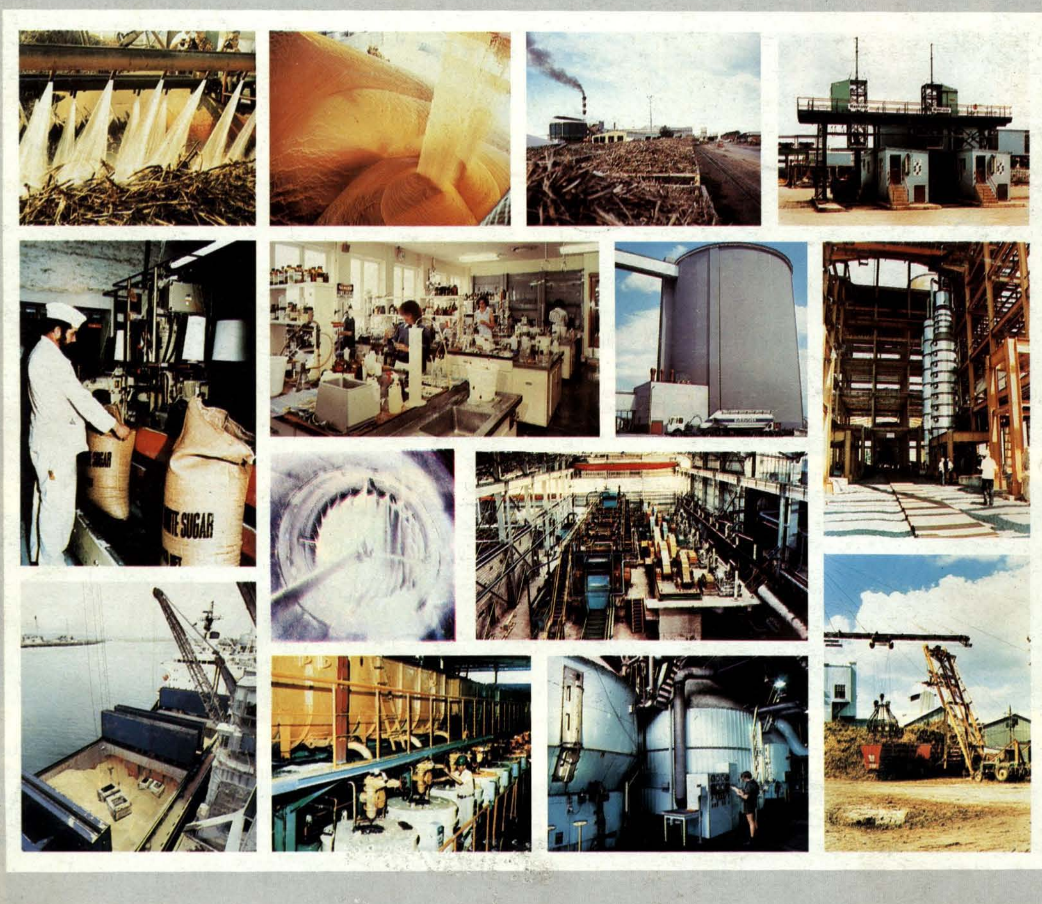
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXVIII/ISSUE No. 1047 MARCH 1986

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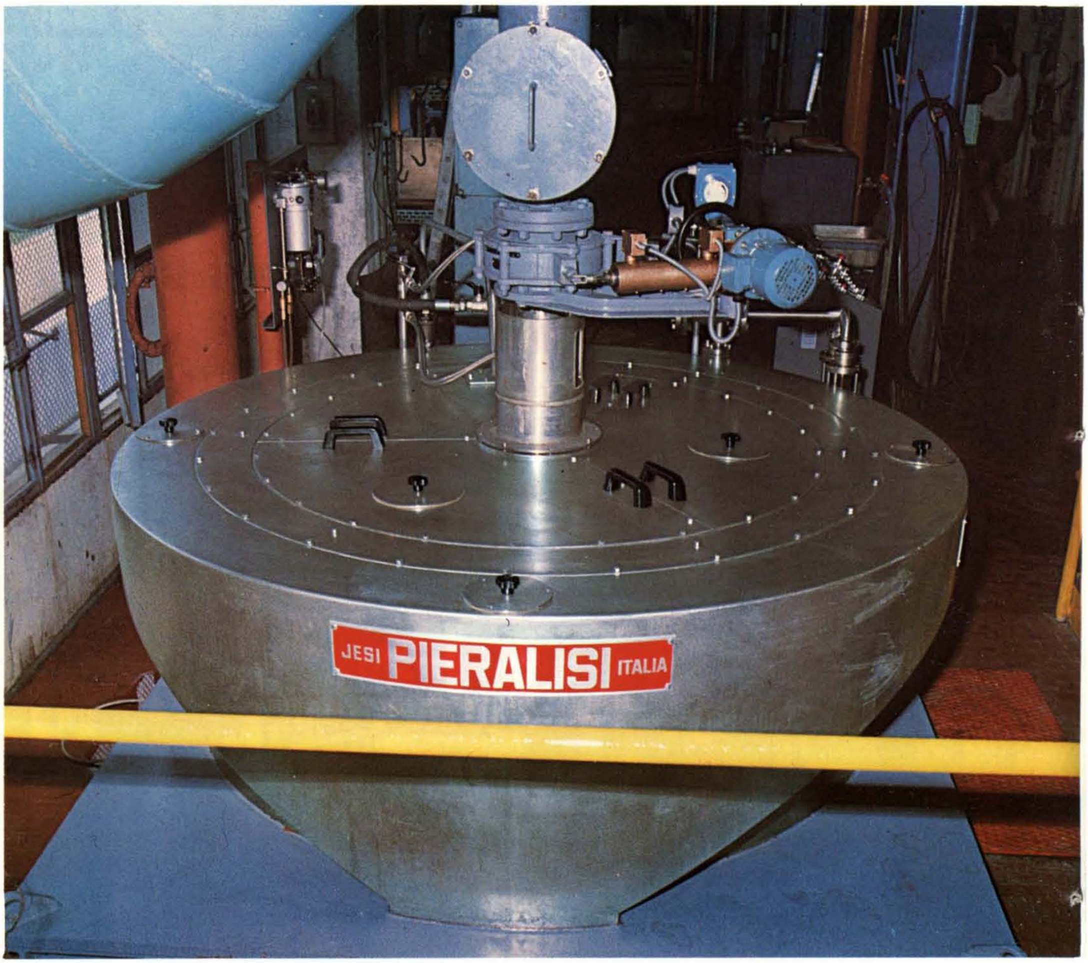

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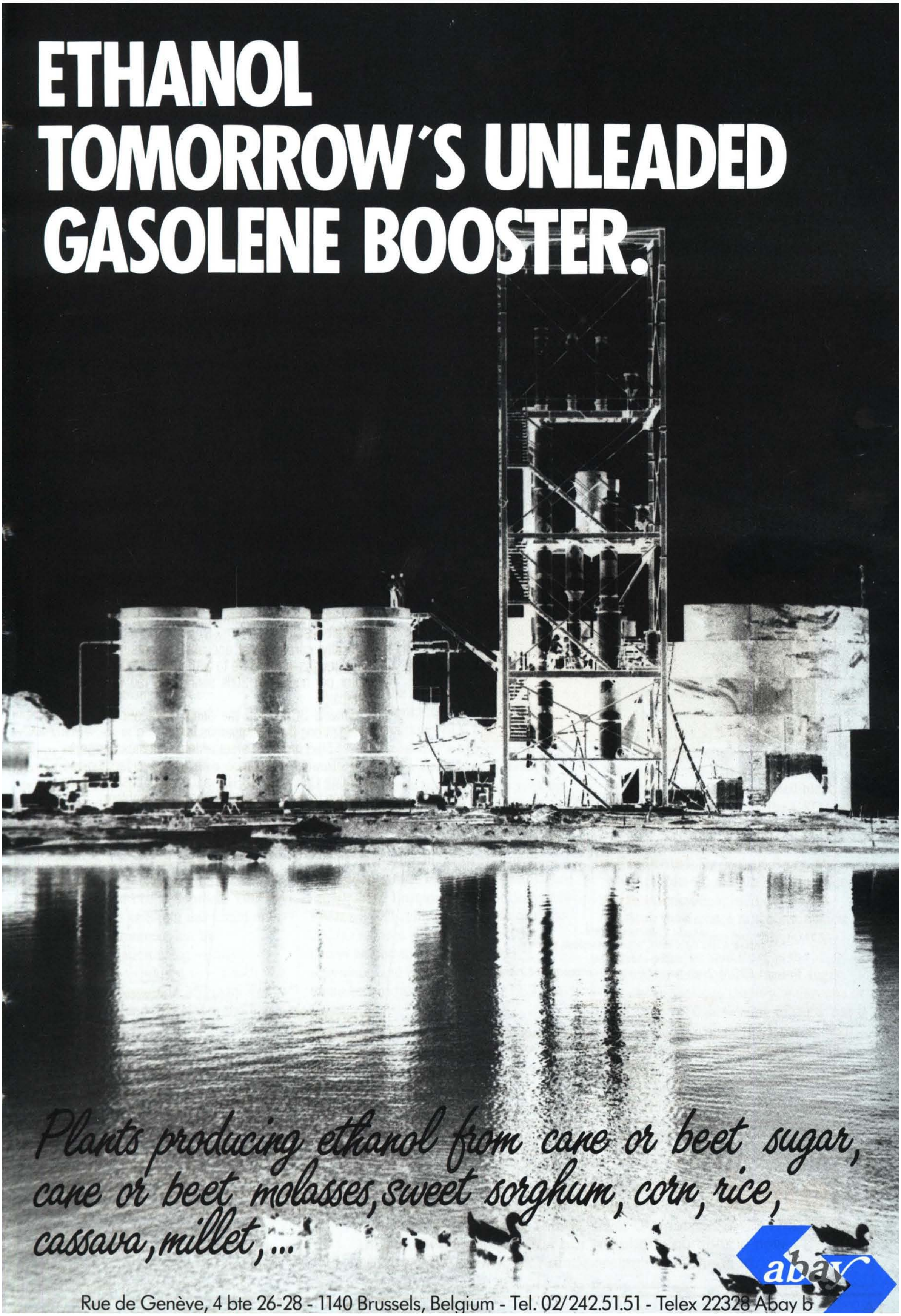
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Notes and comments

ISSCT Congress, 1986

We have learned that South African members of the ISSCT are to be barred from attending the Congress later this year in Jakarta. This decision, clearly a political one, appears to us to be futile, wrong and stupid. Futile, since prevention of handful of South African technologists from attending an international meeting will not even be noticed by their government, never mind be a source of pressure for change in their policies. Wrong, because technologists from countries with equally despicable policies will be welcomed, and stupid because the Society will be depriving itself of valuable technical information originating in one of the most advanced and efficient cane sugar industries in the world. Discoveries and research which benefit the sugar industry do not become unacceptable because of the nationality of the experimenter and we have no doubt that, when such work is published, the most fervent anti-South African will be ready to take advantage of the results reported.

