were made from offcuts of 316 steel purchased earlier.

The results obtained from testing and from feedback from mill staff during this season were not as conclusive as desirable, owing to unexpected problems with wear in the screens, particularly in high-capacity machines. The results showed more scatter than was previously experienced, owing to these wear problems, which were considered to be exacerbated by the lower resistance to chloride attack exhibited by 304 as against 316 stainless steel. However, some conclusions were able to be drawn even from this season's performance.

The 316 screens in loading pots lasted very well and showed superior mechanical strength and resistance to deformation compared with Cr-Ni screens previously used. In the Bosco machines at one mill the screens lasted the entire season (2800 hours) and were still in acceptable condition when removed.

The 304 screens, when not worn, gave equal capacity and purging efficiency to the Cr-Ni screens and indications are still present of a lower purity rise through these machines.

These results, together with those from 1987, encouraged the two organizations to proceed further with the project, using 316 as the screen material.

Expressions of interest were called for from companies wishing to license this technology, and a number of replies were received. After examining these replies BSES and CSIRO granted a world-wide licence to ActionLaser Pty. Ltd. of Sydney, NSW, Australia.

Performance of commercially produced screens

Commercial production was commenced by Action-Laser in time to produce screens for the 1989 crushing season. The interest in these screens was very good, some 85% of Australian factories purchasing at least one screen for the 1989 season. Supplies of 316 stainless steel were obtained in annealed and half-hard condition and this alloy was used exclusively. The performance obtained was better than that achieved using 304, but wear problems were still encountered with high-capacity machines. The wear is an abrasion phenomenon quite different from the corrosion effect experienced with Cr-Ni screens. With Cr-Ni screens the chromium loss and subsequent wear occurs mainly below the colour line, where a significant amount of molasses is still present in the material moving up the screen. With the stainless steel screens the wear occurs above the colour line where the lubricating effect of molasses is no longer present.

In spite of the continuance of this problem the results were encouraging. Factories equipped with low-throughput lower rotational speed machines did not have the abrasion problem to any large extent. Screens in these machines have lasted 1800 hours or more and in some cases for a full season's operation. This results in significant savings in downtime, and in labour to change screens. Lower purity rise through machines was also reported. The loading pot screens in Bosco centrifugals, once again, lasted the full season, in this demanding application. Encouraging results have also been achieved in overseas trials in Hawaii.

Following the reports of wear of the stainless steel screens in high capacity machines, work was carried out by ActionLaser on the surface treatment of 316 screens, to avoid this problem.

During these experiments some controlled comparisons were carried out on a low-grade station equipped with CC6 machines. Samples were obtained from two identical machines, side-by-side, fed with the same massecuite, one being fitted with stainless steel laser-cut screens and one with conventional

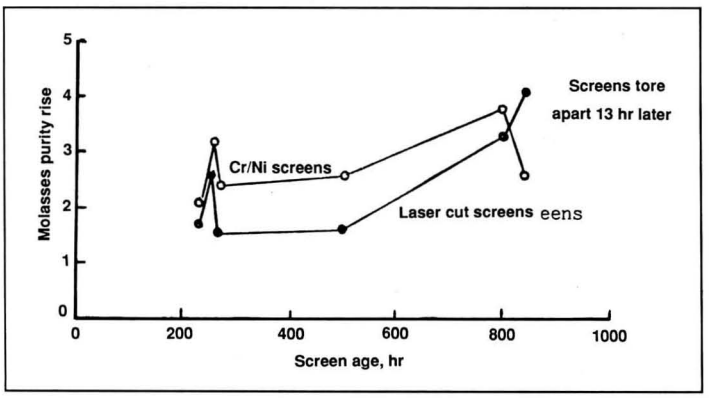


Fig. 9. Purity rise *versus* screen age

chrome-nickel screens. The machines were run at the normal production rate, conditions being kept the same for both machines as far as possible. In this case, purity rise across the machine was the basic parameter of interest and the results, plotted against screen age, are shown in Figure 9.

It can be seen that, until the laser-cut screen had begun to deteriorate owing to abrasion, the purity rise through this screen was consistently lower than that through the Cr-Ni screen. The average difference over the five relevant tests was 0.7 units of purity.

If screen life can be prolonged this figure will be an underestimate, as the results at 800 hours are obviously showing the onset of deterioration. It should be noted that screen life at the factory where these trials were carried out was below average owing to the heavy material being handled.

Subsequent to these trials, a further development in surface treatment has occurred which, it is expected, will enable a 2000-hour life to be achieved in all continuous low-grade centrifugals, a figure which has currently been achieved in machines such as the BMA K1000. Under these circumstances the screens would have a life three times as long as that of Cr-Ni screens, under Australian conditions, and a pattern of purity rise against time of season would be of the form shown in Figure 10.

If we consider that the average difference in purity rise is 0.75 units, which is in line with the results achieved in tests on a K1000 and a CC6 machine, substantial savings will be achieved, even allowing for the greater cost of screens. This is illustrated in Figure 11 which shows estimated costs, including screen cost, cost of downtime, and the value of the difference in sugar lost to molasses, for a CC6 and a K1000 machine. These figures are based on an improvement in recovery of 0.15 units and a sugar price of US$350 per tonne.

As well as their acceptance in Australian mills for low grade centrifugals, the screens have already been exported to a number of overseas areas including the US Mainland, Hawaii, Argentina, India, Cuba, France, South Africa and Mauritius. Orders received for the 1990 season indicate wider use by Australian sugar factories than in 1989.

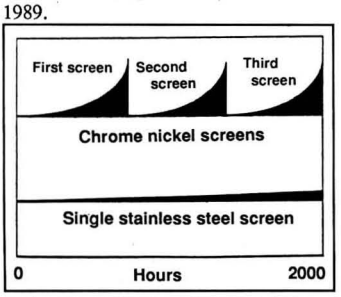


Fig. 10. Expected purity rise behaviour

As well as the application to low-grade centrifugals, stainless steel laser-cut screens have been used in the new continuous high-grade centrifugal manufactured by NQEA Australia, using features developed by BSES and the University of Queensland[5]. The screens were supplied with 100 μm wide slots. They have performed well, with no significant wear evident at this stage, and have achieved good molasses purity figures.

Conclusions

The development of laser-cut stainless steel surface treated screens provides an attractive alternative to the conventional chrome-nickel screen. Because of the higher purchase price of these screens – in Australia some four times those of chrome-nickel – it is recommended that precautions be taken against mechanical damage by large objects fed in with the massecuite. The screens are tougher than conventional screens and are more resistant to damage, but can still be damaged under severe impact from a large object.

Notwithstanding their significantly higher price the screens present an opportunity for significant savings, for a number of reasons:

(i) longer screen life, with consequent reduced down time and lower screen fitting costs;

(ii) reduced screen blinding, owing to the fully divergent shape of the slot, thus maintaining machine capacity;

(iii) better mechanical strength, resulting in better resistance to impact and to the distortion which can cause slot enlargement; and

(iv) reduced loss of sugar to molasses; in the low-grade application this results in an increase in overall recovery of sugar, currently estimated conservatively at 0.15 units.

The writers feel that these advantages justify the use of these screens, and consider the development to be a successful example of applied research adopted as commercial practice.

5 *I.S.J.*, 1990, **92**, 249.

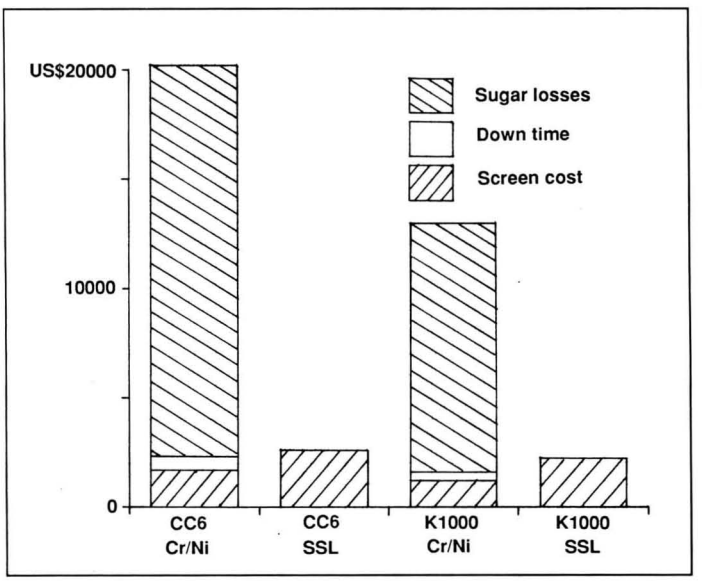


Fig. 11. Relative cost comparison of chrome-nickel and SSL screens over a 2000-hour period (at a sugar price of US$350 per tonne)

Acknowledgements

The authors wish to acknowledge the help of a number of colleagues who assisted materially with this work. They are: Dr. P. Donaldson and Mr. D. Kells of ActionLaser, Mr. L. K. Kirby and Dr. C. C. Ryan of BSES, Mr. B. Bartlett and Dr. H. Kaebernick of CSIRO.

Summary

A new type of screen has been developed for use in continuous centrifugals. This type of screen, made by laser perforation of stainless steel sheet, is designed to overcome the problems of chromium shedding and slot enlargement experienced with chrome-nickel screens. A surface treatment is applied to the stainless sheet to reduce wear by abrasion. The new screens, while more expensive than Cr-Ni screens, have a longer service life, suffer less from blinding, and the reduced slot enlargement results in lower losses of sugar to molasses.

Tamices cortados con láser para centrifugación continua

Un tipo nuevo de tamiz ha sido desarrollado para el uso en centrífugas continuas. Este tipo de tamiz, hecho de láminas de acero inoxidable con perforaciones hechas con rayos láser, ha sido diseñado para resolver los problemas del desprendimiento del cromo y del alargamiento de las perforaciones que se experimentan con los tamices cromoníquel. A las láminas de acero inoxidable se les aplica un tratamiento de superficie para reducir su desgaste por abrasión. Los nuevos tamices, aunque son más costosos que los tamices Cr-Ni, tienen una vida de uso más larga, menos problemas de obstrucción, y el alargamiento de las perforaciones se ve reducido lo que resulta en una pérdida menor de azúcar hacia las melazas.

Des toiles de centrifuge continue coupées au rayon laser

On a développé un nouveau type de toile pouvant étre utilisé dans les centrifuges continues. Ce type de toile est produit en perforant des feuilles en acier inoxydable au rayon laser. On vise ainsi à éviter les problèmes de bavures du chrome et d'agrandissement des ouvertures qu'on rencontrait avec les toiles en acier au chrome-nickel . On applique un traitement de surface à la feuille en acier inoxydable afin de réduire l'usure par abrasion. Les nouvelles toiles coûtent davantage que les toiles en Cr-Ni mais elles ont une durée de vie plus longue, elles souffrent moins de colmatage et le fait que les perforations sont moins agrandies fait qu'il y ait moins de sucre passant dans les mélasses.

Lasergeschnittene Siebe für kontinuierliche Zentrifugen

Ein neuartiges Sieb ist für kontinuierliche Zentrifugen entwickelt worden. Durch Laserperforieren eines Rostfreistahlbleches erzeugt, ist dieses Sieb dafür bestimmt, die an Chromnickelsieben gefundenen Probleme von Chromverlieren und Schlitzvergrösserung zu lösen. Das rostfreies Blech wird zu Oberflächenbehandlung untergezogen, um den Abriebverschleiss zu vermindern. Obgleich die neue Siebe teuerer sind als Cr-Ni-Siebe, haben sie ein längeres Dienstleben, erleiden minderes Verstopfen und geben niedere Zuckerverluste in Melassen wegen der verminderten Schlitzvergrösserung.

Drought problems in South-East Europe[1]

In contrast to the wet weather which has hampered lifting of beets in the Soviet Union, many of the beet crops of Bulgaria, Czechoslovakia, Hungary, Rumania and Yugoslavia have suffered from drought so that smaller harvests are expected. In Hungary, sugar yield is expected to be 5% below normal but, owing to an increased area, no shortage of sugar is expected in the country[2]. By contrast, sugar rationing has been introduced in Bulgaria and Rumania where the fall in domestic production has occurred at the same time as a shortfall in previously agreed supplies from Cuba.

1 Czarnikow Sugar Review, 1990, (1801), 139.
2 MTI News Agency Report, October 5, 1990.

More and more CC-6 Centrifugals in Australia.

Battery of "Low Grade" Centrifugals,
CSR Limited, Victoria Mill,
Ingham, Queensland, Australia

- Farleigh
- Kalamia
- Macknade
- Marian
- Mossman
- Mulgrave
- New South Wales
- Pioneer
- Victoria

The performance of a new design of continuous centrifugal

By L. K. Kirby*, C. R. Greig**, P. G. Atherton*, E. T. White*** and C. R. Murry****

Introduction

NQEA Australia Pty. Ltd. has, during the past two years, developed an advanced technology continuous centrifugal for the sugar industry. The new "superfugal" design arises from developments licensed from the Bureau of Sugar Experiment Stations (BSES) and the University of Queensland[1-3].

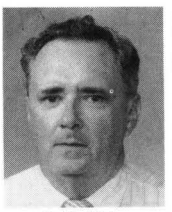
The development has focused on providing a high capacity, continuous machine that would find application over the full range of sugar produced in the raw sugar factory and refinery. In addition to machine capacity, the key issues have been the elimination of crystal breakage and the minimization of molasses purity rise and power consumption.

Two prototypes have been manufactured and installed by NQEA. At Kalamia Mill, the first prototype was commissioned for high grade service, processing both *A*- and *B*-massecuites. At Inkerman Mill, a second prototype was commissioned for low-grade separation. This paper presents the results of trials on these prototypes.

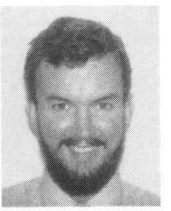
Design

The superfugal prototypes incorporate the following features:
(i) A novel feeding arrangement which also acts as a rate control device and is amenable to automation;
(ii) A static device which results in low crystal breakage;
(iii) Modified drainage ports to eliminate the "teapot effect" discussed by Kirby & Greig[4];
(iv) An improved basket geometry (which has been found to be similar for all massecuites);
(v) A direct-coupled 90 kW motor which is totally enclosed and force-ventilated. A frequency converter provides variable speed operation;
(vi) Laser-cut stainless steel filtering screens.

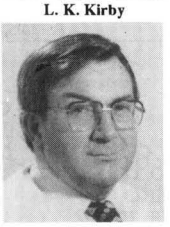
The overall size of the centrifugal is illustrated in Figure 1. While this machine is relatively large compared with most low-grade continuous centrifugals used in Australia, it actually requires less space than other continuous machines offered for high-grade service.



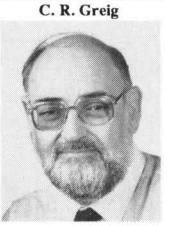
L. K. Kirby



C. R. Greig



E. T. White



C. R. Murry

High-grade massecuite separation

Installation and commissioning

The superfugal was installed on the

Paper presented to Australian Soc. Sugar Cane Tech., 1990.

* Bureau of Sugar Experiment Stations, Bundaberg.
** Yencorp, Brisbane.
*** Chemical Engineering Dept., University of Queensland, Brisbane.
**** NQEA Australia Pty. Ltd., Cairns.

1 Anon: Various BSES reports and technical communications, 1966 - 1989.
2 Greig: "Studies on continuous sugar centrifuges" (Ph.D. Thesis, University of Queensland), 1990.
3 Swindells: "A mathematical model of a continuous sugar centrifuge" (Ph.D. Thesis, University of Queensland), 1982.
4 *Proc. Australian Soc. Sugar Cane Tech.*, 1986, 179 - 183.