It is certainly against the spirit, if not the letter, of the ISSCT Constitution for any bona fide member to be barred from attendance. At the 1983 Congress invitations were received from India and Indonesia; both delegations were asked if all members would be welcomed. The Indian delegation said that this could not be expressly guaranteed, but the Indonesian delegation categorically confirmed that it would be so – which was one of the main factors in acceptance of their invitation – and this makes the ban even more deplorable.

World sugar prices

As E. D. & F. Man noted in their survey of *The Sugar Situation*[1], the raw sugar market during December saw many similarities to that of December 1984. Soviet Union offtake failed to materialize and Western raw differentials gradually eroded to the extent that many cargoes traded at distressed levels. The unusual absence of Brazilian raw sugar, resulting from substantial postponements and diversion of production to alcohol and high test molasses earlier in the year, was more than replaced by higher availability of Cuban, Guatemalan and Mexican sugar held in operator hands. The resultant effect on the world market was a precipitous decline in the second half of the month. From $140.50 per tonne on December 2, and a range of $138 - $146.50, the LDP dropped sharply on December 20 and ended the month at $125.50 per tonne, this also being a consequence of the successful passage through Congress of the US Farm Bill with its no-cost provision.

White sugar values were also reasonably steady during the period from December 2 to 19, ranging between $173 and $ 179.50 per tonne. Thereafter, the LDP(W) also started to slide, similarly to a raw sugar values, but not so steeply, to end the month at $163.

In January the LDP continued to slide with a slight temporary improvement on January 8/9 on news of Chinese purchases. It reached a low of $116.50 on January 17 but a week later climbed to $136.50 on news that Cuba was seeking to defer shipment of 500,000 tonnes until 1987, that India had returned to the market as a buyer, and on publication of F. O. Licht's new estimate of world sugar production which included a lower figure for 1985/86. Postponements of deliveries by Brazil and rumours of a sale of up to 200,000 tonnes of sugar to the Soviet Union helped to improve market sentiment, and the LDP reached $141 per tonne before falling back to $139.50 on January 31.

The LDP(W) moved very closely in parallel with raw sugar values, the premium of $37-38 scarcely varying through the first half of January, but thereafter rising to $40-44 during most of the second half, but returning to $37 and $38.50 for the last two trading days.

Morocco sugar production and consumption[2]

Before 1963 Morocco imported all its requirements in the form of raw sugar which was refined, largely into loaves. In that year a national plan was launched to establish a domestic sugar industry and there are now thirteen sugar factories, including nine which process beet alone, three process only cane and one processes both crops. All produce white sugar except four beet sugar factories whose outturn, together with imported raws, is refined at the country's two refineries. In the early stages of the plan it was hoped that, by 1985, Morocco would be self-sufficient in sugar. However, consumption has moved ahead and average imports in 1980/84, at around 270,000 tonnes, are virtually the same as in 1970/74. There seems little prospect of closing the gap before the year 2000.

US sugar consumption[3]

Total use of sugar in fiscal 1985 (October 1984 - September 1985), including sugar from imported blends and mixtures, is estimated by the USDA at 8.1 million short tons, raw value, more than 600,000 tons down from the previous year. Dr. Robert Barry, an analyst at the Economic Research Service for the Department, told the USDA Outlook Conference that consumption in 1986 might decline by only 50,000 - 75,000 tons; he said there is the possibility that consumption of sugar may even increase slightly within one or two years. The stabilizing of sugar use is because displacement of sugar by high fructose syrups in beverages is virtully complete. However, for the first time, US

1 1986, (416).
2 C. Czarnikow Ltd., *Sugar Review*, 1985, (1744), 163 - 164.
3 F. O.Licht, *Int. Sugar Rpt.*, 1985, **117**, 710 - 711.

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consumption of corn sweeteners will be higher than that of cane and beet sugar in 1986.

Mexico sugar production 1984/85[4]

Mexico achieved a record crop for the second year in a row, and official estimates foresee still a third record harvest in the current campaign, according to the *Latin America Commodities Report*. However, the government must still subsidize the sugar industry and an expected drop in the amount of preferential credits could well affect future production. Production in 1984/85 totalled 3,225,000 tonnes, tel quel, from 35.64 million tonnes of cane, while the 1985/86 harvest is expected to reach 37.3 million tonnes and to yield 3.3 million tonnes sugar.

A financial report issued by the state-owned Azúcar S.A. shows that prices have remained markedly below costs. During 1984/85 government subsidies to the sugar industry rose 174.5% in nominal peso terms while preferential financing volume was up 44.9%. At the same time, the sugar industry's earnings fell by 11.2% in nominal peso terms. Indeed, losses by the 52 sugar mills operated by the government amounted to 2400 million pesos or 1.02 pesos per kg of sugar produced. However, no financing cuts will affect the 1985/86 crop.

Nicaraguan sugar deal with Cuba and the USSR[5]

Cuba and the Soviet Union are to buy at least 25,000 tonnes of Nicaraguan sugar this year at prices more than three times the world market level. Cuba, one of the world's biggest producers, will buy around 15,000 tonnes at $380 per tonne after its own crop was severely damaged by Hurricane Kate in November last. The USSR will soon take delivery of 10,000 tonnes at an undisclosed "preferential rate" and may also buy a further 15,000 tonnes after that. Nicaraguan sugar production in 1986 has been estimated at about 230,000 tonnes, an increase of 30,000 tonnes on 1985, while exports are currently forecast at 88,000 tonnes, up from 66,000 tonnes last year. Cuba's share will come from the newly-opened Victoria de Julio mill which was built with Cuban aid and began operations last year.

CCC sale of Florida sugar for alcohol manufacture

On December 3 the Commodity Credit Corporation announced a tender to be held on December 19 for some 122,000 short tons of the 304,000 tons or so of cane raw sugar in its possession and stored at four sugar factories in Florida. By specifying the destination as for non-human consumption, the CCC was able to circumvent Federal regulations which require that forfeited sugar be sold at a minimum of 105% of the loan rate plus carrying and storage charges, i.e. a minimum of 18.732 cents/lb.

On December 23, the Corporation announced that the only successful bidder was Shepherd Oil Company of Louisiana whose offer was nearly half the world price. About 28,000 tons was sold at 2.75 cents/lb and the remaining 93,000 tons at 3.125 cents/lb. It is estimated that the USDA/CCC will lose more than $36 million by the sale[6].

The CCC owns a further 182,000 tons of cane raws and it was earlier expected that a successful sale of Florida tonnage would presage more tenders for the disposal of this amount. C Czarnikow Ltd. reported[7] that, if the entire 304,000 tons were converted to ethanol it would produce an estimated 40 million gallons, only a fraction of the US demand for ethanol currently estimated at 600 million gallons. Such conversion would , of course, have an appreciable effect on the world statistical position. However, the rally in futures prices, atrributed to the Farm Bill recently signed by President Reagan, reduces the likelihood of loan forfeitures in 1985/86 and so the sugar might be offered for sale for human consumption.

China sugar supply situation[8]

China's sugar supply is likely to fall short of demand at least until 1990, despite rapidly increasing domestic output and imports, according to official Chinese sources. With a production of 4,310,000 tonnes, white value, in 1984/85, China ranks sixth amongst the world's largest producers. Domestic consumption increased by an average of 400,000 tonnes annually from 1981 to 1985, while production rose by 348,000 tonnes. Meanwhile, annual imports of sugar for the same period totalled 1 million tonnes. The state intends to increase output to 6 million tonnes a year by 1990 by improving planting methods, readjusting sugar cane prices, upgrading refineries and encouraging technical cooperation with other countries. The price of refined sugar, which has remained constant for more than 20 years, will have to be increased, in order to provide factories with the funds needed to expand production. Improved cane varieties have raised ouput from 35 to more than 45 tonnes per hectare, while beet yield has increased from 15 to 22 tonnes/ha. To improve industrial efficiency, China has imported equipment from Belgium and the UK and holds technical exchanges with ten countries.

Sugar export prices

At the Department's Agricultural Outlook Conference, a USDA official, John Nuttall, refered to excessive supplies preventing a sustained price rally[9]. Despite the depression in price in recent years, he said, producers were still maintaining output. He put this down to the fact that most sugar is sold for a much higher price than the narrowly-traded world free market prices. Exports in 1984 probably fetched about 13.5 cents/lb instead of the 5 cents/lb free market price, he estimated.

Papua New Guinea sugar industry[10]

The Ramu sugar factory was established in 1982 and in 1984 produced 34,000 tonnes of sugar while 1985 output is

4 F. O. Licht, *Int. Sugar Rpt.*, 1985, **117**, 712.
5 *Public Ledger's Commodity Week*, January 11, 1986.
6 *Dyergram*, January 3, 1986.
7 *Sugar Review*,1985, (1744), 171.
8 F.O.Licht, *Int. Sugar Rpt.*, 1985, **117**, 599.
9 *Public Ledger's Commodity Week*, December 17, 1985.
10 F.O.Licht, *Int. Sugar Rpt.*, 1985, **117**, 654 - 655.

estimated to have reached 38,000 tonnes. Production is set to rise by approximately 2% per annum over the next five years to reach the factory's installed capacity of 44,000 tonnes by 1990. This will meet the small increase in domestic demand and also the US quota. The factory is operated by Ramu Sugar Ltd. which is 49% owned by the PNG government with the rest owned by various sugar production and banking interests. Associated with the sugar factory is a distillery which produces alcohol from molasses for blending with petrol. The facility has an annual production capacity of 6 million litres and is currently producing 4 million litres from 7000 tonnes of molasses.

Total production of cane in 1985 is estimated at 412,000 tonnes, of which 333,000 tonnes is estate cane and 78,000 tonnes from outgrowers. Estate yields are about 70 tonnes/ha. Imports of sugar peaked at 31,245 tonnes in 1981 but have been restricted since August 1983. Consumption appears to have stabilized at 28,000 tonnes (8.4 kg per caput) in response to a high retail price.

Australia sugar crop, 1985[11]

Cane crushed in Australia in 1985 totalled 24.41 million tonnes, down 1.1 million tonnes from the record 25.51 million tonnes crushed in 1984. The decline was largely due to a rain near the end of the season in December, notably in the central area of Queensland around Mackay. As a consequence, between 600,000 and 700,000 tonnes of cane were left to stand over to the start of the next season in June. Sugar production reached only 3.38 million tonnes, 94 N.T., down some 180,000 tonnes from the record 3.55 million tonnes produced in 1984/85; a decline in the cane sugar content from 13.62% last season to 13.58% in 1985/86 contributed to this fall in output.