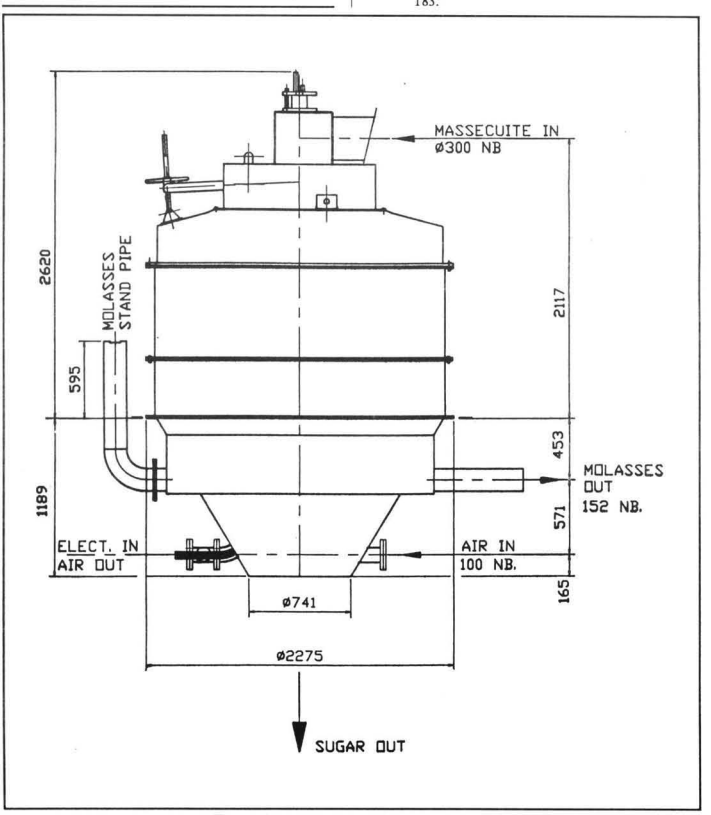


Fig. 1. General outline of superfugal

Table I. Typical high-grade massecuite properties at Kalamia Mill

	Dry substance, %	True purity	Crystal content, % massecuite	Mother liquor consistency at 50°C, Pa.s	Crystal mean aperture, mm
A-massecuite average	90.8	87.8	52.4	1.3	0.8
Range	89.0-92.0	84.7-90.9	44.8-60.0	0.7-1.7	0.73-0.85
B-massecuite average	91.4	82.2	48.6	6.1	0.75
Range	90.1-92.6	80.0-85.9	44.3-53.0	4.6-9.2	0.73-0.78

end of the Kalamia centrifugal station in line with the existing batch machines. With this installation *A*-massecuite was fed directly from the side of the receiver, while *B*-massecuite flowed to the machine via an 18-metre length of 450 mm diameter hot-water-jacketed pipe. In both cases, the available massecuite head was often insufficient for the machine to run continuously at high rates for long periods.

Steam is added to heat the feeding device and to heat the massecuite layer flowing onto the screen. The machine is fitted with three water sprays at different levels, which facilitate control of pol and moisture.

Commissioning trials were carried out during the last two weeks of the 1988 crushing season and in September 1989. These trials covered the elimination of teething problems related to: feeding (especially high crystal content massecuites); wash water application; crystal breakage device settings; product sampling; and mechanical reliability.

It was decided to work in the speed range from 750 to 1000 rpm as in this range high capacities could be achieved without compromising the sugar crystal size distribution. The main trial series focused on these two speeds, as they are close to the synchronous speeds of 8-pole and 6-pole induction motors.

The main trial series was carried out during October and November 1989. The results are reported below.

Performance

The NQEA superfugal was operated at up to 120 tonnes/hr on *A*-massecuite and up to 80 tonnes/hr on *B*-massecuite while producing JA sugar. The capacity-sugar purity relationships shift according to massecuite properties. For typical Kalamia Mill materials (Table I), nominal capacities were of the order of 75 tonnes/hr on *A*-massecuite and 45 tonnes/hr on *B*-massecuite, based on JA sugar production, as this was the brand being produced routinely by the factory.

As shown in Figures 2 and 3, the sugar purity can be controlled by

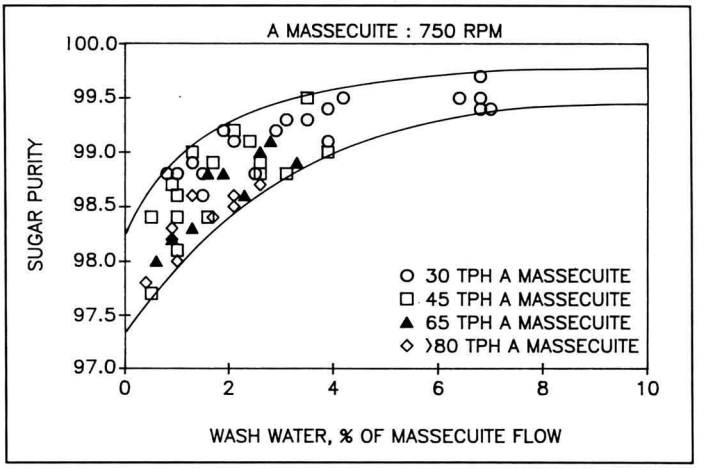


Fig. 2a. *A*-sugar purity as a function of % wash water addition at 750 ppm

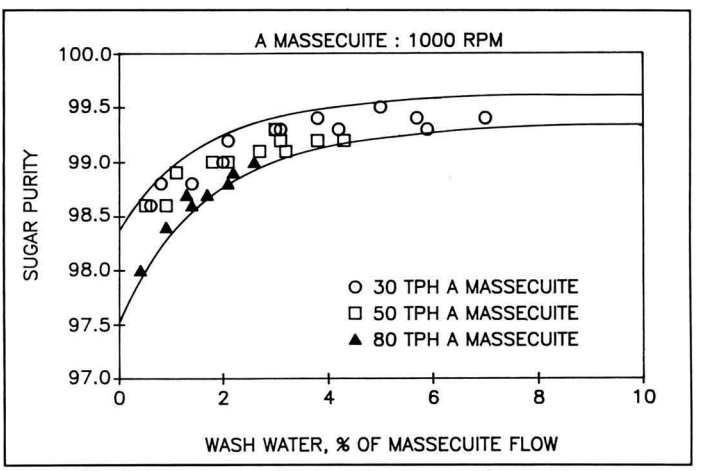


Fig. 2b. *A*-sugar purity as a function of % wash water addition at 1000 ppm

ISJ Abstracts

Cane sugar manufacture

Suitability of industrial yield as techno-economic criterion for planning of the crushing season

A. E. Morales P. *ATAC*, 1989, **48**, (4), 2 - 7 *(Spanish)*.

Statistical analysis of the curves of 96° sugar yield and of pol in cane showed that, in general, the date of maximum yield precedes that of maximum cane pol. Further analysis demonstrated that 96° sugar yield was a better criterion than cane pol for optimizing the start and length of the crushing season.

Corrosion of some materials by flue gas condensation in bagasse-fired boilers

T. Llanes O., R. Monduí G. and A. Arrascaeta R. *CubaAzúcar*, 1989, (Apr./June), 20 - 25 *(Spanish)*.

Corrosion of ferrous metals in contact with flue gases from bagasse-fired boilers was mainly attributed to the carbonic acid gas formed from CO_2 at dew point, indicating the need to avoid condensation or to use stainless steel.

The film evaporator and its effect on the energy economy of a sugar factory. I

C. Vázquez B. *CubaAzúcar*, 1989, (Apr./June), 26 - 31 *(Spanish)*.

The principle of operation of a climbing-film evaporator is explained. While its major disadvantage is the need for the feed juice to be hot, its important advantages include the short juice retention time and resultant reduction in steam consumption. Although operation of a film evaporator as 1st and 2nd effects at 45 psig resulted in much higher total sugar losses than in conventional effects at 15 and 25 psig, the combined costs of the lost sugar and annual operation of the film evaporator were outweighed by those of fuel oil.

Cane juice carbonatation: a possible outlook in sugar manufacture

P. Morales G., O. Tirado J. and J. Valdés C. *CubaAzúcar*, 1989, (Apr./June), 48 - 52 *(Spanish)*.

In laboratory tests, conventional clarification of mixed juice was compared with two schemes: (i) where clarified mixed juice was carbonatated and then subjected to double filtration and (ii) where settling of the carbonatation juice was combined with final filtration. Results showed that carbonatation of clear juice gave a better filtrability and lower reducing sugars content than clarification alone while method (ii) gave the lowest colour content. Improvement in carbonatation efficiency would reduce the CaO content and pH.

Combined action of irradiation with formalin and heat on pure solutions and cane juices for the reduction of *Leuconostoc mesenteroides*

S. Acosta D., J. Lodos F. and L. Cruz. *ATAC*, 1989, **48**, (5), 28 - 35 *(Spanish)*.

Samples of crusher juice and of pure *L. mesenteroides* suspensions were subjected to irradiation with ^{60}Co plus (1) treatment with 100, 500, 1000 and 1500 ppm 37% formalin and (2) heating at 30, 50 and 60°C for an unspecified time. Gamma-ray doses were 50 - 400 Gy in (1) and 20 - 450 Gy in (2). Results showed that use of irradiation allowed a reduction in the time needed for normal treatment with formalin or heat to produce a given reduction in the bacterial count, and thus reduced the operational costs.

Use of spiral trough tubes in heat exchangers

K. L. Wang, T. Y. Li and Q. S. Lin. *Indian Sugar*, 1990, **39**, 827 - 829.

In tests on clarified juice heating, a single-spiral copper tube having a pitch of 25 mm and a depth of groove formed by the spirals of 1 mm had a heat transfer coefficient that was 50 - 200% greater than that of a smooth copper tube. While heat transfer fell with scale formation in both tubes, the decrease was more rapid in the smooth tube and the amount of scale in the spiral tube was smaller and much easier to remove. The pressure drop in the spiral tube was only slightly greater than in the smooth tube, so that only slightly more power was needed.

Influence of minimum air temperatures and stale cane deliveries on cane: sugar ratio

M. E. A. Shaw. *J.A.S.T.J.*, 1988, **49**, 12 - 15.

See *I.S.J.*, 1990, **92**, 120A.

Practical aspects of the control of cane quality at New Yarmouth Estate

W. W. McPherson and D. J. Crossbourne. *J.A.S.T.J.*, 1988, **49**, 18 - 21.

A relatively poor cane:sugar ratio at New Yarmouth was attributed to a number of factors, including poor cane burning and harvesting, excessive extraneous matter, "mincing" resulting from cutting of the cane stalk into an excessive number of small billets, and inadequate cane yard organization with high average daily carry-over quantities. A dramatic improvement in the ratio and an increase in the hourly crushing rate were brought about by a number of measures which are discussed.

First experience with a bagasse-fired automatic step-grate boiler

T. M. Scheutzlich and H. C. C. Bourzutschky. *J.A.S.T.J.*, 1988, **49**, 39 - 50.

See *I.S.J.*, 1990, **92**, 60A.

Evaluation of a trayless clarifier including comparison with a Graver clarifier

D. Foster and A. Welsh. *J.A.S.T.J.*, 1988, **49**, 51 - 62.

A description is given of the SRI trayless clarifier, a small version of which (having an hourly capacity of 6.8 tonnes of juice) was tested at New Yarmouth. The results of trials indicated a consider-

able reduction in retention time and a significant increase in throughput as well as decrease in sugar losses and colour formation by comparison with a Graver continuous tray-type clarifier used at the factory, but the average clear juice purity was lower (78.01 as against 78.07).

Studies on the origins of colour and its development in the processing of sugar

R. A. Ramsingh. *J.A.S.T.J.*, 1988, **49**, 63 - 71.

Studies at New Yarmouth and Monymusk sugar factories revealed two main areas of colour development: (1) from crusher juice to mixed juice and (2) from clarified juice to syrup, with the major contribution coming from (2). Soluble non-sugars were the main source of syrup colour. The level of phenols rose from crusher to mixed juice and then progressively decreased until the final sugar product. Although temperature by itself was not associated with colour formation, when coupled with other parameters such as pH, concentration, retention time, hydrostatic pressure, etc. it contributed to it. Juice colour rose with a fall in pH, with lower purity (under the effect of the Maillard reaction between amino-acids and invert sugar) and with increased levels in evaporation (when the juice layer at the bottom is subjected to a greater hydrostatic pressure and so has to be heated longer to obtain the required water evaporation).

The effect of reducing ID fan speed on boiler furnace operating characteristics

D. A. Ingram. *J.A.S.T.J.*, 1988, **49**, 72 - 79.

Investigations showed that reducing the speed of the induced-draft fan in three bagasse furnaces at Worthy Park sugar factory from 475 to 450 rpm (so as to reduce wear of the blades) did not significantly affect furnace temperature and combustion, provided the bagasse moisture content was kept below 50%, although a speed of 460 rpm was satisfactory in dealing with possible fluctuations in moisture. If the moisture level could be maintained at no more than 48%, the fan speed could be further reduced. All the boilers performed satisfactorily and up to 5% energy saving proved to be possible as a result of the speed reduction.

In the factory - low and high technology

S. J. Clarke. *Sugar Bull.*, 1990, **68**, (6), 9, 14; (7), 12, 19.

Experience in Australia and South Africa in the use of clarified juice and syrup instead of water for boiling, sugar dryer arrestor sprays, dilution of clarifier flocculants, molasses and low-grade sugar, remelting and sugar washing in centrifugals so as to reduce the evaporation requirement is discussed as an example of a low-technology approach to factory process improvement. High-technology applications include the use of modern construction materials for equipment, continuous boiling, the production of grain by continuous flash cooling crystallization and the new continuous centrifugal ("Superfugal") of Australian design and construction.

Trials for improving cane preparation and milling efficiencies

K. Khan. *Sugar J.*, 1990, **52**, (10), 12 - 13.

Problems associated with cane preparation at Brechin Castle sugar factory in Trinidad are discussed. The proportion of chopped cane has risen to 42%, with cane billets having an approximate length of 45 cm. Whereas the feed of this cane to the two knife sets is easily controlled, whole-stick cane presents problems, particularly when it is tangled, and unprepared billets could enter the mill while whole stalks would cause chokes on the belt conveyor. Reducing the number of pairs of holders on the first set from 19 to 13, increasing the knife length to provide a setting of 15.3 cm as against 23 cm, introducing hooked knives on the second sets (without altering the number of holders) and adjusting the knife sets at the point where they were about to touch the carriers caused a dramatic reduction in chokes on the first set and on the belt, while the Preparation Index was raised from 50 to 70. Removal of the discharge roller pinion on the last mill in one of the two tandems caused a reduction in throughput and considerable friction between the feed and top rollers, so that their surfaces tended to get smooth very quickly and the top roller had to be roughened by arc welding at least twice a week. Although the mill accepted ground whole-stick cane very well, lumps of mud occasionally entered the mill with the chopped cane, causing noticeable slippage. Because of these and associated problems, the pinion is being reinstalled.