US import quota cut alternatives

It has been supposed that the requirements of the Farm Bill passed by Congress recently, and now part of US law, would require reduction of sugar imports by either a cut in the level of the present quota or extension of the time over which the quantity of sugar could be imported. However, members of the US Sugar Users and Cane Refiners Associations have proposed four alternatives as a means of discouraging loan forfeitures[12]. The alternatives, used separately or in combination, are seen as a means of averting a reduction in sugar imports from the Caribbean and Latin American countries. Apparently the White House Inter-Agency Sugar Group is currently reviewing the proposals. They include:

(a) a proposal for the USDA to charge processors interest on loans covering forfeited sugar; currently interest must only be paid when the loans are repaid, not if they go into default,

(b) a requirement by the USDA that processors pay the transportation costs of forfeited sugar,

(c) a requirement that if processors fail to accept a bid for sugar under loan that is greater than the loan level plus carrying charges, the processor would have to remove an equivalent amount of sugar from the loan program; in other words they would have to pay off their loan for that amount of sugar immediately, and

(d) domestic production quotas on cane and beet growers; currently the Secretary of Agriculture does not have the power to impose production limits on sugar and apparently only Congress may limit domestic production which for sugar seems unlikely in the light of recent Farm Bill deliberations.

World sugar production, 1985/86

The latest estimates by F. O. Licht GmbH of world sugar production in the period September 1985 - August 1986 were published recently[13]. By comparison with Licht's first estimate in October last, the total is set some 500,000 tonnes lower at 97.2 million tonnes, while the revised figure for 1984/85 is 101 million tonnes. Many of the beet sugar crops are now expected to be higher than estimated earlier, reflecting the good weather which prevailed during the late autumn in Europe, so that the beet sugar total is about 500,000 tonnes higher. On the other hand, adverse weather has hit crops in the Caribbean, Oceania and some parts of South America and has reduced the cane sugar total by a million tonnes. The overall reduction is not sufficient to eliminate surplus stocks but, as Licht points out, a somewhat healthier situation may be in prospect in 1986/87 if there is no significant increase in production. On that assumption, a gradual improvement in prices can be expected as demand growth is likely to reduce stocks to more manageable levels. "The situation for the industry as a whole, however, is far from rosy as it has to adapt to a shrinking world market as a result of the striving for self-sufficiency, the effects of US sugar policy, and the emergence of a host of new-calorie sweeteners."

Philippines sugar shortfall likely[14]

Philippine sugar production for the first four months of the 1985/86 crop year, which began last September, reached only 380,000 tonnes, indicating that the national production target of 1.3 million tonnes for the crop year may not be realized. The industry has to set aside 208,000 tonnes to ship to the US as its share of the US import quota and production is not expected to be enough to meet both this quota and domestic demand. However, officials hope to cover part of the shortfall with a surplus of about 100,000 tonnes carried over from 1984/85. If the reduced production trend continues, the Philippines could face an acute sugar shortage next year.

World sugar consumption trends

F. O. Licht GmbH have recently published an account[15] of their survey of changes in the sugar consumption of 100 countries over the period 1980/81 to

11 F.O.Licht, *Int. Sugar Rpt.*, 1986, **118**, 38 - 39, 56.
12 *Dyergram*, 1986, (2-86), 2.
13 *Int. Sugar Rpt.*, 1986, **118**, 41 - 48.
14 *Financial Times*, January 22, 1986.
15 *Int. Sugar Rpt.*, 1986, **118**, 1 - 6.

1985/86. Overall consumption growth has slowed down significantly since the early 1970's. In the 1950's it was 5% per year, in the 1960's 3.7% and in the 1970's 2.4% with less than 2% per year so far in the 1980's. Consumption in the industrialized countries now accounts for 47% of the total against 61% in 1972/73; growth is thus more dependent now on the economies of developing countries.

In some developed countries, notably the USA, consumption has dropped owing to substitution by HFS and non-caloric sweeteners. In the developing countries, however, consumption rose from 30.6 million tonnes in 1973/74 to 49.8 million tonnes in 1983/84. Per caput consumption is still generally well below the plateau it tends to reach as countries get richer and increase in consumption should continue, while populations are also rising, in many cases at a rapid rate. The growth rate has slackened, however; in South America consumption has remained stagnant since 1980/81 and in Africa consumption has been held back by economic difficulties. Trend figures indicate a consumption level of 107 million tonnes by 1990/91, representing an average annual rate of 1.2%. Such a level will not require much additional production capacity but the question arises whether, after a long price depression as that which we have seen, the cane and beet will be available from growers.

The Business of Sugar

The sound of surf

A sharp fall in oil prices may not be such good news!

The world is divided into those who believe that governments and powerful groups can control markets and those who reckon market forces ultimately overwhelm any such attempts. It is no surprise that the former usually advocate government intervention whilst the latter emphasize the need to free markets and promote competition. The free-marketeers have scored two victories in the argument recently.

On October 24, 1985 the International Tin Council defaulted in the London Metal Markets to the tune of £550 million. That happened because the ITC tried to fix prices at too high a level and ended up with a lot of tin it could not pay for. Results: suspension of the tin market, anguish amongst banks and brokers, and eventually cheaper tin.

OPEC - the biggest cartel of all time - finally cracked in January and oil prices have suddenly fallen around 30%, which may sound like good news to every one except a few sheikhs.

The problem with cartels is that every member wins by policing all the other members to stick to the rules, while he privately busts the rate and scoops extra sales. Tired of cutting back their own production to suit the rate-busters, the Saudis have opened the taps and the other members are now in deep trouble with falling revenues. Undoubtedly, there is a lot of smug satisfaction in the western world, all the sweeter following years of expedient (but nauseating) crawling to some of the nastier regimes.

The snag is that high oil prices have been a touchstone of economic planning these past ten years. On the strength of high oil prices, industries have been created or destroyed, investment made, billions lent, government budgets set and even wars fought and financed. A lot of these decisions could soon be looking pretty sick. Capital assets are worth only as much as the stream income they generate; cut the income and the owner has neither income nor capital value to repay the loans borrowed to buy the assets.

Whereas in free markets prices adjust slowly, cartels collapse suddenly. As borrowers default, where will the mayhem end? World financial markets have displayed symptoms lately which alarm people with long memories. Enormous corporate take-overs with little commercial logic. Colossal trading in bonds and securities without the traders investigating too closely what it is they are buying and selling. Junior security dealers, at least in the UK, switching firms overnight at six-figure salaries. High stock market prices the world over. Turmoil in currency markets. A looming crunch over an immense US government budget deficit. International debt re-scheduling and financial collapse and scandal in Hong Kong and Singapore. These are all disturbing features, as are collapsing domestic property prices in Germany, and the failure of several banks in the US, with most of the rest sitting on billions of dollars of non-performing farm loans. There are billions in non-performing third-world debt hanging on the entire western banking system. In the UK, billions have been borrowed short and lent long by the Building Societies on highly geared domestic property loans.

In 1929 it was private speculators who built the bubble that burst and caused a default domino. Since then, governments the world over have erected defences - bu like the Maginot Line, built to fight the last war. In the past ten years, let alone the past fifty, markets have changed dramatically. Corporations and countries, not private speculators, are the main participants. All forms of credit have ballooned, but especially international credit. The description "black gold" may yet acquire a sinister meaning.

The blue skies of the post-war boom long since gave way to stormy seas. Let us hope that it is not the sound of surf we are hearing right now.

The message for sugar is in two parts. First, attempts to control markets always fail. In the short term, they disrupt international production but eventually cause painful readjustments when protected production (as in the EEC) are exposed to international market forces. Secondly it is unwise to borrow money to buy farmland if crop prices depend on artificial support prices; if you do, you will be giving too many hostages to fortune.

Bystander

Sucrose monocrystals

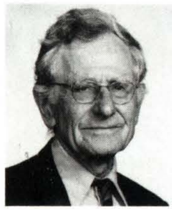
By Andrew VanHook*, Giorgio Mantovani† and Giuseppe Vaccari†

Introduction

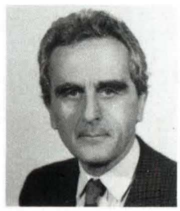
Efforts to grow large and perfect crystals are old and many, likely a subconscious urge to duplicate the massive minerals[1] and startling[2] gemstones found in nature. While these, as well as their man-made counterparts, are most frequently to be found in museums and collections, they also do have considerable technological and commercial importance[3,4,5].

While sucrose crystals as such do not occur in nature their ready availability as a proprietary product, their attractiveness and cheapness all invite study by amateur[6,7] and expert[8,9] alike. Ordinary granulated sugar is a fine example of a good crystalline product but relatively small, being only a few tenths of a millimetre in overall size. Larger crystals are readily available in the forms of "coffee crystals" from England, etc., "kandis" from India, "rock sugar" from China, "diamonts" from Holland, "rock candy" from Germany, etc., etc. (Fig. 1).

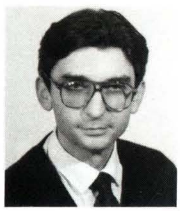
While each of these crystals is an appealing product, even casual inspection reveals opacity and a host of imperfections. The production of a clear, flawless crystal thus appears to be distinct from growing a large one, at least to date. Accordingly, this presentation will consider these two aspects in reverse turn.



Andrew Van Hook



Giorgio Mantovani



Giuseppe Vaccari

Large sucrose crystals

Kukharenko's[10] largest crystal weighed $2^1/_2$ kg but unfortunately his Specimens were lost during World War II[11]. Fig. 2 pictures a 2-kg crystal grown in the laboratory at Ferrara. This is fairly clear but not uniformly so throughout. The surfaces are well developed and smooth and the edges sharp. Sandera, in Prague, had a crystal weighing $1^1/_2$ kg and comparable ones have been grown from time to time in laboratories and sugar houses throughout the world. Most, though, are not particularly good specimens in that they are usually opaque white with many steps, terraces and the like on some of the faces. The largest ones of this kind, to our knowledge, are a 7 lb crystal grown in the C & H laboratories by Dr. N. Smith[7] and another weighing 8 lb grown by Paul Alston in the old Western Refinery in San Francisco. No doubt larger ones can be grown, and possibly have been, but the question of quality is uncertain for the difficulty of attaining perfection

*Holy Cross College, Worcester, MA, U.S.A.
†University of Ferrara, Italy.

1 "Cristaux géants" (Musée National d'Histoire Natural, Paris) 1983, 11pp.
2 Nassau: "Gems made by man" (Clinton Book Co., Radnor, PA) 1980.
3 Mullin: "Crystallization" (Butterworth, London) 1972.
4 Buckley: "Crystal growth" (Wiley, New York) 1951.
5 Gilman: "The art and science of growing crystals" (Wiley, New York) 1963.
6 Holden & Morrison: "Crystals and crystal growing" (M.I.T. Press, Harvard, MA) 1982).
7 Patterson: Private communication, 1981.
8 Vaccari *et al.*: *Sugar J.*, 1982, **44**, (11), 12-15.
9 Kelly & Mak: "The Sucrose Crystal" (Singapore University Press) 1975.
10 *Planter and Sugar Mfr.*, 1928, 80.
11 Gerasimenko: Private communication.