Sugar mill low-speed gear alignment by infrared thermometry

J. G. Loughran and F. Forzatti. *Proc. 12th Conf. Australian Soc. Sugar Cane Tech.*, 1990, 139 - 146.

It is difficult to manufacture large low-speed gears, such as used on cane mills, to high standards of accuracy, so that they may have built-in geometric errors when put into service. Methods generally used for gear alignment are time-consuming, require the mill to be shut down and have limitations. However, infrared thermometry has been found to provide a rapid means of measuring alignment; it is based on the creation of a temperature gradient across the tooth face when misalignment causes non-uniform tooth loading. Its principles are explained and the apparatus and method applied to a pair of gears at Pleystowe sugar factory described. An alignment correction procedure used to predict the required change in bearing displacements gave excellent results. It is emphasized that the technique is suitable for rapid assessment of misalignment of in-service gears under load, whereas new gears should always be aligned by conventional methods.

Beet sugar manufacture

Energy and environmental protection

P. Wertán. *Cukoripar*, 1990, **43**, 75 - 77 *(Hungarian)*.

Means of reducing the energy consumption in sugar factories are outlined and the increased atmospheric pollution and risk to the ozone layer caused by greater volumes of SO_2 and nitrogen oxides when excessive amounts of fuel are burnt is discussed.

Uniformity, modularity and compatibility of IRIS automation programs

P. Crevits, A. Deleurence, B. Portales and G. Windal. *Sucr. Franç.*, 1990, **131**, (143), 45 - 49 *(French)*.

The Cheops and Cleopatra microcomputer systems for automatic pan station control[1] have been used for some years in a large number of French factories. The Rameses and Zoser schemes[2] for automatic control of evaporation and diffusion, respectively, are of more recent development and have been installed at fewer factories. At Chevrières factory (where all four systems have been installed) a new function, automatic transfer, was introduced in the Cleopatra program to provide interconnexion between the schemes via the Ethernet network. In addition, modular programming has proved sufficiently advantageous in the Rameses system that it is to be applied to the Zoser and Cheops systems. A filter scheme for the Cleopatra system will be provided by the Horus process.

A steam-jet compressor in the heat and energy system of a sugar factory

Z. Krivan. *Listy Cukr.*, 1990, **106**, 103 - 110 *(Czech)*.

A computerized method of calculating the dimensions and operational parameters of steam-jet compressors is described and the question of suitable incorporation of the compressors in a sugar factory energy scheme discussed.

Modernization of the automatic process control system at Smirice sugar factory

J. Záruba. *Listy Cukr.*, 1990, **106**, 114 - 117 *(Czech)*.

Details are given of microprocessor-based automatic monitoring and control of juice flow introduced at Smirice factory for diffusion, 1st and 2nd carbonatation and evaporation in place of a ducted cable system.

A beet sugar factory can also be self-sufficient in energy

E. Otorowski. *Gaz. Cukr.*, 1990, **98**, 61 - 62 *(Polish)*.

It is suggested that, by using pressed and dried pulp as fuel, beet sugar factories could cover their fuel requirements as do cane sugar factories by burning bagasse. A fuel balance is calculated for a factory having a daily beet slice of 2400 tonnes which assumes a pulp yield of 6% on beet, a dry solids content of 90% after drying and a yield of 12 tonnes/hr; it is estimated that 3.05 tonnes/hr of oil would be consumed in the drying process.

Cleaning the screen of an AWO-1000 centrifugal with compressed air

A. Fajfer and K. Majewski. *Gaz. Cukr.*, 1990, **98**, 63 *(Polish)*.

While a conventional scraper rotating at 50 rpm removes most of the sugar that accumulates on the screen of an AWO-1000 centrifugal used for *A*-massecuite, a gap of 1.5 mm has to be maintained between the scraper and screen so as to avoid damage to the latter; as a result, a layer of sugar remains. In tests, playing a stream of compressed air onto the screen and onto the distribution disc removed this residual layer and thus increased sugar yield by about 0.03% on beet, raising centrifugal throughput by about 3%, reducing consumption of wash water and of steam (as a result of the smaller amount of wash syrup recycled) and allowing the scraper blade to be further removed from the screen, the life of which was thus prolonged. The costs of installation and use of the compressed air attachment represent only 10% of the extra return.

Heating waste water at Melno sugar factory

A. Mosiewicz, B. Mosiewicz and K. Marciniak. *Gaz. Cukr.*, 1990, **98**, 64 - 67 *(Polish)*.

While anaerobic treatment of waste water in Polish sugar factories reduces the impurities by some 40% in October when the temperature of the effluent is >25°C in the fermenter, a fall in the ambient temperature in November/December causes a corresponding fall in the temperature of the waste water and a resultant fall in fermenter performance. Details are given of a system introduced at Melno in which some of the vapour sent from the evaporator and pan station is bled from the main condenser to a subsidiary condenser where it raises the temperature of untreated effluent to 40°C before it is transferred to the fermenter. In 1988/89, when the scheme was first operated, the COD and BOD_5 of the anaerobically treated effluent averaged 95 and 22 mg/dm³, respectively. Some teething problems are noted and remedial measures described.

The technology of oxidizing agents and disinfection in the sugar factory

J. M. Hoen. *Sucr. Franç.*, 1990, **131**, (144), 26 - 28 *(French)*.

Chlorine- and bromine-based oxidizing agents are powerful bactericides. However, while Cl-based bactericides are highly efficient, they need to exceed the Cl break-point, suffer a pronounced fall in performance above pH 6, are difficult to handle and have a narrower range of action than Br-based bactericides; on the other hand, the latter have a major disadvantage in the great care needed to inject them into a system. Actibrom is a

1 Windal: *I.S.J.*, 1990, **92**, 86A.
2 Crevits: *ibid.*

mixture of hypochlorous and hypobromous acids which acts as a highly effective bactericide at small dosage rates over a wide range of pH. Sugar factory investigations showed that semi-continuous injection gave better results than continuous application except in the beet washer where the continuous dosage rate depends on the quality of the beet and where the use of Actibrom may not be suitable in all cases.

Thermocompression in multiple-effect evaporation

G. Salani. *Ind. Sacc. Ital.*, 1990, **83**, 39 - 42, 44 - 46 *(Italian)*.

The benefits of vapour compression for multiple-effect evaporation are discussed and the pros and cons of mechanical and thermal compression considered. A system installed at an Italian sugar factory is described in which a battery of five steam jet ejectors compressed a mixture of live and low-pressure vapour and fed it at 53.3 tonnes/hr and an average of 170°C to a pre-evaporator acting as thermocompressor which was the source of the low-pressure vapour fed to the ejectors. Because of a slight drop in the juice temperature between the pre-evaporator and the 1st effect which was below the desirable boiling temperature, some intermediate heating was necessary. However, the results vindicated the use of thermocompression rather than MVR.

Use of selected bacterial biomasses to reduce the ammonium nitrogen content in sugar factory effluent

C. Silvatici. *Ind. Sacc. Ital.*, 1990, **83**, 47 - 52 *(Italian)*.

Lagooning of sugar factory effluent has to be maintained over a long period because of the presence of nitrification inhibitors and hence an ammonium-N level which falls only very slowly. Experiments in 1987 and 1988 are reported in which (i) Biolen IS 80 was used at the close of the campaign in October to oxidize the sulphur compounds responsible for the denitrification, (ii) Biolen IN 100 was added in November (when the temperatures promoted biological activity) to oxidize the reduced form of N, and (iii) Biolen IN 100 was employed at the end of February/beginning of March (when the temperatures were again favourable for bacterial activity) to bring about final nitrification of ammonium-N. Results showed an ammonium-N level that was below the upper limit by the end of April and allowed a saving of approx. 1.3 million kWh that would have been used for prolonged aeration.

The use of infinite series for optimizing placement and operation of chromatographic separators

M. Kearney. *Paper presented to Tech. Conf. British Sugar plc*, 1990, 18 pp.

See *I.S.J.*, 1990, **92**, 123A.

Cathodic corrosion protection of a diffuser

R. Rosenqvist, H. Hallanoro and T. Ramo. *Paper presented to Tech. Conf. British Sugar plc*, 1990, 20 pp.

Uniform corrosion is the main type of electrochemical corrosion in diffusers and may be found on all the surfaces in contact with juice; galvanic corrosion occurs when the diffuser is partly plated with stainless steel, and erosion corrosion is caused by sand and clay. While minimum corrosion occurs at pH 6, juice quality and pulp pressing properties are favoured by a pH of 5 at which, however, corrosion is accelerated in carbon steel units. An aluminium coating provides relatively good corrosion protection at about pH 6 but needs regular renewal which is rather expensive. The principle of cathodic corrosion protection is explained and a corrosion monitoring system used at Naantali factory in Finland (where experiments were conducted on a DDS diffuser) is described. Daily measurements of the surface potential showed that values in the bottom part of the diffuser were much higher as a result of the more aggressive corrosion conditions caused by a relatively high conductivity, temperature and abrasion than in the middle and upper sections; moreover, since an aluminium coating reduces the surface potential, the high values indicated that most of the coating that had been applied to the bottom part had disappeared. However, corrosion rates for unprotected and protected pairs of monitoring specimens at three levels and at varying distances from the juice end showed up to 95.1% protection at those points where the highest corrosion rates were recorded in an unprotected state. Cathodic protection was unsatisfactory where most of the weight loss was due to mechanical abrasion or where the juice level towards the pulp end was often low. At all monitoring points on the diffuser body, it was possible to reduce the corrosion rate to a level corresponding to <0.08 mm loss of metal thickness over a 75-day campaign, and even on the scroll a decrease in loss to approx. 0.09 mm was possible. For a campaign length of 1530 hr, the total energy consumption for protection of the diffuser was calculated at 8300 kWh.

QuaT temperature measuring system for process metrology

K. Wassmuth. *Zuckerind.*, 1990, **115**, 453 - 456 *(German)*.

The salient features of the QuaT oscillating quartz temperature measuring system developed by Heraeus Sensor GmbH are described, including its sensors, sensor bus system and interfaces. The measuring scale is from – 40° to +300°C and accuracy is ± 0.1°C up to +100°C and thereafter 0.1% of measured value. Advantages and typical applications are indicated.

Spark detectors and extinguishers

W. Henze. *Zuckerind.*, 1990, **115**, 484 - 485 *(German)*.

A brief survey is presented of GreCon spark detectors, alarms and extinguishers (including automatic ones) used or suitable for use in sugar factories.

Sugar refining

Pipe kiln modifications to equalize the bone char flow

T. N. Pearson and G. R. Snook. *Paper presented to 49th Ann. Meeting Sugar Ind. Tech.*, 1990, 17 pp.

The stationary pipe kilns used for bone char regeneration at the Sugar Land refinery of Imperial Holly Corp. in Texas were built in 1925; in 1935, each of the 80 cast iron retorts was replaced with three thin-walled steel retorts. In 1982, a significant drop in performance between new and stock char was found; experiments showed that the flow in the middle retort was almost double that in the two outside retorts, so that the char in the middle retort had less time to regenerate and less time to cool. Modifications to a kiln to separate flow into independent paths for each retort are described; they resulted in equal draw rates and more consistent char regeneration while also contributing to regular maintenance and more efficient location of blockages and leaks.

The automation of a low-grade vacuum pan at Savannah

J. B. Thompson. *Paper presented to 49th Ann. Meeting Sugar Ind. Tech.*, 1990, 7 pp.

A 3-boiling recovery system is used at Savannah refinery, with the *A*-pan used to boil 2nd massecuite of 69 - 71 purity from 1st and 2nd massecuite run-offs and remelt syrup from another refinery and to produce footing for 3rd massecuite of 71 - 73 purity from affination syrup and 1st massecuite run-off. A DDS automatic system was installed with the aim of improving the quality of the footings and so reducing molasses losses; because it was thought that fluctuation in ash contents and purities could cause conductivity problems, a nuclear density gauge was introduced as an alternative to a conductivity probe for supersaturation control, the DDS system being able to accept a signal from either unit. Observations over a number of weeks showed good control of the evaporation rate, with the conductivity-based system operating well provided there was no dramatic change in purity; however, a change in raw sugar quality necessitated new set points and indicated the apparent unsuitability of conductivity control on low-grade pans. The nuclear density gauge installed for just a few days gave promising results, with good repeatability for both graining and feed control; there seemed to be less variation in the graining set point than with conductivity. Since the new system has been used only by the day shift, a noted improvement in the consistency of massecuite purities as well as in purity drops may be a combination of automatic control and greater attention to pan operation by personnel.

Refining of sugar with reactive precoat technology

A. Tavares and R. Kunin. *Paper presented to 49th Ann. Meeting Sugar Ind. Tech.*, 1990, 29 pp.

Ecosorb S-801 is a powdered, strongly basic anion exchange resin in Cl^- form designed for use as a precoat in the decolorization and clarification of syrups and polyhydric alcohols. While it is normally used once and discarded, it usually has some residual decolorization capacity which may be utilized by adding the partially exhausted precoat to defecation or by using two precoats in series, with the once-used precoat treating darker syrup. The performance of the resin on cane raw sugars and syrups of various origins is discussed, and the effect of precoat thickness noted. In a trial on treatment of 65°Bx syrup with Ecosorb S-404 powdered active carbon (found to give better filtration and decolorization than standard kieselguhr) followed by Ecosorb S-801, the colour after both stages was reduced from 550 ICUMSA units to a maximum of 200 units after 25 hr at 80°C, a flow rate of 0.12 gal/min/ft^2 and a precoat dosage of 1.2 lb/ft^2. The economics are discussed. Treatment of a filtered and washed raw sugar with S-601 cation exchange resin in Na^+ form halved the initial calcium content of 190 ppm after 5 hr and removed all of the Ca from sugar mixtures of 50 and 40 ppm after 7 and 8 hr, respectively. Other Ecosorb products are also mentioned.

Study of the possibility of multi-stage concentration of purified raw sugar melt. I. High-temperature treatment of melt. II. Factory-scale trials. III. The change in colour as a mathematical function of process parameters

I. B. Mitev and L. Bozhkov. *Nauch. Tr. Inst. Zakharod-obiv.* (Gorna Oryakhovitsa), 1988, **7**, 43 - 47. **II.** Idem: *ibid.*, 63 - 76. **III.** B. Mitev, L. Bozhkov and M. Antonov. *ibid*; 77 - 81; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (11), Abs. 11 R1500, 1501, 1502.

I. An increase in colour of melt (purified by liming, carbonatation and sulphitation) as a function of temperature and time of heating, pH and invert content was investigated under laboratory and pilot plant conditions. It was found that the increase in colour of the melt intended for evaporation was only slight (up to 18%) at up to 20 minutes' heating time, pH up to 7.2 and a temperature of up to 100°C. With increase in the heating period or pH, there needs to be a corresponding fall in temperature to keep the colour at the same level. The results suggest that multiple-effect evaporation may be applied to melt, and factory-scale investigation is recommended. **II.** Two-stage evaporation of the purified melt was investigated under factory conditions. It was found that at a boiling temperature of up to 90°C, a heating period of up to 20 min and a pH of 7.0 - 7.5, a Brix of 65 - 70° was obtainable, while the colour and sucrose degradation losses did not exceed the levels found in pan boiling. A 30% reduction in steam consumption (on weight of processed raw sugar) is possible with the method. **III.** A mathematical equation is presented relating melt colour content to pH, time and temperature of evaporation. A nomogram has been constructed for use in selecting technological conditions under which it is guaranteed that the colour increase will be 15% or less.

Starch based sweeteners

The high fructose syrup (HFS) situation in the USA. I. What is HFS? II. Forecast of sweetener consumption in the USA

I. J. Lodos F. and M. Cordovés H. *CubaAzúcar*, 1988, (July/Sept.), 54 - 58. II. J. Lodos F. *ibid.*, (Oct./Dec.), 13 - 17 *(Spanish)*.

I. The manufacturing technology and properties of 42%, 55% and 90% HFS are outlined.
II. In a discussion of the predicted sweetener consumption in the USA the belief is expressed that there will be a substantial increase in the use of HFS in soft drinks, processed food and milk products.

Unconventional raw material for manufacture of sugar products usable in non-alcoholic beverages: a review

K. A. Kalunyants and A. A. Kochetkova. *Izv. Vuzov, Pishch. Tekh.*, 1989, (3), 19 - 24 *(Russian)*.

A survey is presented of enzymatic processes and their end-products for use in the manufacture of non-alcoholic drinks, including: invert syrup from sucrose; glucose-fructose syrups from corn starch, sorghum, cellulose-containing materials and rye starch; glucose-galactose syrups and lactose from whey and fructose syrups from inulin. It is stated that little has been done in this field in the Soviet Union.

Continuous production of very enriched fructose syrup by the conversion of glucose to ethanol from glucose-fructose mixtures in an immobilized cell reactor

D. W. Koren and Z. Duvnjak. *Int. J. Food Sci. Tech.*, 1989, **24**, 429 - 437; through *S.I.A.*, 1990, **52**, Abs. 93.

The yeast *Saccharomyces cerevisiae* ATCC 36859, which preferentially utilizes glucose in glucose-fructose mixtures, was immobilized and used for the continuous production of very enriched fructose syrup. A syrup containing 99% fructose on reducing sugars was produced from a solution containing 10.1% (w/v) glucose and 9.8% fructose at a low dilution rate (0.106/hr). When the dilution rate was increased to 0.366/hr, the ethanol productivity increased to 12.7 g/litre/hr. This is 16% less than in a similar medium containing only glucose as the carbohydrate. In a food-grade mixture of HFS and Jerusalem artichoke juice, the fructose content was increased from 55% to 95% on reducing sugars. Purification of the product with activated carbon and ion-exchange resin produced a stable, colourless and very enriched fructose syrup suitable for human consumption.

High-fructose syrup - a potential rival to cane sugar

J. K. Gehlawat. *Chem. Ind. News*, 1989, **33**, (10), 760 - 763; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (5), Abs. 5 R1511.

The process for manufacture of HFS from maize is briefly described. It is noted that HFS is an ideal substitute for raw cane sugar. Although at present it has only started to appear on the Indian market, it is possible that it will be produced on a large scale in the near future. The only criterion for HFS manufacture in India will be the economic considerations. Nevertheless, it is suggested that the advantages of HFS manufacture will favour development of Indian agriculture.

Bacterial glucose isomerase (D-xylosoketolisomerase)

A. M. Bezborodov and I. V. Ulezlo. *Fundam. Nauki - Nar. Khoz.*, 1990, 256 - 257; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (12), Abs. 12 R1385.

Two members of the Actinomycetes family that produce active glucose isomerase were selected: *Actinomyces olivocinereus* and *Lactobacillus brevis* ; cultivation conditions were chosen in which costly components could be replaced with a waste product from whey manufacture. The glucose isomerase was immobilized on a silica support and that from *A. olivocinereus* was used to isomerize D-glucose to D-fructose continuously in a columnar reactor. The effective parameters and activation energy at varying flow rates were calculated. During 32 days' continuous operation activity fell to 84% of the initial value. A recycle system allowed immobilized glucose isomerase of low activity to be used. The sugars in HFC obtained from potato starch glucose syrup were separated by ion exchange chromatography on KU-2-2 sulphocationic resin of low cross-linkage (2 - 3% DVB) in Ca^{++} form with recycling. Treatment of the fructose fraction by evaporation in a rotary unit and double recrystallization in alcohol yielded a crystalline fructose in a yield of 69.8%.

Determination of dextrose equivalent in starch hydrolysates using cerium (IV)

L. S. Griffith and P. Sporns. *J. Agric. Food Chem.*, 1990, **38**, 1356 - 1358.

The dextrose equivalent (DE) of starch hydrolysates is important as an indirect measure of the degree of hydrolysis, an increase in which is indicated by a higher DE; higher hydrolysed products are sweeter and more soluble in water as well as having different effects on rheology and texture. Although the Lane & Eynon or similar copper oxidation-reduction methods have been the traditional and official methods of DE measurement, they are time-consuming. However, a method using cerium (IV) was simple, rapid and inexpensive and gave an excellent linear correlation (r = 0.995) with results of the Lane & Eynon method. The time for reduction of a fixed amount of Ce(IV) by an excess of one of a number of sugars as 4% w/v solutions was governed by the sugar concentration, and colorimetric conversion of Ce(IV) to Ce(III) could be observed visually, although greater accuracy was possible spectrophotometrically at 445 nm. The method is suitable for process control of starch hydrolysis.

Laboratory studies

Viscosity and molecular structure of pure sucrose solutions

M. Eszterle. *Zuckerind.*, 1990, **115**, 263 - 267.

Dynamic viscosity data for pure sucrose solutions were analysed by the least squares method as a function of molar concentration and temperature. Expressions derived from the free volume theory were used to interpret diffusion and molecular structure in the solution. In undersaturated solutions the free volume was found to decrease linearly with increase in the molar concentration since water molecules make a much greater contribution to diffusive movement than sucrose molecules, suggesting a constant degree of hydration of sucrose molecules until saturation is reached. Below 40°C, free molecules of water were squeezed out of sucrose hydrates as a result of association; this did not occur at higher temperatures because of the presence of fewer water molecules in the hydrates. In supersaturated solutions the free volume decreased linearly with increasing supersaturation. Formulae are presented for calculation of viscosity in both under- and supersaturated ranges of concentration.

Comparative study of two methods for determination of pol % in cane

R. Mejías A., S. Ravelo B. and B. M. Torres P. *CubaAzúcar*, 1989, (Jan./March), 34 - 39 *(Spanish)*.

Comparison of pol % cane as calculated from a factory balance and as determined by the hydraulic press method showed that the latter method gave a value that was on average 0.6% higher, indicating that 6 tonnes of sugar failed to be reported for every 1000 tonnes of cane entering the factory. Calculation of unknown losses as PJM – (PA + PM + PCH), where PJM = pol in mixed juice, PA = pol in sugar, PM = pol in final molasses and PCH = pol in filter cake, showed a difference between the losses and sugar recovery which was identical to that found for pol % cane (with the recovery figure being always higher) and which contrasts with the current view that undetermined losses represent 0.75% pol in cane.

Comparison of the Noris, Bliss disintegrator and press methods in bagasse pol determination

E. Rodríguez, E. León and B. Torres. *ATAC*, 1989, **48**, (5), 11 - 14 *(Spanish)*.

The single-digestion method of bagasse pol determination was compared with disintegration for 10 min at 3 different speeds and with hydraulic pressing for 1 min at 200 kg/cm^2. For 27 samples tested, no significant differences were found between the values given by the three methods and the repeatabilities and errors were similar, so that it is recommended to continue using the hydraulic press method.

Sucrose losses in the refining process. I. Determination of the chloride content in sugar products

O. Yanigova, S. Castro O. and M. Delgado P. *ATAC*, 1989, **48**, (5), 23 - 27 *(Spanish)*.

Two methods were compared for chloride determination in refinery liquors: (1) a modification of the Mohr titration method in which 6 - 8 drops of 5% potassium chromate were added to a 50 ml aqueous solution containing 10 g of sample, and the end-point marked by the change from yellow to dark orange when 0.1N silver nitrate was added; and (2) a polarographic method using a calibration curve plotted for 2, 4, 6, 8 and 10 mg additions of NaCl to 10°Bx sucrose solution; the polarograms were obtained by adding 10 ml 1M sulphuric acid to a weighed aliquot of liquor corresponding to 10 g soluble solids and making up to 100 g, and polarography was carried out at 0 - 2 V. Results for raw and clarified liquors showed that, while method (2) was more accurate (99.54% as against 98.44%) and more precise, method (1) was sufficiently accurate, reproducible and rapid for laboratory control.

Comparison of two types of hydraulic press for pol determination in cane

B. M. Torres, R. Mejías and R. J. Rodríguez. *ATAC*, 1989, **48**, (5), 36 - 39 *(Spanish)*.

Statistical analysis of the results for cane pol determination showed that a Soviet hydraulic press gave a lower error (5.720% and 6.783% for field and factory samples, respectively) than a Brazilian model (7.514% and 7.916%, respectively) and cost less, a factor of major importance in Cuba.

Removal of starch with amylase enzyme in cane sugar refining

W. S. C. Tsang, J. X. Guo, M. A. Clarke, M. A. Godshall and C. D. Dooley. *Paper presented to 49th Ann. Meeting Sugar Ind. Tech.*, 1990, 18 pp.

A rapid ion chromatographic (IC) method is described which was used in attempts to analyse products of starch hydrolysis (including glucose, maltose, maltotriose and dextrins) brought about by treatment with Termamyl 1 alpha-amylase. Attempts at direct determination of the hydrolysis products as reducing substances in cane sugar factory products proved difficult (if not impossible) since the enzyme did not by itself break down the starch. Monitoring the increase in glucose level as a result of maltooligosaccharide degradation using alpha-glucosidase and maltase also failed to give an accurate indication of the degree of starch degradation; even after 16 hr, only the maltose and maltotriose were broken down to glucose. Even amyloglucosidase, known to convert starch quantitatively into glucose, had caused less than 1% dextran hydrolysis 20 min after addition of the enzyme. However, combining enzymatic treatment with IC gave results for starch analysis in raw sugar that were in close agreement with the iodine method (r = 0.984), with the IC giving slightly higher values. Experiments with 60°Bx syrup showed that most of the starch was hydrolysed by 10 ppm Termamyl 1

within the first minute; the enzyme was more stable at lower temperatures, while the degree of hydrolysis produced by the same amount of enzyme was much higher at lower Brix.

Method for the determination of moisture in raw sugar

G. Vaccari, M. A. Godshall and M. Nemeth. *Zuckerind.*, 1990, **115**, 383 - 386.

The method for moisture determination in raw sugar that was tentatively adopted at the 19th Session of ICUMSA in 1986 involves heating a small aluminium or glass dish and its cover for about 30 min in an oven at 105°C, allowing it to cool in a desiccator and weighing it accurately, after which about 10 g of the sample are added to the tared dish, the cover immediately replaced and the dish and contents reweighed to 0.1 mg, the weight of the sample thus being obtained by difference. The cover is removed and placed beneath the dish which is placed in the oven at 105°C for 3 hr away from the walls where the heating elements are located. The cover is then replaced and the dish removed for thorough cooling to room temperature before reweighing. The difference in weights of the dish and contents before and after drying represents the water content and is calculated as % original sample weight. Collaborative studies were conducted by 8 laboratories on 10 samples each of cane raw sugar and beet raw sugar containing 0.05 - 1.5% moisture. Statistical analysis of the results showed that the method is suitable for ≥0.5% moisture, but a more sensitive method is needed for <0.5% moisture.

The relationship between viscosity and molecular structure in pure sucrose solutions

M. Eszterle. *Cukoripar*, 1990, **43**, 65 - 70 *(Hungarian)*.

Application of the least squares method to values of relative viscosity found for pure sucrose solutions of 20 - 78°Bx at 10 - 80°C showed that the theory of free volume was valid for molecular diffusion in cases of unsaturation whereby the free volume decreases linearly with molar concentration. Hence it is concluded that, as a result of hydration, the number of water molecules is identical to that of the sucrose molecules and is governed not by concentration but only by temperature; the number of hydrated molecules was calculated on this basis. In a supersaturated solution, the free molar volume falls linearly with the supersaturation coefficient and molecular association takes place between the water and sucrose; it was found that at 40°C this association causes the water molecules to be squeezed out. The viscosity may be calculated using the various formulae, given knowledge of Brix, saturation concentration and viscosity of water; a computer program has been devised for approximate calculation.

Interlaboratory analyses

J. P. Lescure, J. P. Ducatillon and P. Bourlet. *Sucr. Franç.*, 1990, **131**, (143), 19 - 23 *(French)*.

For three years, IRIS (Institut de Recherches de l'Industrie Sucrière) has organized series of collaborative analyses during the French beet campaign so that each laboratory can check its performance and improve the reliability of factory process control; 54 laboratories participated during 1989. Results of white sugar analysis for conductimetric ash, colour, visual quality, turbidity, SO_2 and cleanness, and of molasses and syrup colour and purity determination are discussed with the aid of diagrams.

Analysis of liquid sugars

J. C. Giorgi, J. P. Lescure and J. P. Ducatillon. *Sucr. Franç.*, 1990, **131**, (143), 27 - 31 *(French)*.

Because of problems (including difficulties and lack of precision in analysis using official methods) regarding control of liquid sugar quality within the EEC, French and German laboratories collaborated in a search for more suitable methods. It was concluded that refractometric Brix using a correction factor based on the Rosenbruch formula and polarimetry based on $[a]_D = -20.03°$ were of adequate precision and accuracy for liquid sugars containing <3% invert sugar. While the Berlin Institute method for invert sugar determination as recommended by ICUMSA is highly sensitive, it suffers from inadequate reproducibility, although for low invert contents (≤3%) the error is considered acceptable at <0.3% on total sugars; the Lane & Eynon method for total reducing sugars is preferred for highly (e.g. >10%) inverted samples. HPLC using one of three different types of column is less precise than the above methods but is much more specific and is of value as a means of determining the glucose: fructose ratio; factors governing the precision of chromatographic analysis are listed. Enzymatic analysis is suitable for much more complex products.

Thermal conductivity of sucrose

D. A. MacCarthy and N. Fabre. *Food Prop. & Computer-Aided Eng. Food Proc. Syst.*, 1989, 105 - 111; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (10), Abs. 10 R1519.

The thermal conductivity of five types of refined beet sugar of varying granulometry was studied in the temperature range 17.2 - 64.8°C. It was found that the conductivity rose from 0.085 to 0.167 W/°C with increase in the mean particle size and increased slightly with temperature rise.

Evaluation of error in weight measurement

N. Yu. Lavrov and L. V. Khorunzhaya. *Sakhar. Svekla*, 1990, (3), 46 - 47 *(Russian)*.

The error that may arise in sample weighing on a Soviet VLR-200-11 laboratory balance and the relevant standard specifications are discussed and a method described for calculating the error in both direct and differential weight measurement.

By-products

Animal feed trials in Cuba

Anon. *Tech. Rpt. Inst. Cienc. Animal*, 1987/88, 12 - 16, 37 - 43, 46 - 49.