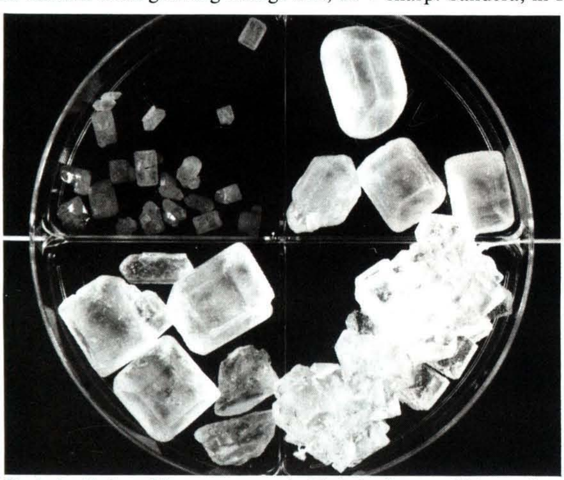


Fig. 1. A collection of fancy sugar crystals. Clockwise from top: "Diamonts" (Holland), "Rock candy" (US), "Lump sugar" (China), "Coffee crystals" (Australia)

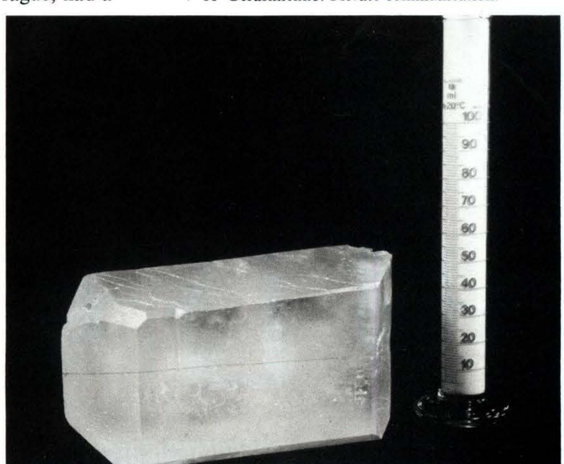


Fig. 2. A 2-kg crystal grown in the laboratories at Ferrara

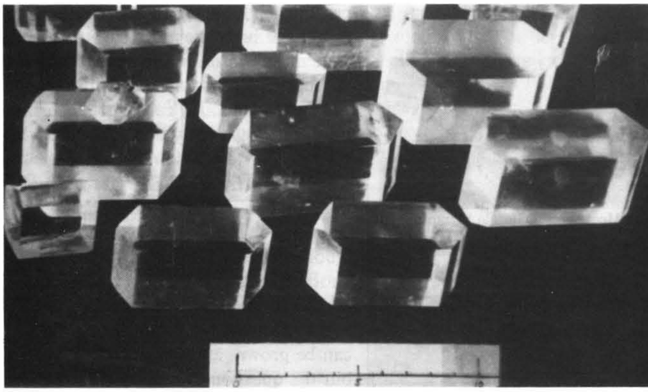


Fig. 3. Sucrose monocrystals (Courtesy of Professor V.M. Sheftal, 1981)

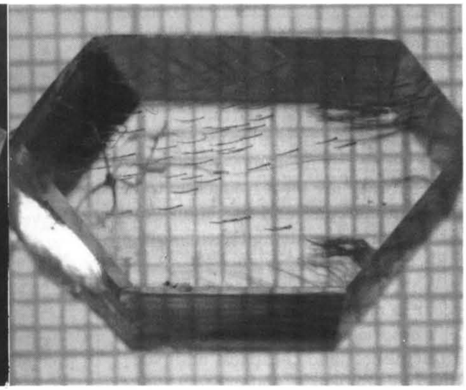


Fig. 4. Sucrose monocrystal weighing 2.8g (Courtesy of Professor C. A. Accorsi)

seems to be exacerbated as size increases. This has been general experience in crystal growing but nonetheless both size and quality have improved[12, 13] as experience accrues.

"Perfect" sucrose crystals

Aside from their aesthetic appeal, good crystals are required for optical and other studies. This need has been spurred most lately[14] by interest in non-linear optical properties for laser applications[15]. Sucrose is only one of many crystals examined for this purpose as well as for its piezoelectric properties.

Some years ago[16] Professor Sheftal of Moscow University grew some remarkably fine specimens of considerable size. Some of his 43 crystals, ranging from 10 to 220 grams in size are illustrated in Fig. 3. Sheftal's method was essentially one of very slow cooling from 49.1° to 45.5°C over a 3-month period. No details of purity, etc. are given in the published reports, the chief emphasis being on the necessity of very slow cooling and uniform conditions in order to avoid a plethora of imperfections. The syrups were not stirred. Vaccari and co-workers[8] also discuss these same problems, particularly twinning.

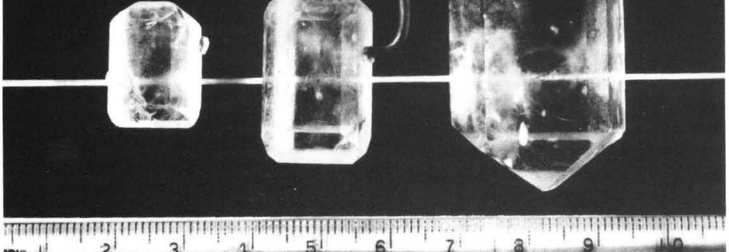


Fig. 5. Sucrose monocrystals weighing 0.85, 4.5 and 23.8g, respectively, grown at Holy Cross College

Fig. 4 is a 2.8 g crystal grown by Prof. Accorsi in a syrup containing 5 g low MW dextran, 1 g of glucose and 1 g of fructose per 100 g water. It is quite clear through a thickness of 8 mm but some striations and inclusions are evident. Similar "good" crystals[17] have been grown from pure syrups at Holy Cross College (Fig. 5) but our general experience is that clarity deteriorates as size increases. No doubt patience and experience are the primary requisites for further improvements in quality and size. However, "good" crystals were grown at Ferrara from clear seeds in a long (5 × 100 cm) column maintained at 30°C. A 1-mm seed suspended on a long filament was lowered 1 cm/day through unstirred 0.025 supersaturated syrup. Over a three months period crystals, such as pictured in Figure 6, were obtained while only 0.05% invert on sucrose developed.

12 Walker & Buehler: *Ind. Eng. Chem.*, 1950, **42**, 1369.
13 Brooks *et al.*: *J. Cryst. Gr.*, 1968, **2**, (5), 279.
14 *C & E News*, 1982, 18 Oct.
15 Halbout: *Ph.D. Thesis* (Cornell University) 1981.
16 "Crystal growth" (I 16 Consultants Bureau, New York) 1957.
17 VanHook: *Zuckerind.*, 1984, **109**, 638.

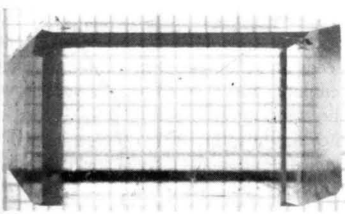


Fig. 6. Sucrose monocrystal weighing 2.2g grown at Ferrara

Experience in our laboratories suggests the following guidelines for further progress in these directions. They are presented in order of what we consider relative importance together with appropriate comments. They are mostly quite general, in recognition of the fact that crystal growing is still very much an art but mindful that it is also rapidly becoming a science.

(1) Slow growth — very slow growth — is absolutely essential for good crystals. Sheftal[16] stresses this requirement at length. The growth potential should be increased gradually from slight subsaturation [see (2) below] to no more than 1-2% supersaturation as growth proceeds at ordinary temperatures, but should then be decreased as size increases. This rate is equivalent at most to only a few tenths of a millimeter per day so that a good, safe specification would be 0.1 mm/day. This is approximately 1 molecular layer per sec.

(2) Supersaturation can be generated by evaporation of water, by falling temperature, injection of more supersaturated syrup* or addition of salting out solvent such as glycerol or alcohol. Evaporation is apt to generate obnoxious grain as discussed in (4) below. The second method is most convenient but suffers from enhanced inversion over long periods of time. While invert is to some extent a grain inhibitor this is not significant under the limit of 2% on sucrose which we have set arbitrarily for most of our work. Greater amounts consume some of the nutrient sucrose and eventually arrest growth.

Careful annealing of crystals must be exercised upon addition to or removal from syrups not at ambient temperature.

The other two procedures seem to be equally suitable but additions must be made with care and never beyond a total of $\sigma_i = 0.01-0.02$, or even less. Such a limit is dictated by experience[10,18] as well as being the usual dividing point (σ_i) between parabolic and linear growth in the BCF[19,20,21] theory. Murphy and colleagues at Colorado State University[22] also distinguish between non-nucleating and nucleating growths at similar low levels.

This inherent instability of growth with respect to supersaturation is probably the result of interplay between matter and heat transport and, in a sense, is analogous to that observed with respect to size[23,24,25]. Small, microscopic crystals are often optically clear and flawless and invariably grow slower than larger and less clear crystals[17,26,27]. The difficulties of continuing good growth seems to increase markedly as growth proceeds and the opinion[28] has even been expressed that perfect crystals of finite size are impossible — "A perfect crystal bounded by simple faces probably would not grow at all"[29]. Experiment and theory are in accord with this. No doubt, many of these problems have their roots in the number and activity of dislocations[17,20] on the individual crystal faces so that more knowledge of their disposition will do much to alleviate the art of growing perfect crystals.

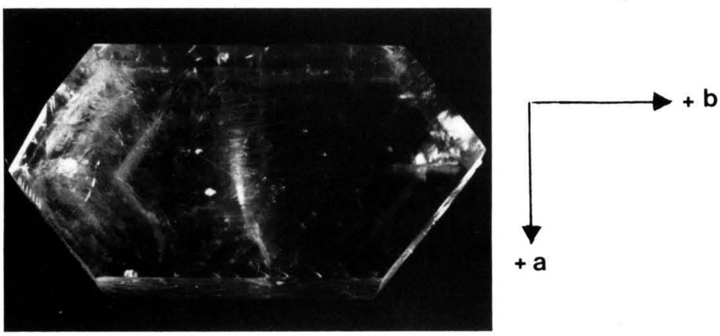
Incidentally, optical clarity, freedom from strain and good form are the only criteria we have used so far to gauge our crystals and more sophisticated examination[30] remains to be done.

(3) Selection of starting seed is also vitally important. We have found that seed formed spontaneously by slow cooling and/or evaporation is the best. Clean, flaw-free single crystallites are transplanted to slightly undersaturated syrup in order to dissolve adhering parasites, etc. If developed on a thread, the selected individuals are readily isolated before transfer. Clamps or dope, however thin, seem to lead to strain as the crystal develops so that loose crystals and occasional turning are preferred. The annoyance of separating without fracture those seeds adhering to the bottom of a crystallizing dish may be circumvented by forming on a layer of ethylene dibromide, mercury or other such liquid. These crystals, however, may be plate-like in form so that considerable growth is necessary[31] for them to assume a natural habit. The same is true for cleaved sections, etc., which should be affined in slightly unsaturated syrup of 95% alcohol before growing. Flat crystals present the slowest growing faces [a(100)] for development whereas slabs cut normal to the most rapid growth direction, i.e. parallel to the smallest face, are generally the best seeds[5,27]. For this purpose, a slab as indicated in Fig. 7 was sawn out and grown to the illustrated crystal. The first layers of

*This has alternately been accomplished by periodically heating a bed of nutrient crystal with a section of intervening baffles to catch any shower of loosened fragments and grain. It has not been found possible to set up a steady working temperature gradient between nutrient and crystal — stratification sets in and forced circulation only aggravates parasites.

18 Smythe: *Sugar Technol. Rev.*, 1971, **1**, 191.
19 Bennema: *J. Crystal Gr.*, 1968, **3**, (4), 125.
20 Valcic: *ibid.*, 1975, **30**, 129.
21 Aquilano *et al.*: in "Industrial crystallization 1984" Ed. Jancic & deJong (Elsevier, Amsterdam) 1984, pp. 91-96.
22 *AICHE Symp. Ser.*, 1980, **76**, (193), 65.
23 Sekerka: in "Morphological stability in crystal growth" Ed. Hartmann (N. Holland, Amsterdam) 1973.
24 Estrin *et al.*: *J. Coll. & Interface Sci.*, 1982, **85**, (2), 319.
25 Parker: in "Solid state physics", Vol. 25 (1970), Ed. Seitz & Turnbull.
26 Strickland-Constable: *J. Cryst. Gr.*, 1971, **9**, 102.
27 Egli: in "The art and science of growing crystals" (Wiley, New York) 1963; *Disc. Faraday Soc.*, 1949, (5).
28 Powers: *Sugar Technol. Rev.*, 1969/70, **1**, 85.
29 Bunn: *Disc. Faraday Soc.*, 1949, (5).
30 Ribet-Sauvage: *Doctoral Thesis* (Montpellier Univ.) 1982.
31 VanHook & Brown: *Ind. Sacc. Ital.*, 1973, **66**, 46-47.

growth are most critical and it often appears to be virtually impossible to avoid small imperfections at this point. The flaw is likely to recur periodically throughout the growth process. In some crystals certain zones persist in developing flaws while other adjacent areas are growing perfectly at lower rates than necessary. In such instances the flawed areas can be reduced to a minimum by properly orienting the seed. Some sections can grow practically without flaws. These "capped" areas can be sawn out and used for growing clear crystals (Fig. 7). It is important to distinguish between growth flaws and mechanical flaws. The latter are usually not harmful and may even be helpful, but growth defects usually propagate and multiply. Mechanical flaws, such as those induced by sawing, are usually readily healed by lapping and subsequent growth. The most critical stage in the growth process is then the deposition of the first few layers onto a seed. Seeds and their supports should be tempered to the same temperature as the solution, or slightly higher, before they are introduced. In reverse, careful annealing is necessary whenever removing the crystal from its mother liquor.



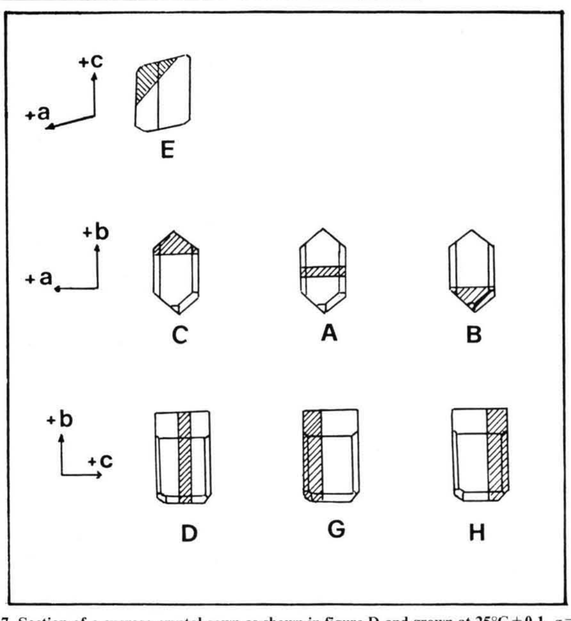


Fig. 7. Section of a sucrose crystal sawn as shown in figure D and grown at 25°C ± 0.1, σ = 0.10. The left end shows a large part practically without flaws which can be sawn again and tentatively used as a seed for the preparation of clear crystal

"Prestige" seed[32] from ordinary granulated or even larger grades may be suitable but we have found in such instances that considerable affining is necessary before proceeding with growth. The dissolution should be gentle (σ<0.01 or superheating <1°) in order to avoid deep etch pits and to reduce the number of dislocations or growth centres[20]. Proper faceting may also be effective with such crystals. In any event, the early growth period is quite critical, being not only exceedingly slow[26] but definitive of the quality of the subsequent crystal.

(4) Spurious grain is troublesome. Even the gentlest motion instigates grain in the presence of a growing crystal[28] but some agitation is advocated to avoid inclusions, etc.[12, 33, 34]. To stir or not is then the question. The advantage is not great insofar as rate of growth is concerned since prolonged times are required anyway. In our work we have found a slow, continuous rocking motion or only occasional disturbance adequate. In most of our experiments only occasional manual agitation was employed.

Grain inhibitors such as glycerol, dextran, partially degraded syrups, etc. are helpful. Closed containers and an immiscible layer of xylene, etc. reduces surface evaporation which may otherwise give rise to a shower of extraneous crystals which may deposit upon the surface of the growing crystal. This can be avoided to some extent by baffles which deflect or collect the falling particles. Since grain

32 Powers: in "Food microscopy", Ed. Vaughan (Academic Press, New York) 1979.
33 VanEchart & van der Linden: *J. Cryst. Gr.*, 1979, **47**, 196.
34 Brice: "Growth of crystals" (North Holland, Amsterdam) 1973.

depletes nutrient sucrose, the crystal should be isolated and removed as grain becomes excessive and the supersaturation restored. If the crystal is removed for this purpose it should be done so with careful annealing, then wiped with lint-free cloth and stored over saturated syrup if there is to be any delay in returning it to the syrup. Or, better still, it should be removed via copious flushing in a series of ethylene glycol-alcohol saturated syrups; this avoids disturbance of surface features[35].

(5) Temperature uniformity within a few tenths of a °C seems adequate and 30°C is a convenient compromise between inversion and growth effects. Lower temperatures are also feasible and the threshold rate of about 0.1 mm/day can be attained by higher supersaturation. Grain formation appears to be subdued at these lower temperatures and the deterrent effect of enhanced viscosity can be overcome to some extent by utilizing aqueous alcohol as solvent. These benefits of lower temperatures may be explained by the diminished temperature sensitivity of growth of any given syrup[36], and possibly the higher value of σ_i in the definitive BCF theory. Sudden temperature and concentration changes must be avoided, as pointed out by Sheftal[16] who also specified temperature control within 0.1°C. (A drop in temperature seems to be more disastrous than a slight increase.)

Some surfactant is beneficial as a brightener. This is to be a topic for continued consideration and it is hoped that a report can be made at the forthcoming meeting of the ISSCT. At the same time we expect to continue looking at the factors mentioned above in an effort to eliminate or reduce the inclusions which are inimical to clarity. No doubt, non-uniform growing conditions are the chief instigators of this kind of imperfection. These experiments are extremely time-consuming, however, so we offer this initial report in the hope of stimulating others to work on the problem.

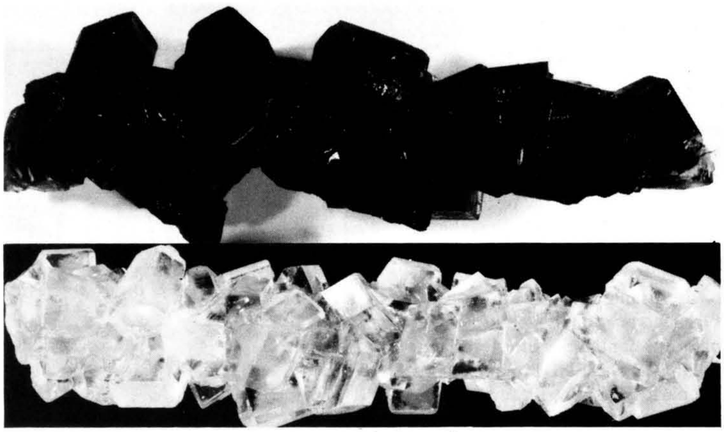


Fig. 8. Brown and white candy

Sheftal employed pure sugar solutions in his trials and, presumably, so have most others. However, it is common sugar house experience that at times superior crystals come out of molasses and other impure syrups. Fig. 8 is a random comparison of some white and brown candy on hand for which this appears to be so, although, admittedly, this is a very subjective opinion.

In our work we have found syrups containing dextran, glycerol, etc. very beneficial. The role of the additives in these cases may be described as that of a mineralizer[27] which probably functions as a grain inhibitor, dislocation controller or otherwise. Marked influence on habit is observed in many of these cases[8, 9].

Conclusion

It is hoped that the above description, which is highly empirical, may be helpful to anyone undertaking the building of bigger and better sucrose crystals. The cardinal principles involved are good seed and very slow growth. These have sound foundations in imitation of nature in practice and in theory.

Acknowledgement

Mr. Joel Villa's services are greatly appreciated.

Summary

The experience of the authors and other workers in the growing of large and perfect crystals of sugar is reviewed and the necessary conditions and techniques examined.

Monocristaux de sucre

On passe en revue l'expérience des auteurs et d'autres chercheurs au point de vue de la croissance de gros et de parfaits cristaux de sucre. On examine les conditions requises et les techniques mises en oeuvre.

Saccharose-Monokristalle

Dargestellt werden die Erfahrungen der Autoren und anderer Wissenschaftler über das Wachstum von großen und einwandfreien Zuckerkristallen und die dafür notwendigen Bedingungen und Techniken.

Monocristales de sacarosa

Se presenta un examen de las experiencias de los autores y otros en el crecimiento de cristales grandes y perfectos de azúcar. Se discuten las condiciones necesarias y las técnicas empleadas.

35 Albon & Dunning: *Acta. Cryst.*, 1959, **12**, 219.
36 VanHook: *Proc. 1980 Tech. Session Cane Sugar Ref. Research*, 103.

Analysis of sugar boiling and its technical consequences

Part III. Continuous processing

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The continuous method of operation offers the advantage of always working with the lowest $\Delta\vartheta$, as illustrated in Part II of this series. Continuous crystallization by evaporation is nowadays of great importance, especially because of the simplicity of process control and process automation, constancy of the incoming and outgoing streams with stable operation, and also the resultant possibility of fuel saving[1].

The Braunschweig Institute and Lage sugar factory cooperated in designing a plant for continuous after-product boiling for the 1981/82 campaign, with the participation of Braunschweigische Maschinenbauanstalt AG[2]. The operating scheme is illustrated in Figure 1 in which KFK represents the vacuum pan for producing the crystal footing and K1 to K4 the series of four continuously operating vacuum pans.