Research on various types of dairy cattle rations based on cane by-products is outlined. A new product, Saccharea, obtained from treated crushed cane has given milk yields of up to 3.5 tonnes per lactation when included at 91% in a concentrate. Solicaña is sun-dried cane which has been included at up to 50% in a feed; this and a concentrate containing up to 30% Gicabú (a product obtained from filter cake) have given average yields of 3.2 tonnes per lactation and can replace approx. 87% of the cereals normally used. Yields of 9.8 kg/day and a birth rate of 86% were obtained with rations containing pre-digested bagasse pith. Factors such as low N and mineral contents and a high soluble sugar content plus other aspects of fibre digestibility adversely affected the use of cane as the sole feed component; although urea is an adequate supplement, the contribution of true protein is an important factor to consider. A study of the effect of soluble sugars in cane on ruminal cellulase activity showed that sucrose, fructose and glucose inhibit endogluconase activity; 56.25 g of sugar in the total rumen volume is optimum for adequate cellulolysis. Results of feeding trials with mineral-supplemented cane showed that cane consumption reached a maximum of about 6.7 kg dry matter/day and gave a maximum milk yield of 10 kg/day and a lower reproductive response with an average interval between calving and conception of 130 days, indicating that the dietary potential of a given type of animal is the governing factor in the use of cane-based rations. The presence of 1.5% urea (expressed as trichloroacetic acid-precipitated N) in Saccharina, an energy/protein supplement obtained from fermented crushed cane, was found to have a positive effect on the fermentation process by increasing the utilization of total soluble carbohydrates and the cell wall components as well as the *in vitro* rumen bacterial biomass. Advantages of the product and of Saccharina produced from bagasse pith enriched with cane juice and fed to geese and pigs are indicated. Research on growth factors in rumen micro-organisms is mentioned. A silage containing 11.8% crude protein by weight was obtained from 100 g cane (fresh weight) to which was added 1.1% urea, 0.5% mineral salts and 0.5% zeolite by weight before compaction to 500 kg/m^3. At a semi-commercial level with 450 tonnes of cane, the same conditions gave a silage containing 8.6 - 10.0% crude protein and having a pH and temperature of 3.9 - 4.2 and 37.3 - 40.1°C, respectively. In feed trials divided into three stages of 90, 97 and 61 days, respectively, liveweight gains of 803, 749, 825, 776 and 811 g/day were ob-tained in Stage 1 when 3 kg of a green forage:cane silage mixture per 100 kg liveweight was fed in proportions of (i) 100:0, (ii) 75:25, (iii) 50:50, (iv) 25:75 and (v) 0:100 plus a mixture of molasses and 3% urea fed *ad libitum*. In Stage 2 when no cane was added, the daily weight gains ranged from 627 to 781 g, while in Stage 3 when fresh cane was used in the mixture, the daily gains were: (i) 870, (ii) 698, (iii) 975, (iv) 742 and (v) 890 g. Further trials involving fresh or ensiled cane fed *ad libitum* plus green forage with or without a protein supplement showed that voluntary consumption of cane in either form had a "physiological limit" of 1.8 kg dry matter per 100 kg liveweight. Maximum daily gains of 624 and 553 g were obtained with fresh cane and cane silage, respectively. In studies with rams, dry matter digestibility increased as the sugar content fell in diets containing whole cane or stalks from which the juice had been extracted (in both cases the cane being sun-dried and crushed). Fibre digestibility was greater with the juice-extracted stalks. The results are discussed of investigations on rumen kinetics and fermentation and intestinal pathway of digesta in which the basal diet contained cane trash. Molasses/urea added at 3% to a ration containing hay reduced the consumption of both hay and dry matter. Cane tops and green leaves, dry leaves and leaf sheaths from cane cleaning centres were found to have metabolizable energy contents of 8.0, 5.0 and 4.6 MJ/kg dry matter, respectively. Since consumption of standard forage by commercial animals was found to increase at a greater rate than live weight, those animals weighing more than 175 kg could be expected to utilize cane residue (CR) together with an energy/protein supplement. The ligno-cellulose component in CR was much more readily degraded by Zebu than by Holstein cattle. A scheme to achieve a liveweight gain of 400 g/day in beef cattle fed on CR is outlined. Sheep and beef cattle fed on CR exhibited mineral deficiencies, indicating the need for supplements containing both macro- and micro-elements. A daily gain of 150 g was obtained with Zebu cattle fed on CR *ad libitum* and 2 kg of a supplement containing final molasses and filter cake, whereas animals receiving CR with molasses directly in the feeding trough lost 140 g/day. Trials in which bulls were fattened during 299 days showed weight gains of 905, 916 and 727 g/day when they were fed on (i) a cereal concentrate plus restricted forage and final molasses + urea, (ii) the same as (i) but with *B*-molasses replacing final molasses and (iii) rations without any molasses. Two feeding schemes are outlined. Inclusion of up to 30% on dry matter of Saccharina to replace cereals in pig rations did not affect performance during the reproductive cycle; this was also found with mixtures of torula yeast and *B*-molasses. The liveweight gains of pregnant sows was linearly related to the proportion of final molasses in the diet; however, increase in the amount of molasses beyond 60% of the dry matter in the diet was not accompanied by any increase in weight gain. Dehydrated cane meal in diets for young pigs did not affect the non-fibrous dry matter digestibility but increase in the proportion to 20% and 40% caused an energy loss of 8% and 15%, respectively, because of failure to digest all the fibre. Replacement of 60% of the cereal (23% of the dry matter) by Saccharina in molasses-based rations fed

to sows did not affect animal performance, but gave a 20% increase in daily weight gain of castrated males, although carcass fat was reduced. Inclusion of final molasses as the main source of protein in diets for pregnant sows caused a low energy utilization; in fattening trials, energy consumption was wholly inadequate when final molasses was the main energy source, but calcium consumption was high.

Effect of incorporation of sugar cane trash into field soil on cane yield and soil fertility

D. B. Shinde, A. M. Navale, B. R. Vaidya and S. B. Jadhav. *Indian Sugar*, 1990, **39**, 905 - 908.

Incorporation of chopped trash at 7.5 tonnes/ha plus a mixture of five fungal cultures increased cane and sugar yield to 173 and 19.38 tonnes/ha, respectively, as against 161 and 16.04 tonnes/ha in the untreated control. At 2.5 and 5.0 tonnes/ha the trash had a smaller effect which was still better than the control, while unchopped trash gave slightly lower yields than the chopped material. Treatment increased nutrient uptake and improved soil fertility.

Recent developments in ethanol fermentation processes

S. C. Bassapa. *Bharatiya Sugar*, 1990, **15**, (6), 19 - 20, 23 - 28.

A survey of alcohol manufacture from cane molasses includes: suitable strains of yeasts and bacteria; fermentation kinetics (metabolic pathways; the effects of sugar concentration, pH, temperature and oxygen; fermentation by-products and ethanol tolerance by yeast; and nutrient requirements); alternative substrates; and the results achieved with different processes.

Indian ethyl alcohol industry - need for improvements

S. L. Venkiteswaran. *Bharatiya Sugar*, 1990, **15**, (6), 29 - 30.

Since only 10% of the molasses in India is used for purposes other than alcohol fermentation, more than 1100 million litres of ethanol are produced annually. Because of this large quantity and the low price for molasses and coal, there was no incentive to improve on the traditional fermentation technology to cut costs; however, the costs have now risen sharply and the question of vinasse disposal has become a major issue. The only innovation has been the introduction of yeast recycling, while some research has been conducted into the use of alternative raw materials. Various directions in which fermentation technology may be improved are outlined, mostly based on work in the USA.

Scope for improvement in the conventional batch (alcohol fermentation) process

S. V. Arbatti and U. M. Kale. *Bharatiya Sugar*, 1990, **15**, (6), 33, 35 - 36.

Suggestions are put forward on means of improving fermentation efficiency and alcohol quality in India. Aspects discussed include molasses quality and the effects of storage, the quality of water used and the need for treatment, fermenter hygiene, temperature control during fermentation, addition of nutrients, yeast quality, etc.

Binary yeast cultures in the presence of supplements enhance the rate of ethanol production in cane molasses fermentation

S. G. Patil and B. G. Patil. *Bharatiya Sugar*, 1990, **15**, (6), 37 - 40.

Experiments were conducted on alcohol fermentation of molasses with a mixture of *Saccharomyces cerevisiae* var. *ellipsoideus* NCIM 3281 and *S. uvarum* NCIM 3509. In batch fermentation, use of the yeast mixture gave a 29% increase in ethanol yield after 48 hr by comparison with use of each yeast individually; however, use of chitin as a supplement gave a 48% increase in yield, while addition of fungal mycelium to the yeast mixture gave a 45% increase. However, when yeast recycling was used, there was no difference in alcohol yield between use of the mixture and each supplement, while the yield was only 1.5% greater than when the mixture was used on its own but the overall increase was 3.0 - 3.8% by comparison with the use of individual yeasts without supplement.

Performance evaluation of molasses-based distilleries – a new approach

P. V. L. Narasimham and P. Srimannarayana. *Bharatiya Sugar*, 1990, **15**, (6), 45 - 48.

It is argued that current methods of defining alcohol fermentation efficiency are misleading and may not provide a fair comparison between distilleries. An alcohol balance is drawn up which includes the amount available from molasses and fermented wash, the amount in rectified spirit and vinasse and the undetermined and total losses. The overall efficiency, i.e. that of fermentation and distillation, is then given as 100 (alcohol in rectified spirit/alcohol available from molasses), while the reduced overall efficiency (ROE) is that at a standard molasses fermentable sugars content of 45%. ROE values are calculated for 5 distilleries and the reduced standard yield is calculated for 10 plants to demonstrate the unsuitability of the current system of assessment.

Continuous fermentation of cane molasses to ethanol by the Encilium process

S. Nene. *Bharatiya Sugar*, 1990, **15**, (6), 49 - 50.

Disadvantages of conventional batch processes for alcohol manufacture include the need to discard the yeast at the end of each cycle, contamination of the open fermenter, inability to recover the CO_2 or the alcohol in it and fall in conversion efficiency resulting from a temperature rise to >40°C. The Encilium continuous process overcomes these drawbacks while also using a highly flocculent yeast. The developers guarantee a 90% conversion of fermentable

sugars, corresponding to an ethanol yield of 280 litres/tonne of *A*-molasses. Existing batch fermenters and ancillary plant may be used for the process at minimal additional costs. The economic benefits are calculated.

Ecofine modernized distillation system

A. Karkare. *Bharatiya Sugar*, 1990, **15**, (6), 51.

Ecofine bubble cap columns and high-velocity condensers are described which contribute to a steam consumption of 2.0 - 2.1 kg/litre of rectified spirit compared with 2.6 - 3.5 kg/litre in conventional distilleries.

Improvement in alcohol quality

S. V. Arbatti. *Bharatiya Sugar*, 1990, **15**, (6), 57, 59 - 60.

A sample of alcohol from a molasses distillery in India was found to have an unpleasant odour and to contain excessive amounts of *n*-propanol and ethyl acetate. The failure of Indian distilleries in regard to alcohol quality is discussed, and the use of stainless steel plant blamed for high impurities contents. The advantages of copper distillation columns are indicated, the major impurities in rectified spirit discussed and a call made for a better approach to quality and its control.

Hiferm continuous fermentation – an ideal process

J. Godbole. *Bharatiya Sugar*, 1990, **15**, (6), 73 - 74.

The Hiferm continuous fermentation process without yeast recycle uses 5 - 7 fermenters and is suitable for upgrading a batch system of alcohol manufacture from molasses at minimum investment. The system and a batch conversion package are described. Advantages include a higher alcohol yield and quality, a 25% reduction in vinasse quantity and a 20% decrease in process water consumption as well as a substantial fall in operating costs by comparison with batch fermentation.

Potential for MVR in Indian distilleries

S. Devotta and S. Gopichand. *Bharatiya Sugar*, 1990, **15**, (6), 75, 77.

The significant scope for mechanical vapour recompression (MVR) in molasses distilleries is discussed. While MVR can reduce steam consumption by 2.65 tonnes/hr at an electricity consumption of 300 kWh in a distillery producing 40,000 litres of alcohol per day, the additional power requirement may present some difficulties; these and the economics are discussed.

Modernization of Indian distilleries adopting a conventional process

K. P. Singh. *Bharatiya Sugar*, 1990, **15**, (6), 79 - 80.

For improvement in distillery operation, recommendations are made regarding molasses storage, quality of yeast and water, prevention of excessive fermenter temperatures, distillation column instrumentation, energy conservation (including use of adequate insulation, preheating of the wash and increasing its alcohol content so as to reduce steam consumption) and anaerobic treatment of vinasse.

Biostil – a perspective

A. Deodhar. *Bharatiya Sugar*, 1990, **15**, (6), 81, 83, 85 - 87.

Melle-Boinot batch fermentation and the Vogelbusch continuous cascade system are described and the benefits of yeast recycle indicated. Details are then given of the Alfa-Laval Biostil system which is claimed to overcome drawbacks with the Vogelbusch scheme; it does not require molasses pretreatment but uses high osmotic pressure to prevent contamination, and uses recycling of weak wash to increase distillation efficiency while reducing the volume of effluent.

Molasses decolorization using immobilized Basidiomycete cells. IV. Decolorization of cane molasses

H. Tamaki, S. Takaoka, S. Kishihara and S. Fujii. *J. Jap. Soc. Food Sci. Technol.*, 1989, **36**, 827 - 831; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (11), Abs. 11 R1507.

The use of immobilized *Ceriolus hirsutus* IFO 4917, a member of the Bacidiomycetes family, to decolorize cane molasses and melanoidin solutions was investigated. Optimum process parameters were found to be a temperature of approx. 30°C and a pH of approx. 4.5. In a bioreactor with immobilized cells, decolorization of the melanoidins and molasses may be achieved within 6 and 4 days, respectively.

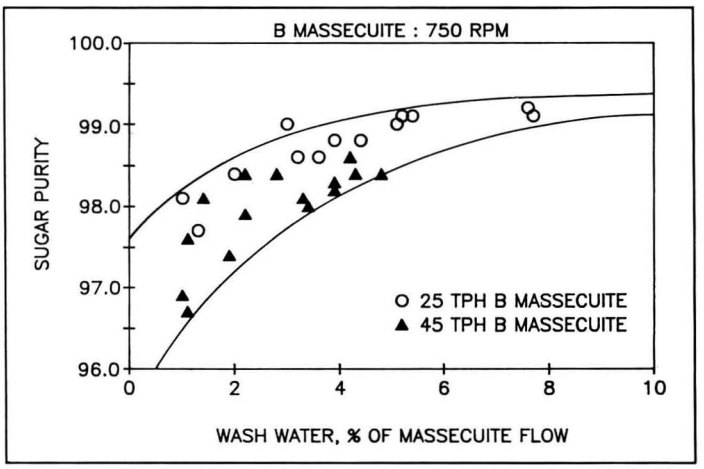


Fig. 3a. *B*-sugar purity as a function of % wash water addition at 750 ppm

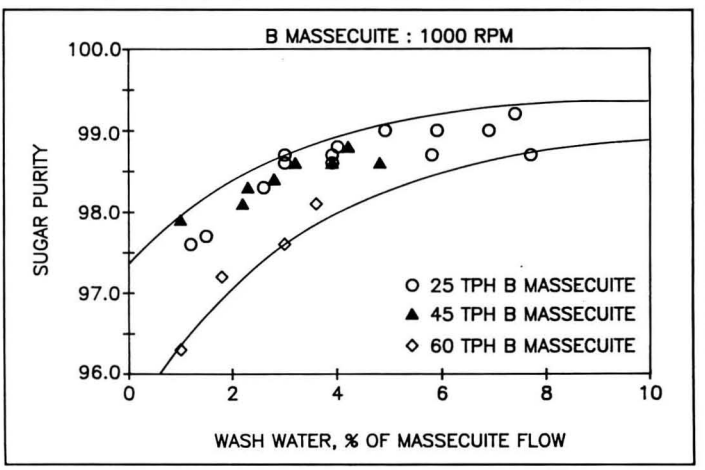


Fig. 3b. *B*-sugar purity as a function of % wash water addition at 1000 ppm

varying the flow rate of wash water at a given rate. The effect of wash water rate on sugar purity was both consistent and repeatable. The substantial amount of scatter in the data is believed to arise from variation in the separating properties between massecuites.

For *A*-massecuite, the sugar quality can be controlled to Brand JA level at a nominal wash rate of 1% on massecuite, or to Brand 1 level at a nominal wash rate of 3.5% on massecuite. VHP sugar (>99.4 pol) was produced at wash rates of greater than 6%. For B-massecuite, the sugar quality can be controlled to Brand JA level at about 3% wash water, and to Brand 1 level at about 7% wash water.

The performance of the superfugal is likely to vary according to massecuite properties and these results apply to the conditions encountered at Kalamia Mill. A larger crystal size or lower mother liquor dry substance would increase the machine's capacity.

From the results, there appears to be little benefit associated with increasing the basket speed from 750 to 1000 rpm. It was observed that the colour line is always very low on the screen (<20% up the basket) and, under these conditions, it is felt that washing would be the controlling mechananism rather than filtration, as is the case in low-grade centrifugalling[5]. It would therefore be expected that basket speed would have limited influence on the performance of a high-grade centrifugal.

Crystal breakage

The superfugal incorporates a static device designed to eliminate crystal damage from high velocity impacts with the machine's casing and from mid-air collisions on the flight path from the basket lip to the sugar chamber wall. The device is made of resilient polyurethane material which showed little evidence of wear after all the trials had been carried out. Damage from mid-air collision can be very severe at high levels of pol. Grist analyses were carried out on sugar produced by the superfugal and by Kalamia Mill's batch centrifugals. Sugars were sampled prior to the dryer but after they had passed through a screw and elevator. Trials were conducted so that *A*-or *B*-sugars from either the batch centrifugals or the superfugal could be sampled independently.

Figure 4 shows that the percentage fines produced by the superfugal only marginally exceeded that produced by the batch centrifugals (factor of 1.09) when operating at 750 rpm. This marginal difference was observed over the entire range of sugars produced, from Brand JA through to VHP. At 1000 rpm, the superfugal produced a significant increase in the proportion of fines in sugar. This is to be expected as the energy of the discharging crystals is increased by almost 80% from the value for a basket speed of 750 rpm.

Unfortunately, throughout the main trial period, the factory produced a consistently high fine grain in sugar.

5 Greig *et al.: ibid.*, 1985, 179 - 188.

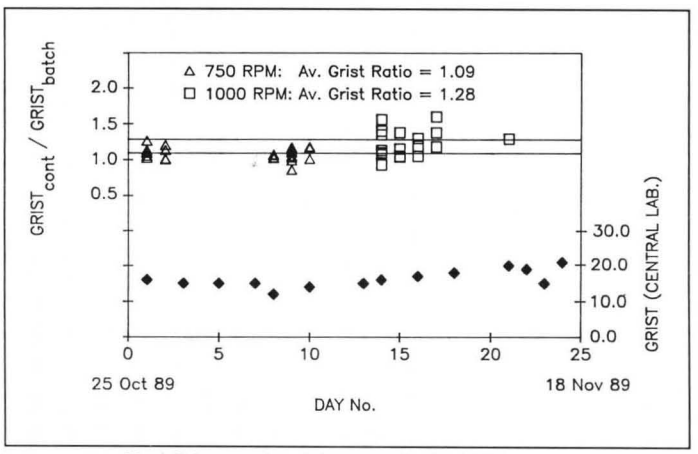


Fig. 4. Grist comparisons between superfugal and batch sugar

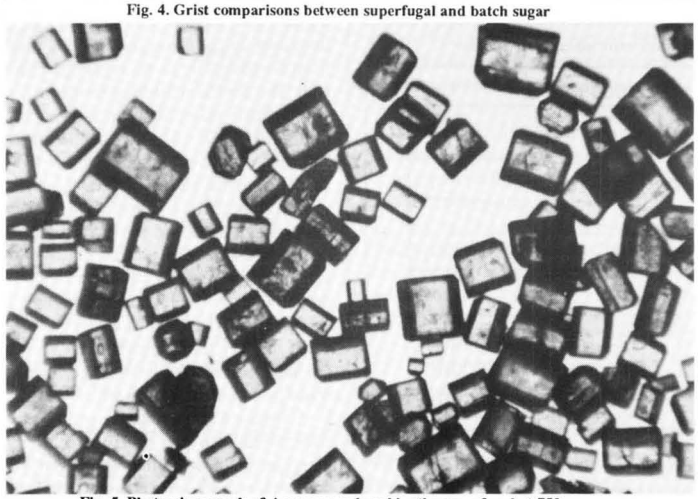


Fig. 5. Photomicrograph of *A*-sugar produced by the superfugal at 750 rpm

This was discovered to be due to a fault in the seed pan. The fines tended to comprise mainly fine crystals generated in the pan and not fractured from the centrifugals. A photograph of a typical sugar from the superfugal (at 750 rpm) is shown in Figure 5.

Molasses purity rise

Molasses purity rise studies were hampered by the inability to get consistent and reliable values. It is probable that sample deterioration and crystal precipitation contributed to the problems, which seemed to worsen toward the end of the trial period. Delays between sampling and actual analyses also increased during that time. These anomalies prevented the establishment of a firm relationship between molasses purity rise and sugar purity for the superfugal.

Earlier trials successfully provided comparisons between the batch centrifugal purity rise and that of the superfugal. These comparisons are shown in Figure 6. There was no significant difference in the molasses purity rise with both centrifugals producing JA sugar. Also shown are the purity results with higher superfugal sugar purities (up to 99.7) compared with those from the batch units producing JA sugar. The average difference is still only 0.7 units. The three trials on day 16 in which a very high purity rise difference was reported coincided with a measured batch molasses purity rise of negative 4.0 units. The figures, which are included in the average above, are obviously incorrect. Omitting them from the data results in an average purity rise difference of zero.

Power consumption

Power consumption was monitored using an Easterline "tong tester" which measures the line voltage and current for each phase, and the phase angle. Figure 7 shows a typical comparison between the cyclic demand of the batch centrifugals and the very steady demand of the continuous machine.

The average specific energy demand was also obtained for the batch centrifugals by integrating under the power *versus* time graph and dividing by the estimated throughput of the centrifugals. The negative contribution of the regenerative braking was included in the calculation. Figure 8 provides a comparison between the batch machine and the superfugal at both 750 and 1000 rpm. Using a nominal capacity of 50 tonnes/hr massecuite, the superfugal energy requirement at 750 rpm is 0.64 kWh/tonne massecuite (less than 20% of the batch) and at 1000 rpm is 0.9 kWh/tonne massecuite.

Low-grade massecuite separation

Installation and commissioning

The superfugal at Inkerman factory was installed on an existing staging in line with five Western States CC5 machines. Massecuite from the continuous crystallizers flow under gravity through a finned tube primary heater prior to distribution through individual secondary heaters to each centrifugal. A special

Ring-reinforced basket = proven protection.

Years of operation in the sugar industry have firmly established the inherent safety of the Western States basket design. The basket's stainless steel side sheet is reinforced by numerous, high tensile strength, weldless, steel rings . . . each machined from a forged billet. These rings contain the rotating mass should the side sheet ever fail. Or, should a ring fail, the basket still has a high degree of reinforcement because of the numerous remaining rings. We have refused to depart from this design principle . . . a primary reason why Western States Centrifugals offer proven protection against violent basket failures.

safet

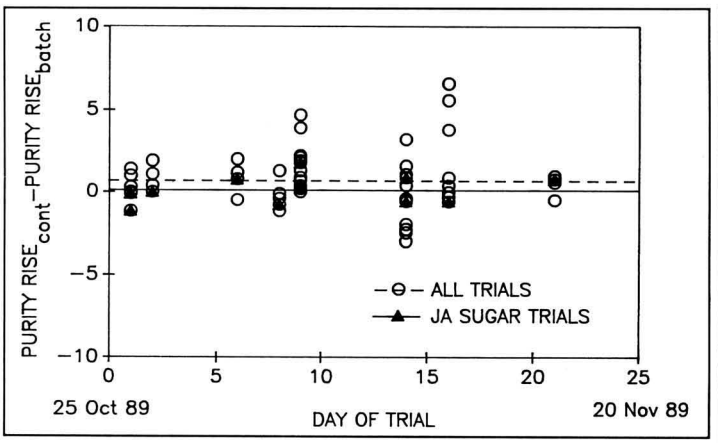


Fig. 6. Comparison between superfugal and batch molasses purity rise

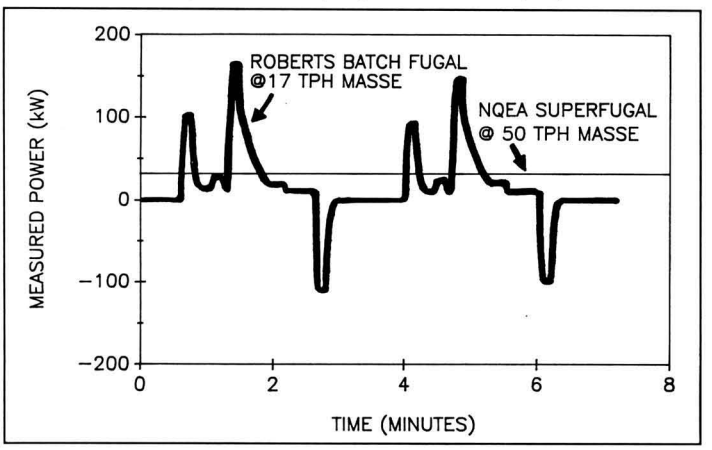


Fig. 7. The energy demand-time profile of batch centrifugals and superfugal

finless type of heater was designed for the superfugal, to cope with space limitations and with a very high secondary heating requirement.

This machine was first operated during September 1989. Commissioning trials covered the selection of suitable operating speeds, adjustments to the feeding arrangement and the setting up of appropriate water/steam addition systems. The machine incorporates an intermittent water flush to prevent fouling of the static crystal anti-breakage device.

An operating speed of 1440 rpm was selected for the main trial series, as this enables the use of a standard 4-pole induction motor for the direct drive arrangement. This speed is low enough to provide a significant reduction in the crystal discharge velocity from that of other machines, but high enough to provide a very high centrifugal capacity relative to other commercial machines.

Purging performance

A series of trials was carried out comparing the superfugal and one CC5 machine operating simultaneously. The selection of the CC5 machine for trial was varied each day. The centrifugal station at Inkerman Mill was consistently producing quite high *C*-sugar purities (>90 true purity). The superfugal performed very well at *C*-sugar purities over the range 85 to 90 purity. Typical *C*-massecuite properties during the trial period are given in Table II.

As shown in Figure 9, the superfugal capacity averaged 3.7 times the capacity of the Western States CC5 machines. It should be noted that the throughput of the superfugal was often limited by the available head, with the wash water flow rate reduced to match the sugar purity with that from CC5. The 3.7 factor underestimates the true capacity of the superfugal as its actual capacity was well above the total amount of material being produced by the low-grade station. As a typical example, the superfugal processed 35 tonnes/hr of massecuite (I/W = 3.2, temperature = 58°C) at a *C*-sugar true purity of 90.

Molasses purity rise

The molasses purity rise was obtained for each trial on both the superfugal and the CC5 machines. As shown in Figure 10, the molasses purity rise from the superfugal was generally lower than that from the CC5 machine. The average difference was just over 1' unit (± 0.8 units).

Crystal breakage

At the time of preparation of this paper only limited consideration of the low-grade crystal breakage analyses has been possible. Figure 11 compares a typical size distribution of *C*-massecuite with sugars from the superfugal and the CC5 machines. A design alteration which was carried out on the high-grade machine, has still to be implemented on the low-grade machine. This alteration overcomes the problem of deflector fouling and substantially eliminates crystal damage.

Power consumption

The specific power consumption

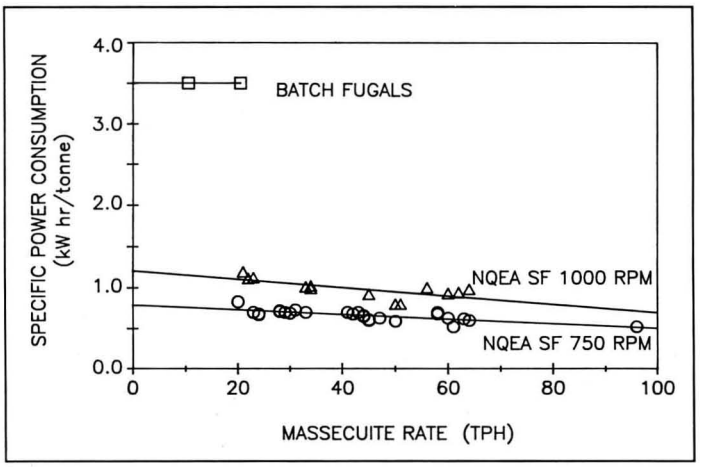


Fig. 8. Specific power consumption of batch centrifugals and superfugal

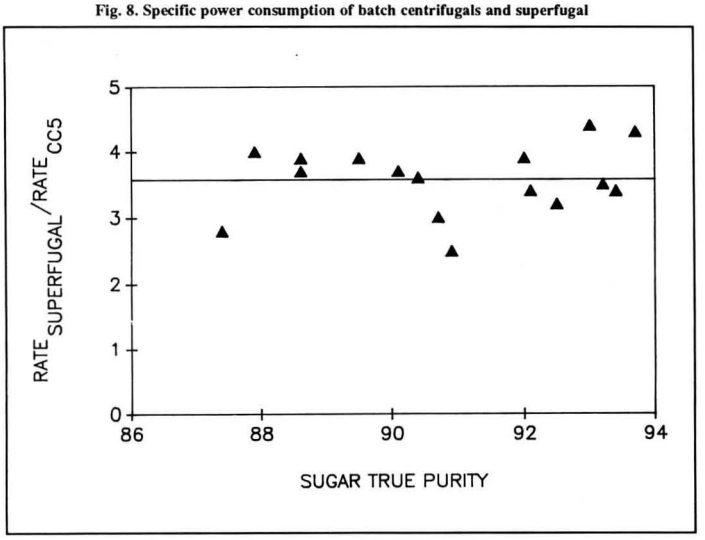


Fig. 9. Superfugal and Western States CC5 *C*-massecuite rates

of the superfugal and of the CC5 centrifugals is compared in Figure 12. It is apparent that the energy requirement of the superfugal is slightly lower than that of the CC5 centrifugal, the average difference being approximately 35%.

Conclusions

The NQEA superfugal has been successfully demonstrated for the production of low-grade and shipment sugars. The nominal capacity of the machine was 75 tonnes/hr *A*-massecuite, 45 tonnes/hr *B*-massecuite and 35 tonnes/hr *C*-massecuite.

Effective control of high-grade sugar pol (from Brand JA to VHP) was achieved by adjustment of wash water flowrates, while *C*-sugar purity was controlled by the wash water flow rate. VHP sugar was routinely produced from *A*-massecuite.

A static device substantially eliminates the crystal breakage problem that has prohibited continuous high-grade centrifugalling in the past. The device is effective over the entire sugar pol range.

High-grade molasses purity rises were not significantly different from those of the batch machine when the superfugal and the batch centrifugals were producing the same brand of sugar. On low-grade material the superfugal had an average purity rise of 1 unit less than the other continuous centrifugals at Inkerman (Western States CC5).

The superfugal's specific power consumption is one-fifth that of its batch counterpart on high-grade processing and some 35% below other continuous machines in use at Inkerman Mill when processing low purity massecuites.