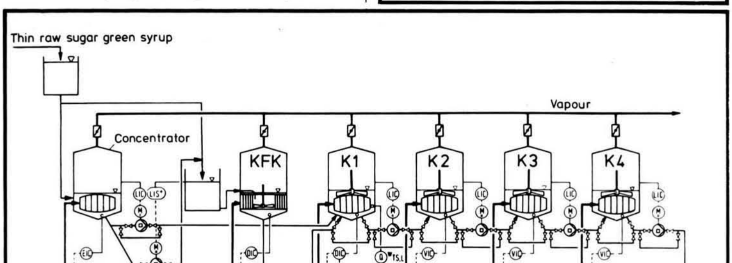


Fig. 1. Operating scheme for continuous crystallization by evaporation of the after product in the sugar factory at Lage since 1983/84. KFK = vacuum pan for producing the crystal footing, K_1 - K_4 = continuously working vacuum pans

Most low green molasses spun from raw massecuite is continuously boiled and fed, along with a batch-produced seed footing (KFK) into the series consisting of four normal vacuum pans (K1 - K4), connected with pipework and pumps. After-product boiling with the plant in the sugar factory at Lage has been carried out for four campaigns with good success.

The product crystal size is determined by the rate of growth, the residence time distribution in the crystallizer and by the grain size

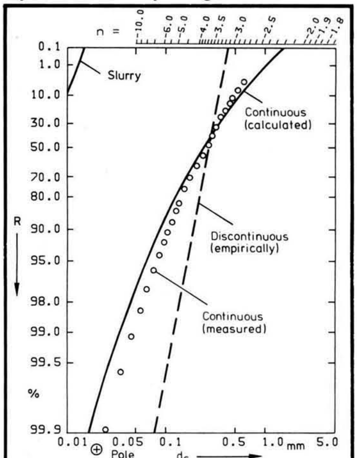


Fig. 2. Cumulative mass distribution for seed slurry and product from continuous after product boiling

distribution of the added seed. As the grain size distribution of the after-product was unsatisfactory when adding "slurry" as seed in the continuous operation, work was started with crystal footing produced discontinuously (KFK).

Figures 2 and 3 show the grain size distributions for the addition of "slurry" in the first boiling pan (K1). By comparison with a discontinuous operating method, the grain size distribution is very wide; an unusually large proportion of fines has to be accepted.

When operating with a crystal footing, as illustrated by Figures 4 and 5, the expansion of the grain size distribution into the range of coarse crystal also becomes clear when comparing with the grain obtained during discontinuous operation. If the after-product is to be re-melted, this expansion is of secondary importance. When using after-product as crystal footing, however, it may be necessary to screen it to separate the coarse component.

A fine component with a crystal size less than 50 µm is not apparent if secondary nucleation can be prevented.

The results described in this chapter show the significance of the crystal footing during continuous crystallization. A cooling crystallizer located before the footing pan (KFK) seems to be unnecessary.

The continuous boiling of after-product makes a service life possible which covers the period of one campaign (by contrast with the continuous working with white sugar, treated below).

Evapo-crystallization tower

Figure 6 shows the evapo-crystallization tower developed by the Braunschweig Institute[1] and built by BMA.

This tower consists of 4 superimposed chambers, connected together. Each chamber is provided with a ring calandria (inwards circulation). The circulation of the level-controlled magma in each calandria is aided by a stirrer in the downtake. The first full-scale tower of this design was installed in 1983 for boiling the white sugar in the sugar factory at Wabern[3]. In 1985 three further towers for white sugar were delivered to the factories at Wabern and Lehrte.

1 Austmeyer: *Zuckerind.*, 1982, **107**, 401.
2 Austmeyer *et al.*: *ibid.*, 1983, **108**, 927.
3 Anon: *BMA Information*, 1983, (22).

ISJ Abstracts

Cane sugar manufacture

Automatic control of crystallization

G. R. Moller. *Proc. 29th. Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 156 - 163.
See *I.S.J.*, 1984, **86,** 73 - 79.

Trend to larger factory equipment and benefits to be achieved

D. J. Wright. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 238 - 242.

A representative of the Australian company, A. Goninan & Co. Ltd., discusses the tendency for larger processing equipment as exemplified by cane mills for installation in 1983 having rollers 2.75 m wide as against a greatest width of 2.15 m in 1973.

Practices in sugar distribution

T. R. Ancheta. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 252 - 259.

The Warren, Walker and Winter - Carp methods of estimating cane sugar yield are described as bases for calculating the proportionment of sugar between farmer and processor. A proposed standard sugar distribution table based on Philippines Sugar Commission standards is presented.

Reviewing to revise the weekly factory statement

T. R. Ancheta. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 260 - 267.

Features of a proposed revision of the standard form for weekly factory balances planned for introduction in 1982/83 are discussed.

Highlights of technical mill performance efficiency auditing

A. A. Cubillan, D. V. Garriel, C. G. Lemoncito and T. R. Ancheta. *Proc. 29th Ann. Conv. Philippines Sugar Tech. Assoc.*, 1982, 268 - 284.

The basic standards and guidelines employed by the Philippines Sugar Commission in auditing the operations of sugar factories are set out, and measures carried out at named factories so as to improve their performances are briefly described.

Behaviour of bulk raw sugar in two industrial piles at different temperatures

M. Canales, A. Mesa, D. Esson, A. Zaborsin, J. Lodos, E. Tkachenko, E. Casanova, V. Yaresko and V. Orlov. *ATAC*, 1984, **43,** (1), 30 - 39 *(Spanish).*

Piles of raw sugar containing 1000 tonnes each were established at different temperatures (ca. 30°C and ca. 40°C), one of which had been cooled by forced air circulation. The piles were provided with a device for sampling sugar within them, and measurements and analyses were carried out over a period of 175 days. Pol, reducing sugars, pH and colour were measured and the results tabulated. They demonstrate that the rate of deterioration of the sugar is reduced by the forced cooling before storage which is therefore recommended.

Evaluation of technological schemes for producing direct white sugar

A. Valdés, S. Ortega, I. Galbán and J. Castañeda. *ATAC*, 1984, **43,** (1), 44 - 53 *(Spanish).*

Three systems of juice sulphitation were evaluated during the 1974/75 season: cold acid sulphitation, hot acid sulphitation and sulphitation with double hot liming. In addition syrup sulphitation was examined. The results are reported and show that the last of the juice treatments gave best results in respect of purification and operational flexibility.

Application of control graphs to the process of raw sugar centrifugation

J. A. Fariñas. *ATAC*, 1984, **43,** (2), 36 - 40 *(Spanish).*

A control graph shows the variation in a particular characteristic of a product within limits established from experience, which enables assessment of the performance of the process and indicates failures before they occur. The results of experiments at Manuel Martínez Prieto sugar factory-refinery showed that colour could be used as the criterion for such a graph to control the centrifugation process, and limits were established for 1st and 2nd sugars at that factory.

Investigation of the coefficient of friction in the top bearings of cane mills. Part I. Influence of antifriction materials

C. Rodríguez M. *ATAC*, 1984, **43,** (3), 16 - 19 *(Spanish).*

Studies have been made with bearings of different metals and coefficients of friction measured. Babbitt metal, 10 mm thick, was no improvement over the standard BrSnPb 10-10 bronze, but a new alloy, BrSnPb 5-12, gave a lower coefficient of friction which represented a 15% saving in energy consumption. Furthermore it represented a 50% reduction in the requirement of tin, a costly material in short supply. The influence of the thickness of the Babbitt metal is to be analysed.

Possibility of hydrostatic lubrication of the bearings of cane mills

L. García F. and C. Rodríguez M. *ATAC*, 1984, **43,** (3), 19 - 23 *(Spanish).*

Because of the high load and low velocity, cane mill bearings operate under conditions of limiting friction but it is possible to provide hydrostatic lubrication by admission of lubricant under pressure through symmetrical entry holes in the housing. The disadvantages of such a system lie in the need for extra equipment such as pumps, valves, etc., and the additional power they consume.

Disinfection of sugar juices with ultrasound

O. Rodríguez, J. Lodos and X. Meneses. *ATAC*, 1984, **43,** (3), 29 - 34 *(Spanish).*

Dextran, caused by the presence of *Leuconostoc mesenteroides*, gives rise to problems in clarification and centrifugation in the sugar factory and refinery, and tests were made to see whether the micro-organism could be destroyed by the action of ultrasound in order to avoid this nuisance. Samples containing 10^5 cells/ml of *L. mesenteroides* were subjected to ultrasonic vibrations at powers of 20 - 100 W for 15 - 600 seconds at ambient temperature. The effects were compared with the antiseptic action of formaldehyde.The latter provided 90% population reduction in pure solutions at 1300 ppm; in crusher juice, 2700 ppm was needed. The same reduction in pure solutions required 25 - 210 seconds for powers of 100 - 30 W and in crusher juice 3 - 21 minutes. Disinfection with ultrasound is economically comparable with that produced by formaldehyde, and presents additional advantages by removal of polymers.

Deterioration of white sugar in storage

M. Lopez B., F. C. Castillo P. and E. L. Ramos S. *CubaAzúcar*, 1983, (July/Sept.), 3 - 7 *(Spanish).*

Samples were taken from white sugar in store and analysed to determine the thermal stability and effects of micro-organisms. It was found that temperature of storage was the most important factor, micro-organisms having no marked influence. The increase in colour of sulphitation sugars was smaller than with raw sugar and equivalent to that produced using a system of syrup neutralization. As with raw sugars, a fall in pH and a small increase in reducing sugars was noted.

Resolution using a programmable computer of 2- and 3-strike boiling systems for the manufacture of white sugar

R. M. Ruiz and G. J. Cárdenas. *Rev. Ind. Agríc. Tucumán*, 1984, **61,** (1), 17 - 38 *(Spanish).*

Material balances for two- and three-massecuite systems used in a Tucumán white sugar factory were solved using a computer. Steady-state equations corresponding to a cycle of operation were established and the balances of total material, total soluble solids and sugar were used, sucrose and pol being considered equal. Data for the calculations were obtained from experimental measurements made at the factory. Steam consumption was calculated using the streams derived from the material balances and the corresponding temperatures for each stream. The method allows rapid solutions of such systems where changes are made in the properties of the streams.

Continuous drying of bagasse in a fluidized bed

M. Boisan, V. F. Frolov and R. Novoa. *Zh. Prikl. Khim.*, 1985, 12 pp; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (9), Abs. 9 R425.

Results are presented of studies on the kinetics of continuous drying of bagasse in a fluidized bed. The experiments were conducted in a cylindrical vessel having a conical bottom. Regression equations were obtained for calculation of the overall coefficient of heat transfer from the gas to the particles and of the moisture content of the bagacillo discharged from the vessel.

Batch drying of bagasse in a fluidized bed

M. Boisan, V. F. Frolov and M. Penedo. *Zh. Prikl. Khim.*, 1985, 7pp; through *Ref. Zhurn. AN SSSR (Khim.)*, 1985, (9), Abs. 9 R426.

A conical vessel was used in studies of the kinetics of bagasse drying in a fluidized bed under batch conditions. The method used to obtain experimental curves of the parameters under investigation and the technique for processing the experimental data are described. Regression equations are given for equilibrium moisture content and the coefficient of drying where the drying rate decreases linearly as a function of basic parameters.