Future applications

A viable alternative to the high-grade batch centrifugal is now available. The performance of the new continuous centrifugal has not been matched or even approached by that reported by any other centrifugal, batch or continuous. Its superior performance is due to a combination of technical innovations, the benefits of which appear to be additive. Its advantage over the other commercial

Table II. *C*-massecuite properties at Inkerman Mill

	Dry substance, %	True purity	I/W	Mother liquor consistency at 50°C, Pa.s	Crystal mean aperture, mm
Average	90.2	64.8	3.6	36.8	0.35
Range	89.0-91.4	64.1-65.5	3.1-4.2	35.6-39.2	0.25-0.65

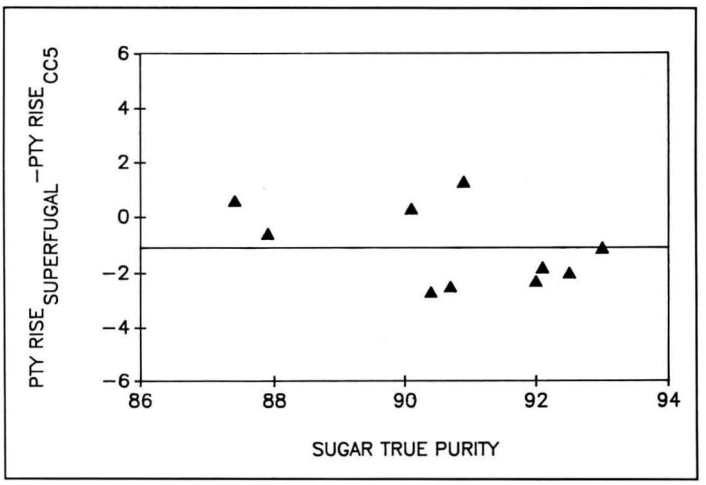


Fig. 10. Superfugal and Western States CC5 molasses purity rise

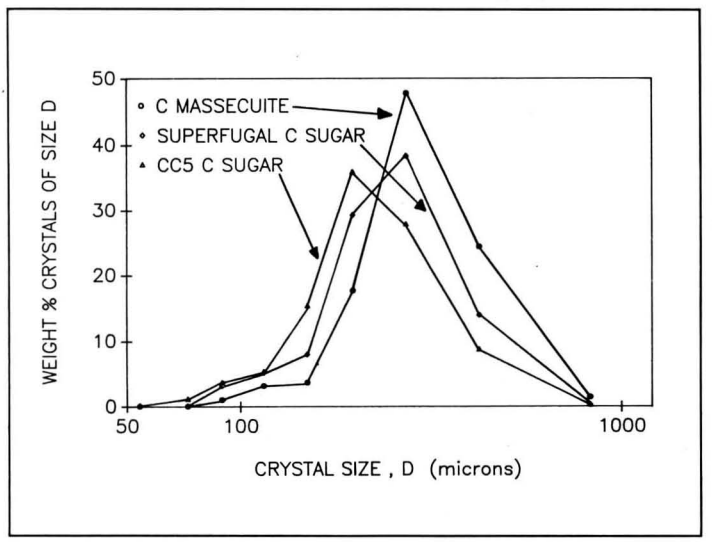


Fig. 11. Crystal size distributions of Inkerman *C*-massecuite, superfugal sugar and Western States CC5 sugar

units cannot simply be explained by size and speed combinations.

The design features allow a versatility of application which is a further asset, with equally impressive results for low-grade or high-grade processing. Preliminary work suggests that this range of proven applications will extend to refinery requirements as well. This aspect has the obvious advantage of standardization of centrifugal equipment and associated ancillary gear.

The time may now be opportune for some reflection on the relatively recent batch to continuous low-grade changeover. This resulted in some 20 different models of continuous centrifugals being supplied to Australian mills by nine different manufacturers. Some were designed to suit the characteristics of the material, some were not. The effect of this diversity on items such as supply of screens and other consumable items was immense.

An opportunity is now presented for the next changeover to be effected with standard size machines. These can also serve as replacements for existing low-grade units as they are retired from service. Current estimates suggest that a 600 tch factory could operate with a total of 5 superfugals, on a single stage, processing *A*-, *B*- and *C*-massecuites. The ease with which pol and moisture are able to be varied in the superfugal, coupled with new techniques such as near infra-red sensing, indicates strong potential to automate the centrifugal process.

Acknowledgements

The financial support from the Australian Industry Research and Development Board, prior to the NQEA Australia Ltd. financing of prototypes, is gratefully acknowledged. Special thanks are due to CSR Ltd. for the provision of many facilities, and to analytical staff at Kalamia Mill who processed all trial samples in addition to their normal duties. Thanks are also to the staff and trades persons at Kalamia and Inkerman Mills for their willingness to assist at all times with an undertaking of a considerable magnitude.

Summary

A new continuous "superfugal" has been developed for the production of low grade sugar and the full range of shipment sugars. The superfugal is a very high capacity machine with low specific power requirements. No problems with respect to molasses purity rise and crystal breakage are evident. It is expected that one superfugal could replace up to four of the higher capacity batch centrifugals currently available for shipment sugar production. On low grade, it should replace four commonly

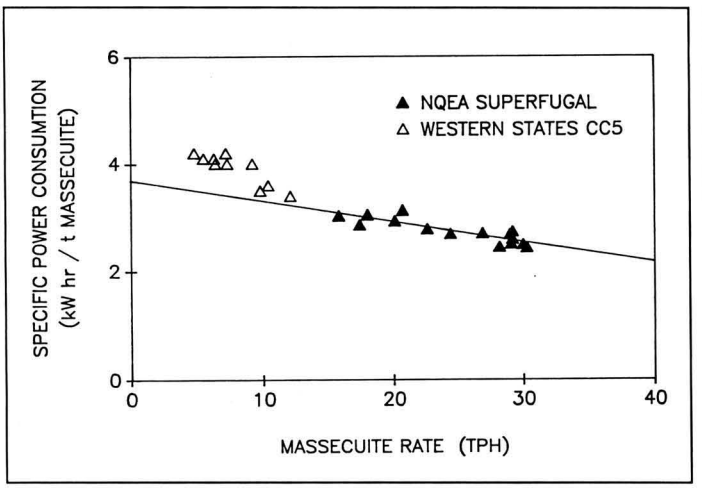


Fig. 12. Specific power consumption of superfugal and Western States CC5 centrifugal

used continuous machines. The superfugal is the first viable alternative to batch centrifugals for high grade separation to be demonstrated in Australia. Its versatility also permits an attractive future option of a single, high grade/low grade centrifugal station for the whole factory. Current estimates suggest that a total of five superfugals could service a 600 tonnes/hr factory. This, together with the potential for automation, should substantially reduce operating and maintenance costs.

El funcionamiento de un diseño nuevo de centrífuga continua

Se ha desarrollado una centrífuga continua "superfugal" para la producción de azúcar de bajo grado y de azúcares de embarque en el rango completo. La "superfugal" es una máquina de capacidad muy alta con requerimientos de potencia específica bajos. No hay problemas evidentes con respecto al aumento de pureza de las melazas ni de quiebre de cristales. Se espera que una "superfugal" pueda reemplazar hasta cuatro de las centrífugas discontinuas de la más alta capacidad corrientemente disponibles para la producción de azúcar de embarque. En el bajo grado, debería reemplazar cuatro máquinas continuas comúnmento usadas. La "superfugal" es la primera alternativa viable a las centrífugas discontinuas para la separación de alto grado a ser demonstrada en Australia. Su versatilidad le permite también una opción futura atractiva de una estación única de centrifugado, de alto y bajo grado para la fábrica entera. Cálculos actuales estiman que un total de cinco "superfugals" podrían hacer el trabajo de una fábrica de 600 toneladas/hora. Esto, en conjunto con el potencial para automatización, debería reducir substancialmente los costos de operación y de mantenimiento.

La performance d'un nouveau type de centrifuge continue

On a développé un nouveau type de centrifuge ("superfugal") pour la production de sucre des jets inférieurs et pour tous les sucres destinés à l'expédition. La "superfugal" est une machine à trés forte capacité avec de faibles demandes en énergie. On n'a observé aucun problème quant à une augmentation de la pureté de la mélasse ou à une cassure des cristaux. On s'attend à ce qu'une "superfugal" puisse remplacer quatre centrifuges discontinues de haute capacité actuellement disponibles pour la production des sucres destinés à l'expedition. Dans les jets inférieurs elle devrait remplacer quatre machines continues habituellement utilisées à cet endroit. La "superfugal" est la première alternative viable apparue en Australie pour des centrifugas discontinues utilisées pour la séparation du sucre dans un jet supérieur. Son universalité permet aussi une future option intéressante vers un type unique de machine installée dans la station de centrifugation et utilisée dans tous les effets de la sucrerie. Des estimations font prévoir qu'une sucrerie de 600 tonnes/heure aurait un total de cinq appareils du type "superfugal". Une telle situation, avec en plus son potentiel d'automation, devrait réduire substantiellement les frais opérationnels et les coûts d'entretien.

Die Leistung einer neuartigen kontinuierlichen Zentrifuge

Eine neue kontinuierliche "Superzentrifuge" ist zur Erzeugung von Nachproduktzucker und Versandzuckern aller Art entwickelt worden. Die Superzentrifuge ist eine sehr Hochleistungsmaschine mit niederem spezifischen Kraftbedarf. Probleme hinsichtlich Melassereinheitszunahme und Kristallbruchs wurden nicht gefunden. Man erwartet, dass eine Superzentrifuge bis zu vier periodische Zentrifugen höherer Leistung ersetzen könnte, die zur Zeit für Versandzuckererzeugung zur Verfügung stehen. Für Nachproduktzuckererzeugung sollte sie vier häufig angewendeten, kontinuierlichen Maschinen ersetzen. Die Superzentrifuge ist die erste rentable Alternative zu periodischen Zentrifugen für Hochleistungstrennung, die man in Australien demonstriert hat. Wegen ihrer Flexibilität wird sie in der Zukunft als attraktive Möglichkeit einer einzelnen Zentrifugenstation zur Hoch- und Nachproduktarbeit für die ganze Fabrik zur Verfügung stehen. Gegenwärtige Schätzwerte lassen denken, dass insgesamt fünf Superzentrifugen einer Fabrik von 600 t/h dienen könnten, was, zusammen mit der Möglichkeit von Automatisierung, Operations- und Bedienungskosten beträchtlich vermindern sollte.

Facts and figures

India sugar export plans[1]

India plans to export 52,726 tonnes of surplus sugar in 1990, according to official sources. The Secretary-General of the Indian Sugar Mills Association said that stocks were sufficient to allow export of 200,000 tonnes without affecting domestic availability. India exported about 783,000 tonnes in 1983 and 307,000 tonnes in 1974; after that, exports were only small quantities sent to preferential markets while India has been forced to make substantial imports since 1985 to meet consumption needs. However, production increased dramatically in the 1989/90 season and the outlook for 1990/91 is also good.

Australian sugar factory expansion[2]

Tully Sugar Ltd., which became an unlisted company instead of a cooperative in March 1990, is undergoing a $Aus 7 million expansion which will see an increase in capacity from 440 to 600 t.c.h. by 1993, with an output higher by 40-50% within an economical crushing season. The change also provides an opportunity for Tully to amalgamate with the South Johnstone sugar factory and thereby give scope for cane land expansion by local growers.

Cuban aid for the Iran sugar industry[3]

In return for crude oil, Cuba is to provide experts to help the Iranian sugar industry. These will modernize the Haft Tappeh sugar factory, train Iranians and provide help in sugar cane cultivation.

US caloric sweeteners consumption estimate[4]

The US Department of Agriculture expects total use of caloric sweeteners, including refined sugar, HFS, glucose, honey, maple syrup and edible molasses, to come close to a record 17 million short tons, dry basis, in calendar 1990, compared with 16.6 million tons in 1989 and 15.6 million tons in 1985. The expansion reflects growth in US population, increased per caput income and changes in consumer lifestyles and tastes. Per caput use is forecast at 135.3 lb in 1990 against 133.6 lb in 1989, and refined sugar use is expected to account for 46.3% of the total, with corn sweeteners representing 52.7%. Domestic HFS production, forecast to increase by 2.6% to 6.02 million tons, dry basis, will not meet requirements of 6.12 million tons – up 2.9% on 1989 – and will have to be supplemented by imports.

1 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 453.
2 *Australian Canegrower*, 1990, **12**, (15), 22.
3 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 473.
4 *U.S.D.A Sugar and Sweetener Situation and Outlook Rpt.*, Sept. 1990, 3.

News and views

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sugar in the 1989/90 crop at a TCTS ratio of 11.74, an output some 2% less than the last crop of 220,800 tons before Hurricane Gilbert struck in 1988, and an improvement of some 25,000 tons over the hurricane-affected crop. Jamaica's current level of sugar output is less than half the record of 506,348 tons produced in 1965 by the then 18 sugar factories. Only 9 factories are in operation today as the industry has undergone considerable rationaliization. The area under cane is down to 100,000 acres from 150,000 acres in the mid-1960's. Productivity is on the rebound after a decline to 1.9 tons of sugar per acre (TSA) recorded in 1982. Yield was just under 2.4 TSA in the crop before Gilbert struck and targets have been set of attaining 3 TSA and an output of 250,000 tons. This would satisfy local and foreign commitments and permit a small excess for building a reserve.

Smut and rust epidemics have been conquered with resistant varieties. The leading varieties today are BJ 7015 (32% of area), UCW 54655 (17%) and BJ 7013 (6%). Others such as BJ 7452, BJ 7465, BJ 7504 and BJ 7627 are undergoing rapid expansion. The West Indian cane fly, a leaf sucking insect once considered the scourge of the industry, now sees only the occasional minor outbreak. *Diatraea saccharalis*, the sugar cane stalk borer, is a pest of greater concern and is being tackled by a program of biological control. Roughly a third of the industry's cane is grown under irrigation – mainly furrow irrigation. Increasing salinization of underground water sources is a major problem and has forced a re-examination of other methods of irrigation. Sugar cane harvesting is still largely by manual cutting, followed by mechanical loading. A variety of mechanical harvesting systems are however, being gradually adopted.

Cane deliveries are now core-sampled before acceptance by the factories. By 1991 the system of payment to growers will reflect quality as determined by the core sampler and not that determined in the factory. In essence, the grower will be paid on the basis of the sugar entering rather than sugar leaving the factory. It is expected that close to 100% of deliveries will be individually sampled so that there should be greater incentive to deliver clean, fresh, mature – good quality – cane.

Although the last sugar factory built in Jamaica opened as far back as 1949, factories have been undergoing a steady process of upgrading and modernization. Many formerly manual processes are being automated and older equipment replaced by more efficient up-to-date versions. The new cane separation plant represents a whole new pioneering concept that revolutionizes the way cane is handled by the factory and makes possible a range of new products. Its cane juice beverage and industrial syrup are already carving a niche in the local market. Longer term plans call for machinery for making charcoal briquettes from rind to be installed. Commercial production of table syrup and amorphous sugar are in the pipeline. If desired, alternative uses can be made of rind or pith with appropriate modifications to the plant.

World sugar production estimates, 1990/91[5]

	1990/91	1989/90
	— *tonnes, raw value* —	
Beet Sugar		
Belgium	1,076,000	1,038,000
Denmark	584,000	530,000
France	4,630,000	4,198,000
Germany, West	3,610,000	3,337,000
Greece	336,000	421,000
Holland	1,277,000	1,240,000
Ireland	245,000	233,000
Italy	1,707,000	1,880,000
Portugal	2,000	2,000
Spain	1,033,000	1,023,000
UK	1,380,000	1,377,000
Total EEC	*15,880,000*	*15,279,000*
Austria	462,000	458,000
Finland	158,000	160,000
Sweden	429,000	421,000
Switzerland	148,000	152,000
Turkey	1,790,000	1,378,000
Yugoslavia	890,000	969,000
Total W. Europe	*19,757,000*	*18,817,000*
Albania	25,000	45,000
Bulgaria	60,000	67,000
Czechoslovakia	690,000	766,000
Germany, East	765,000	678,000
Hungary	522,000	577,000
Poland	1,960,000	1,895,000
Rumania	425,000	543,000
USSR	9,250,000	9,565,000
Total E. Europe	*13,697,000*	*14,136,000*
Algeria	11,000	11,000
Egypt	80,000	76,000
Morocco	415,000	391,000
Tunisia	25,000	22,000
Total Africa	*531,000*	*500,000*
Canada	130,000	117,000
USA	3,429,000	3,091,000
Total N. & C. America	*3,559,000*	*3,208,000*
Chile	380,000	378,000
Uruguay	25,000	25,000
Total S. America	*405,000*	*403,000*
Afghanistan	1,000	1,000
China	1,000,000	850,000
Iran	522,000	468,000
Iraq	20,000	20,000
Japan	685,000	667,000
Pakistan	33,000	29,000
Syria	16,000	15,000
Total Asia	*2,277,000*	*2,050,000*
Total Beet Sugar	40,226,000	39,114,000

	1990/91	1989/90
	— *tonnes, raw value* —	
Cane Sugar		
Angola	26,000	25,000
Burkino Faso	22,000	24,000
Cameroun	81,000	78,000
Chad	35,000	33,000
Congo	33,000	35,000
Egypt	900,000	890,000
Ethiopia	202,000	186,000
Gabon	21,000	21,000
Guinea	20,000	20,000
Ivory Coast	155,000	162,000
Kenya	483,000	444,000
Madagascar	128,000	120,000
Malawi	185,000	184,000
Mali	28,000	25,000
Mauritius	678,000	602,000
Morocco	103,000	100,000
Mozambique	33,000	25,000
Nigeria	55,000	53,000
Réunion	239,000	182,000
Rwanda	4,000	4,000
Senegal	77,000	79,000
Sierra Leone	6,000	6,000
Somalia	55,000	50,000
South Africa	2,230,000	2,293,000
Sudan	400,000	421,000
Swaziland	500,000	504,000
Tanzania	108,000	98,000
Uganda	28,000	25,000
Zambia	140,000	138,000
Zaire	71,000	70,000
Zimbabwe	500,000	497,000
Total Africa	*7,546,000*	*7,394,000*
Barbados	75,000	69,000
Belize	94,000	106,000
Costa Rica	250,000	245,000
Cuba	7,950,000	8,050,000
Dominican Republic	590,000	601,000
Guadeloupe	51,000	27,000
Guatemala	917,000	836,000
Haiti	45,000	50,000
Honduras	230,000	187,000
Jamaica	240,000	220,000
Martinique	9,000	9,000
Mexico	3,629,000	3,406,000
Nicaragua	277,000	170,000
Panama	140,000	121,000
Puerto Rico	69,000	62,000
St. Kitts	25,000	20,000
El Salvador	305,000	213,000
Trinidad	124,000	122,000
USA - Hawaii	820,000	795,000
- Mainland	1,787,000	2,097,000
Total N. & C. America	*17,627,000*	*17,406,000*

	1990/91	1989/90
	— *tonnes, raw value* —	
Argentina	1,400,000	1,017,000
Bolivia	206,000	170,000
Brazi l	7,900,000	7,793,000
Colombia	1,614,000	1,567,000
Ecuador	307,000	327,000
Guyana	172,000	176,000
Paraguay	120,000	112,000
Peru	580,000	575,000
Uruguay	50,000	48,000
Venezuela	565,000	527,000
Total S. America	*12,914,000*	*12,312,000*
Bangladesh	210,000	199,000
Burma	30,000	32,000
China	4,950,000	4,865,000
India	12,500,000	11,965,000
Indonesia	2,228,000	2,225,000
Iran	185,000	163,000
Iraq	6,000	6,000
Japan	283,000	333,000
Malaysia	111,000	114,000
Nepal	15,000	30,000
Pakistan	2,120,000	1,988,000
Philippines	1,900,000	1,750,000
Sri Lanka	45,000	31,000
Syria	16,000	15,000
Taiwan	480,000	511,000
Thailand	3,550,000	3,506,000
Vietnam	475,000	460,000
Total Asia	*29,088,000*	*28,178,000*
Australia	3,615,000	3,844,000
Fiji	470,000	479,000
Papua New Guinea	46,000	45,000
Total Oceania	*4,131,000*	*4,368,000*
Total Cane Sugar	71,322,000	69,673,000
Total Sugar	111,5548,000	108,7787,000

New bulk refined sugar terminal in Algeria[6]

The Algerian Minister of Commerce has announced plans to form a joint venture company with sugar trader E. D. & F. Man (Sugar) Ltd. to build and operate at Algiers what the company said is the world's first bulk receiving terminal for refined sugar. The terminal should be in operation within two years and will handle 240,000 tonnes of sugar a year. It will meet about 30% of Algerian demand. The country imports around

5 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 495 - 501.
6 *Reuters News*, September 21, 1990.

500,000 tonnes of refined sugar per year and has a 300,000 tonnes/year refinery. Attempts have been made to produce sugar domestically but without success.

Corrigendum

In the Autumn 1990 edition of our *Sugar Industry Buyers' Guide*, an article, in both English and Spanish, described the new high-accuracy automatic refractometer model TMR 33-36 of Index Instruments Ltd. Unfortunately, the scale of 1.33 to 1.36 R.I. was given as corresponding to 0 - 2° Brix instead of 0 - 22° Brix. We regret this error and offer our apologies to Index Instruments Ltd.

ISSCT processing/engineering workshop

A Workshop is to be organized on behalf of the International Society of Sugar Cane Technologists with the title "Factory performance monitoring as an aid to increasing productivity". It will be held at the Sugar Milling Research Institute in Durban, South Africa, and will include visits to sugar factories. For each major section in the factory, consideration will be given to (a) What is worth monitoring?, (b) How should the monitoring be done? and (c) What targets should be set? It is proposed that an invited speaker will introduce the subject, followed by descriptions of the system used in each country represented at the workshop, followed by open discussion. Some suggested topics to be covered in this way include: cane quality; cane preparation and extraction; evaporation; pan boiling and crystallization; centrifugation; refining; drying and packing of raw and refined sugars; factory wastes (control of air and water pollution); steam generation and energy conservation; maintenance; and time efficiency. It is proposed to start the Workshop with factory visits on June 13 and 14 while discussions will begin on Monday June 17 and will probably continue for 4 days. The South African Sugar Technologists Association will be holding its annual conference in Durban during the week beginning June 10 with factory papers finishing on Wednesday June 12, and Workshop participants will be welcome to attend this conference, for which there will be no registration fee. The South African immigration authorities have guaranteed that visas will be issued to participants from all countries. This will be the first ISSCT factory workshop to be held in recent years.

German seminar on quality in confectionery, etc.

A seminar is to be held during December 3 - 7 at the Zentralfachschule der Deutschen Süsswarenwirtschaft, at Solingen-Gräfrath. All the proceedings will be in German and the subjects concerned will include food quality, hygiene, quality criteria for raw materials (which in the case of sugar will concern visual appearance, sieve analysis, moisture and SO_2 contents) and sensory testing for taste, smell, etc.

South African Sugar Technologists' Association Annual Congress 1991

The 1991 Annual Congress of the South African Sugar Technologists' Association will be held during June 10 - 15, 1991. The official opening and first technical session will be held at the Marine Parade Holiday Inn, Durban, on June 10, 1991. The factory technical sessions will take place at the South African Sugar Association Experiment Station, Mount Edgecombe, on June 11 and 12 and, if found to be necessary, June 13. The agricultural technical sessions will be held at the Huletts Country Club, Mount Edgecombe on the same days. If time is available a symposium and/or panel discussion may be included in the technical sessions. The Congress Organising Committee has indicated that contributions from overseas authors will be welcomed. Although the deadline for papers submitted by local authors is March 1, 1991, special consideration will be given to extending this deadline in the case of overseas authors. Technologists wishing to present a paper at the Congress should note the following: authors names, the title of the paper and a brief synopsis of approximately 100 words should be forwarded to the SASTA Secretaries. The time allowed for presentation is 20 minutes, after which there is a 10 minute period for discussion. The editorial committee reserves the right to reject any paper. Any further information required can be obtained from : SASTA Secretaries, SASA Experiment Station, Private Bag X02, Mount Edgecombe, Natal 4300, South Africa. Telephone: Durban (031) 593205.

US sugar support prices

On October 1, the US Department of Agriculture announced that the weighted average national price support loan rates for the domestic cane and beet crops grown in 1990 would be 18 cents/lb for raw cane sugar and 21.93 cents/lb for refined beet sugar. The range of rates is 17.66 cents/lb (Hawaii) to 18.44 cents/lb (Louisiana) and 21.27 cents/lb (Idaho and Oregon) to 22.80 cents/lb (Michigan and Ohio). The price support level is the minimum amount that must be paid to growers by processors participating in the loan program.

International Sugar Agreement

The Executive Committee of the International Sugar Organization has recommended that the current administrative Agreement, which is due to expire on Decembeer 31, 1990, be extended for a year; this recommendation was due to be considered at a meeting of the full Council in November, when approval of the Organization's annual budget and a report of the Finance Committee on the proposed move of the ISO headquarters to the Canary Wharf development in London's Docklands next July or August were also on the agenda.

Reduced Philippines sugar exports to the world market[7]

To meet the rising domestic sugar demand and to stem an increase in

7 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 473.

prices, the Philippines is to divert to the home market sugar supplies which had been intended for sale on the world market. The measure is a temporary one which results from supply distortion following the earthquake which devastated several northern provinces.

Beet rhizomania in England again[8]

The UK Ministry of Agriculture has reported another case of rhizomania found on a farm in Norfolk, a few miles from one of the two outbreaks in 1989. This is the fourth occurrence in England and vehicles and people have been banned from the infected field. Rhizomania is a soil-borne disease which affects the root system of the plant and reduces yields. It was first discovered in Britain in 1987.

Cuban technical aid for the Bolivian sugar industry[9]

The Chamber of Agriculture in the Bolivian region of Tarija in the extreme south of the country has announced that a team of Cuban sugar industry technologists will travel to the region to assist in increasing sugar production and diversifying its processing.

Expansion of open-pan sugar production in Colombia[10]

Production of panela open-pan sugar in Colombia in the 1988/89 crop year amounted to 1,064,000 tonnes, according to the US Agricultural Attache in Bogotá. Production in 1989/90 is estimated at 1,075,000 tonnes and in 1990/91 at 1,200,000 tonnes. The cane area planted for panela sugar in 1988/89 was 371,000 hectares and the area harvested 253,000 ha, yielding 12,680,000 tonnes of cane.The area planted in 1989/90 is estimated at 372,000 ha, the area harvested at 253,000 ha and the cane crop 12,680,000 tonnes.

Record China white sugar output[11]

China had a record production of 5.2 million tonnes of white sugar in the 1989.90 sugar season and production is expected to be even higher in 1990/91, according to the China News Service. The optimistic forecast for 1990/91 is based on the fact that the area sown to sugar crops has been increased by 330,000 acres in 1990 to 4,120,000 acres.

Argentina sugar technologists conference[12]

During April 25-26, the Sociedad Argentina de Técnicos de la Caña de Azúcar held their 7th Annual Congress in San Salvador de Jujuy, with some 300 taking part, including technologists from the neighbouring countries of Uruguay, Paraguay and Bolivia. Some 30 papers were presented, on agricultural and industrial topics, and addresses were given by Dr. Ben Legendre of the US on harvesting, post-harvest handling and payment for cane in the US; by Dr. Hasime Tokeshi of Brazil on the importance of leaf scald and the need for early selection of tolerant clones; by Dr. Clímaco Casalet Davila of Colombia on cane breeding by Cenicaña; and by Ing. Enrique Wittwer of the Dominican Republic on energy aspects of the sugar industry.

US loan to Kenya for sugar machinery[13]

The US Export-Import Bank has approved a direct loan to the Nzoia Sugar Co. Ltd., of Bungoma, Kenya, to cover 85% of the $66.7 million purchase of sugar machinery. Nzoia, which is owned by the Kenya government, will purchase the equipment and related services from Arkel International Inc., of Baton Rouge, Louisiana. The equipment will increase Nzoia's milling capacity from 3000 to 7000 tonnes/day. The loan will be repaid in semi-annual instalments over 12 years.

Sugar expansion plans in India

The Uttar Pradesh authorities have set a target of establishing 32 new sugar factories in the state in the current year[14]. The state government has approached the Indian Central Government for permission to open 18 new factories, applications for 11 of which have been received so far. Licences have been given for five new factories, to be located in the Bulandshahr, Meerut, Muuzaffarnagar, Muradabad and Bijnor districts in the western part of the state[15]. The U.P. government is also to to make efforts to revive "sick" factories. The Central Government has approved 32 proposals for setting up cooperative sugar factories in Maharashtra state[16].

Sugar cane by-products in Australia[17]

Bagasse use and sugar by-products were on the agenda of the Sugar Research Institute's Annual General Meeting and Technical Conference in September last. Addresses included some on bagasse-coal briquetting, new bagasse pulping technology, the CSR Biostil process, and lysine and citric acid production. The Bundaberg Sugar Company is marketing a new biodegradable matting made from bagasse and sold under the name "Organimat". It is a substitute for coconut fibre matting (imported into Australia from Papua New Guinea), and decomposes after 12 - 18 months, by which time vegetation has grown through it to stabilize the soil.

Proposed sugar refinery for Cambodia

According to the SPK news agency in Cambodia, the Cimco company of India has proposed the construction of a sugar refinery at an unspecified location in Cambodia.

Trinidad sugar production improvement

It is reported that sugar production in Trinidad rose from 97,000 tonnes in 1989 to 122,000 tonnes this year and is expected to rise further to 124,000 tonnes in 1991.

8 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 485.
9 *Granma* (Cuba), September 30, 1990.
10 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 551.
11 *Reuters News*, September 10, 1990.
12 *La Ind. Azuc*, 1990, **96**, (1055), 34.
13 *Reuters News*, September 24, 1990.
14 *Indian Sugar*, 1990, **40**, 210.
15 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 553.
16 *ibid.*, 534.
17 *Australian Canegrower*, 1990, **12**, (17), 3.

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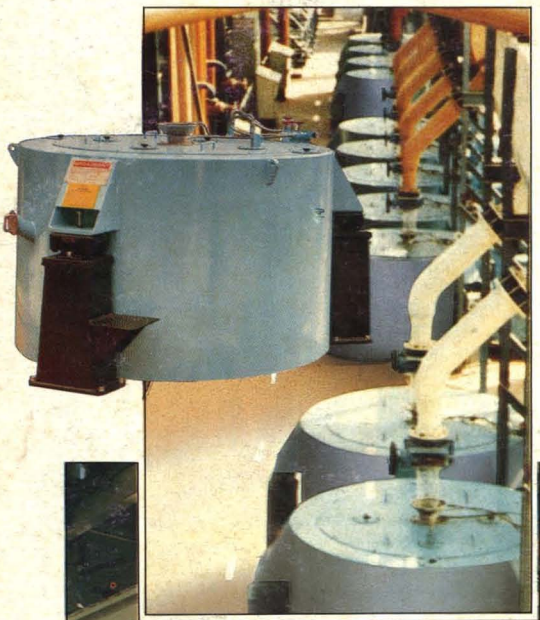

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