Final molasses: analysis and approach to target purities

S. J. Clarke and L. Serebrinsky. *Sugar Bull.*, 1985, **63,** (14), 7.

Since 1980, the Audubon Sugar Institute has conducted an annual analytical survey of the final molasses produced by each sugar factory in Louisiana; the data are used to calculate the target purity achievable by good exhaustion on the basis of the ratio of reducing sugars to ash. The method of calculation is one that was developed in South Africa. Results have shown an annual average molasses purity for the state which exceeds target purities by 5 - 8 units. Since laboratory tests have indicated the possibility of reaching the target purities under ideal conditions, it is felt that there is a substantial incentive to modify factory operations so as to recover the lost sugar. The survey also permits comparison of molasses apparent purities (as determined by polarimetry) with true purities based on titration; results have shown apparent purities usually 8 - 12 units below the true value, which could give a false indication of factory performance. Modifications in analytical procedures recommended to Louisiana processors in 1984 include increasing the quantity of lead subacetate used for clarification, which brings the molasses pol closer to the true sucrose content. It was also recommended to use refractometric Brix in the calculation of apparent purity, giving a value within 2 - 3 units of the true molasses purity.

Final molasses - 1984 survey of low-grade massecuite reheating

S. J. Clarke and L. Serebrinsky. *Sugar Bull.*, 1985, **63,** (15), 8, 15.

In a study of possible reasons for failure to reach target purities of molasses in Louisiana sugar factories, with emphasis on crystallizer performance and the final handling of massecuite, it was found that purity rose by 0 - 2 units during massecuite reheating at 11 factories; purity rises of 2 - 5 units were experienced during reheating at four factories and in the centrifugals at eight, while there was a 5 - 7 purity rise in the centrifugals at one factory. However, overall increases in purity of 2 - 5 and 5 - 7 units occurred at nine and four factories, respectively, and rises of 0 - 2 units at seven factories. Only one-third of the factories showed overall purity rises of <2 units. The purity rise in massecuite reheating was attributed to heating well above the saturation temperature of the molasses and during quite long retention; hence, short-time indirect heating (e.g. using microwaves) is recommended, particularly with its added benefit of minimizing dilution in the centrifugals and thus avoiding the possibility of redissolving crystals. The purity rises in the centrifugals were ascribed to damaged screens and/or excessive dilution.

Diffuser *vs.* milling in several African countries 1983

M. Mochtar. *Gula Indonesia*, 1985, (3), 1084 - 1095.

Operations at Hippo Valley sugar factory in Zimbabwe are described and the advantages of cane diffusion *vs.* milling considered on the basis of South African experience. Possible application of the findings to Indonesian conditions is indicated.

The management process at North Eton mill

A. M. Driscoll and J. H. King. *Proc. Australian Soc. Sugar Cane Tech..*, 1985, 31 - 35.

Aspects of the management process interlinking operational planning, organization, control and direction/coordination at North Eton are discussed, and information is provided on the maintenance season control program and on employee participation in the organization.

Contributing factors in centrifugal screen corrosion

G. J. Kelly, T. G. Casey and L. K. Kirby. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 161 - 168.

Deterioration of low-grade centrifugal screens has been found to occur as a direct result of the highly corrosive nature of molasses. The main contributing factors are the acidic nature of the molasses, its high salinity and the relatively high temperatures at which centrifugals operate. Screen quality is also an important factor; frequently, even new screens have shown significant defects, and variations in quality probably have a more important bearing on screen life than variations that occur in molasses composition between factory areas. It is stressed that the cost of screen corrosion is more than just the cost of replacing the screen, since a rise in molasses purity caused by a worn or damaged screen represents a monetary loss. A typical set of screens in Queensland treats 4200 tonnes of low-grade massecuite before being discarded. However, while the decision to replace screens is influenced by replacement costs on the one hand, and by visual appearance of the sugar and molasses purity rise on the other, the authors feel that, once a screen shows either significant areas of chromium loss or extensive stretching into the contours of the backing gauze, it should be discarded. A normal screen can be expected to show a gradual increase in mean slot width up to perhaps 60% during its working life. The difficulty of inspecting screens *in situ* on some types of centrifugal is mentioned; where a powerful magnifier can be used, weekly changes in the state of a screen can be determined. In difficult situations, screen surface colour is of value as a general guide.

Automated centrifugal screen slot measurement

P. G. Wright, R. Broadfoot, S. R. Reichard and A. Wenta. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 169 - 177.

A Nikon profile projector has been modified by motorizing the sample traversing plate and mounting a linear array of photodiodes in its image plant so as to permit scans of screen slot widths to be made easily. The equipment and its circuitry are described, and its application to examination of low-grade centrifugal screens discussed. The main limitation of the computerized scanning technique is the need to maintain good focus on the slot; while this is easy with a new screen or with flat sections of used screen at 20 × magnification, the operator must still check the focus as each slot is traversed. Perfect focus cannot be maintained at the point of measurement in the case of dented screens, so that the technique is not suitable for measuring the spreading of slots caused by screen damage or by the embedding of the screen in the woven backing gauze. Photomicrographs are reproduced of a screen section of good quality and of three sections of a poor-quality screen. While the average slot width on used screens was found to be some 20% greater than the manufacturers's nominal specification of 60 µm, it could not be established whether this was due to screen wear or whether the slots were initially larger than the nominal, since measurements of new screens have indicated that a 20% departure from the nominal is not uncommon.

Effect of screens on centrifugal performance

C. R. Greig, E. T. White and L. K. Kirby. *Proc. Australian Soc. Sugar Cane Tech..*, 1985, 179 - 188.

A simple mechanistic model is described which has been developed to predict the capacity of continuous centrifugals. It assumes that the massecuite is fed as a uniform layer onto the screen (which is not always the case in practice), that substantially all of the molasses separation takes place below the colour line by a filtration mechanism, that the screen resistance is the controlling factor, that the molasses layer on the screen is of constant thickness up to the colour line (found to be approximately true) and that the flowing molasses is a homogeneous Newtonian fluid of constant viscosity. Encouraging agreement was found between values calculated by means of the model, and data obtained by Greig *et al.*[1] using a small laboratory centrifugal. Results comparable to those obtained in trials on factory centrifugals were obtained once reasonable estimates of variables not usually measured and not incorporated in the model were included. A laboratory sieving device designed to study the

1 *I.S.J.*, 1985, **87**, 35A.

crystal retention characteristics of screens is described. It consists of an 80 mm circle of centrifugal screen on which is placed 5 g of washed sugar; a filter membrane is located below the screen. The apparatus is filled with methanol and the sugar wet-sieved under vibrating conditions. Methanol is drawn slowly through the screen to simulate filtering in a centrifugal basket, and the mass of fines collected on the membrane is weighed at intervals. A considerable difference was found between the performances of a new and a worn screen; moreover, one sample contained more fines than the other so that more passed through the screen during the same sieving time. Hence, treatment of a massecuite of high fines content would compound the consequences of using a worn screen.

A sugar dryer entrainment system - design and operation

R. G. Attard and J. H. King. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 189 - 193.

The cooling efficiency of the dryer station at North Eton was inadequate, so that the rate of colour development in stored raw sugar was excessive. It was concluded that the flow of air to the dryer should be increased so as to produce a higher degree of evaporation and a reduction in the temperature of the discharged sugar. However, installation of an entrainment system was considered essential for elimination of potential sugar dust problems at the higher air flow rates. The head box at the sugar inlet to the dryer was extended to form a large L-shaped box section, the bottom of which slopes to facilitate drainage into the water collecting trough. Two rows of louvre-type entrainment arrestors were installed in the vertical section. A fan supplying air to the sugar discharge end of the dryer was relocated at the end of the horizontal box section to produce an induced draught through the dryer. The exit wall of the dryer was enlarged to allow a uniform air flow, and water sprays were mounted in the opening, while another spray was fitted to the screw conveyor feeding sugar to the drum. The arrestors were kept clean by recycling hot water through three sprays above the louvres; hot water make-up to the system was supplied by another spray line operating continuously. With continuous addition of water via the make-up sprays, the level in the collection trough rises, and at a certain level a valve automatically opens to bypass some of the recycled water (usually of 1 - 2° Bx) to the *A*-molasses trough in the high-grade centrifugal station. Heating and chlorination of the system daily prevents growth of *Leuconostoc mesenteroides*. Tests have shown that the increased air flow has resulted in a 2.6 - 3.1°C fall in temperature (depending on sugar pol) compared with previous results.

Good automatic pans - instrument or pan design?

K. Sullivan. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 195 - 200.

Aspects of pan design, operation and instrumentation are discussed in regard to possible improvements. The importance of good circulation is stressed, and the benefit of the massecuite stirrer mentioned; the disadvantages of operating at low calandria steam pressure are indicated. Extraction of incondensable gases is discussed, particularly the question of location of adequate air vents and of baffling to direct the incondensables to these extraction points. Circulation also benefits from good steam feed; since feed flashes as it enters the pan at elevated temperatures, it is important to ensure that the feed inlet is located where the vapour will be directed to the surface, thus increasing massecuite movement – observations have shown that flashing vapour will head for the point of lowest pressure and not follow the established massecuite circulation pattern. A feed distribution ring around the base of the pan with 3 - 6 inlet points about two-thirds of the distance from the downtake ensures that the flashing feed will pass straight to the nearest tubes and move any massecuite in the vicinity, thus greatly improving circulation. Besides good circulation, an important factor in good boiling is maintenance of stable vacuum conditions; any sudden drop in pressure will increase supersaturation so that it enters the labile zone, resulting in false grain. The chief problem leading to condenser malfunction is associated with the need to discharge the warm water to the seal tank without disrupting the heat transfer area and temperature difference within the condenser. Means of overcoming this are described. Measuring devices discussed include those for measurement of vacuum, level, consistency and supersaturation, with particular mention of the Ziegler supersaturation monitor.

Brix control using a contactless conductivity electrode

B. D. Jenner, K. A. Sheppeard, B. J. Koppen and S. R. Reichard. *Proc. Australian Soc. Sugar Cane Tech.*, 1985, 209 - 213.

With the installation of a new *C*-sugar remelt tank at South Johnstone factory so that the remelt could be returned directly to the syrup tank, there was need for a cheap method of Brix control which could also be applied to final molasses. The standard method of measuring density using a static leg and DP cell, and proprietary systems based on conductivity were considered too expensive. However, an improved version of a contactless conductivity electrode developed by the Sugar Research Institute, based on the principle of using radio frequency currents to measure conductivity[1] was adapted to give adequate Brix control in both applications at less than 20% of the cost of conventional methods. The final molasses Brix was reduced from 86.92° to 86.26°, while control of remelt Brix was adequate; although purity can affect performance of the control, changes in purity were so small as to have negligible influence. Graphs are given of Brix *vs.* output (mA) for both applications. The system is considered applicable wherever purity and temperature fluctuations are small, e.g. in the case of *A*- and *B*-molasses. More precise control could be obtained by using the output signal in conjunction with a 2- or 3-term controller.

1 Reichard & Vidler: *I.S.J.*, 1976, **78**, 85.

Beet sugar manufacture

Questions on the principle of sugar massecuite viscometry with particular reference to low-grade massecuites

T. Szekrényesy, L. Parádi, K. Hangyál and T. Liktor. *Cukoripar*, 1985, **38**, 14 - 21 (*Hungarian*).

See *I.S.J.*, 1986, **88**, 17A.

The vertical crystallizer at Hatvan sugar factory

J. Bakonyi and J. Lichtenstein. *Cukoripar*, 1985, **38**, 24 - 27 (*Hungarian*).

Details are given of a vertical crystallizer installed in the open at Hatvan sugar factory in order to extend the residence time of *C*-massecuite to 36 hours (compared with 24 hours in a previous horizontal crystallizer). The new unit comprises a vessel of 100 m^3 effective volumetric capacity and an effective height of 10.2 m, in which a vertical hollow shaft carries a continuous water-filled cooling element of star-shaped configuration (with six equidistant arms) in plan view. The system rotates at 0.57 or 0.86 rpm. Tests conducted in 1983 are reported, in which massecuite of 92°Bx and 79 Pa/sec viscosity was cooled from 72° to 42°C and the mother liquor purity reduced from 61 to 57, giving an exhaustion that was 1.12% better than in the horizontal crystallizer.

Calcium bisulphite as pressing aid and its antiseptic action: preliminary results

G. Vaccari, I. Velentza, G. Sgualdino, G. Mantovani, G. Turtura and D. Matteuzzi. *Ind. Sacc. Ital.*, 1985, **78**, 39 - 50 (*Italian*).

After a review of the literature on the positive effect of the Ca^{++} ion on pulp pressing and of SO_2 as a bacteriostat in the treatment of diffusion water, details are given of experiments at Casei Gerola and Fermo sugar factories in which Ca bisulphite and Ca sulphate were added, respectively, to diffusion water. Diagrams are presented of the plants used for preparation of the additives. Results of the experiments, involving three RT diffusers at Casei Gerola and one RT and a DDS diffuser at Fermo, showed that Ca bisulphite was better in terms of pressing and disinfection than Ca sulphate, and should be of high concentration and low pH (e.g. 1.8). For maximum effect, the bisulphite should be added as a dilute solution at the tail of the diffuser and in concentrated form at the head, a total SO_2 quantity of 600 ppm on beet being divided 25 - 30:75 - 70 at the head and tail. The sulphate content in molasses was about the same with both additives, tending to increase when dosing was made at the diffuser head. The SO_2 content in dried pulp was much lower than that emanating from the vapour in pulp drying where oil was used as fuel. Almost no SO_2 was found in sugar crystals, while use of Ca bisulphite in diffusion improved the colour of thick juice. The reduction in aerobic thermophiles and mesophiles in raw juice with increased dosage of SO_2 in the range 200 - 1000 ppm was demonstrated using ammonium bisulphite; at 55°C, 600 ppm SO_2 produced marked inhibition of thermophilic growth, while at 30°C 800 ppm markedly inhibited the development of mesophiles.

Temperature-resistant elements for reverse osmosis treatment of hot process waste. Final report

R. J. Peterson, J. N. Thorpe, J. E. Cadotte and J. Y. Koo. *Rpt. US Dept. Energy*. 1983, (DOE/ID/12423-TI), 75 pp; through *S.I.A.*, 1985, **47**, Abs. 85 - 607.

Potential uses of reverse osmosis include the pre-concentration of beet juice before evaporation, where it would lead to considerable energy savings. Tests were carried out on Film Tec FT - 30 thin-film composite membrane, one of a new class of membranes which have higher temperature resistance than conventional membranes. There was a loss of permeate flux above 50°C at a pressure of 200 - 800 lb/in², but even at 60 - 85°C fluxes would be economically attractive, because the loss in flux was almost fully offset by the increased flux due to higher temperature. Spiral-wound membrane elements showed severe loss in performance at high temperatures and pressures. Experimental elements made with an expensive woven metal screen retained useful permeate fluxes (15 - 17 gal/ft²/day) after 165 hours' exposure to 15% sucrose solution at 80 - 85°C and 800 lb/in².

Experience at Zolochev sugar factory in removing impurities from beet by air jet

O. S. Vedrii *et al. Sakhar. Prom.*, 1985, (5), 39 - 41 (*Russian*).

Supplementary removal of light impurities such as loose vegetation from the flow of beets on their way to processing takes the form of a blast of air directed by a fan through a nozzle at the beets as they fall from an inclined belt conveyor onto the hopper feeding the slicer. The trash is thus blown into a hopper contiguous with the beet hopper but with the top sections of both hoppers separated by a swivel flap. The upper far side of the trash hopper away from the beet hopper is provided with a scraper which is in contact with a conveyor belt and removes any adhering material. The angle of the nozzle can be adjusted vertically. Operation of the system has shown the need to replace the flap between the hoppers by a mechanical system operating in conjunction with the conveyor, since the gap between the head drum of the conveyor and the flap periodically became blocked, necessitating manual clearance; with the modified system, the flap is replaced by a small geared roller rotating in the opposite direction to the conveyor drum and linked by connecting rod to another roller which is in contact with the conveyor belt, so that friction indirectly imparts movement to the first roller. The vertical distance between the roller and the conveyor drum is adjusted by bolts.

Preparation and installation of stainless steel sleeves on the end axles of a DDS-20 (S-17) inclined diffuser

T. M. Kosenko. *Sakhar. Prom.*, 1985, (5) , 41 - 42 (*Russian*).

Considerable wear of the end axles where they are located in the sealing glands has been found after 7 - 8 years' operation of DDS diffusers, and it is recommended to use stainless steel sleeves that have a much longer service life than conventional mild steel ones. Advice is given on machining of the sleeves and on their installation.

Modern trends in improvement of sugar crystallization

A. R. Sapronov, V. I. Tuzhilkin and A. P. Shcherenko. *Sakhar. Prom.*, 1985, (5), 42 - 44 *(Russian).*

Details are given of various departures from conventional boiling house practices that have provided the benefits of increased efficiency and reduced energy consumption. Among the techniques mentioned are: boiling of *A*-massecuite on a footing of *B*- or *C*-sugar; addition of 0.05 - 0.07% sodium sulphate by weight to massecuite when low-quality beets are being processed, and affination of *C*-sugar by mingling with *A*-massecuite 1st run-off; boiling *A*-massecuite on crystal footing obtained from the same massecuite by cutting to a second pan after nucleation and crystal growth to 0.2 - 0.3 mm, then boiling simultaneously in both pans, which has cut the total boiling time by 18 - 25%, since there is no need for initial concentration and nucleation in the second pan; the use of a swirler in the form of an inverted frusto-conical element with recirculation opening arranged in a helical line formation; supplementary evaporation of thick juice from 55 - 65°Bx to 78 - 80°Bx in a fore-concentrator (a redundant vacuum pan is suitable for this) followed by holding in a spherical tank at near saturation and subsquent boiling, which starts at the nucleation stage (made possible by the fact that the pan temperature is lower than in the holding tank) – the boiling cycle is cut by 15 - 20% and the steam consumption by 8 - 9%; and modification of this system, in which syrup of 55 - 65°Bx makes up 25 - 30% of the pan contents, while the rest is composed of 78 - 80°Bx syrup.

The effects of colouring matter in yellow sugar on the white sugar colour

I. F. Bugaenko and E. P. Ishina. *Sakhar. Prom.*, 1985, (5), 44 - 45 *(Russian).*

Investigations were conducted on the colour composition of consumption sugar produced by boiling *A*-massecuite on melted *C*-sugar treated or untreated by carbonatation. The colorants in the melt and white sugar were fractionated by passage through a DEAE-cellulose column and the absorbance of the fractions measured at 440 nm after elution successively with distilled water, sodium biphosphate, ammonium chloride and sodium hydroxide. Results showed that carbonatation removed mainly brown colorants (products of melanoidin formation), 70% of the components in this group being eliminated; since melanoidins constituted the main colour fraction in the white sugar, C-sugar carbonatation is clearly advocated.

Change in the microflora of white sugar during its storage

A. I. Belyaev, A. A. Slavyanskii and A. O. Lobanova. *Sakhar. Prom.*, 1985, (5), 46 - 47 *(Russian).*

White sugar in 25-kg sacks was stored for 12 months on pallets in a heated warehouse at 69% average relative humidity (65 - 74%) and an average temperature of 11°C (7 - 15°C). Bacterial counts were determined every two months and the results tabulated. The numbers of slime-forming and lactic bacteria were markedly reduced by sieving the sugar to remove crystals smaller than 0.25mm, whereas screening had almost no effect on the numbers of moulds and yeasts, suggesting that these two groups were associated with large crystals. However, in all samples the overall bacterial population fell during storage, possibly as a result of the weak survival of the non-sporogenous forms under the test conditions. Although sugar having a fractional composition of 0.63 - 1.0 mm was more favourable to microbial development, there was a fall in the yeasts population, while the level at the end of storage in most samples, particularly the unscreened sugar, was 3.5 times greater than at the start. Increased mould formation was noticed, as would be expected, in samples from the lower pallets and where the moisture content had risen. The first six months of storage was the period of greatest instability, with noticeable fluctuation in the numbers of the different groups, although yeasts and moulds flactuated throughout the entire period. In qualitative terms, there was no difference between the unstored and stored sugar micro-organisms. Examination of the microbiology of the empty sugar sacks showed 4.5 - 29.3 million bacteria per sack, or 510 - 3650 per cm^2.

An addition to a device for trapping vegetation and other light impurities

V. E. Ryzhikov. *Sakhar. Prom.*, 1985, (5), 55 - 56 *(Russian).*

Where a jet of air is directed at the falling stream of beets leaving the conveyor feeding them to the hopper above the slicer, light trash falls into a hopper adjacent to the beet hopper with an acute angle separating the two entrances, which thus form a bifurcation of the section between the end of the conveyor and the fan. However, at the factory in question, trash has been found to accumulate at the point of intersection between the two hoppers, and it is recommended to install a driven roller, rotating in a direction opposite to that of the conveyor drum, above the apex, so as to guide the trash into its hopper.

Sugar beet storage

K. Vukov and K. Hangyál. *Sugar Tech. Rev.*, 1985, **12**, 143 - 265.

The literature on the subject is reviewed in some detail, with 199 references covering: processes taking place in harvested beet, the effects of storage conditions, physical and chemical changes in stored beet, biochemical processes, microbiology, changes in the processing quality of stored beet, factors influencing storage losses (period of storage, temperature and beet condition), storage technology, etc.

Laboratory studies

High-performance thin-layer chromatographic separation of sugars: preparation and application of aminopropyl bonded-phase silica plates impregnated with monosodium phosphate

L. W. Doner and L. M. Biller. *J. Chromatography*, 1984, **287**, (2), 391 - 398; through *Food Sci. Tech. Abs.*, 1984, **16**, (9), Abs. 9 L 644.

Impregnation of aminopropyl-bonded silica HPTLC plates with monosodium dihydrogen phosphate (the method of preparation is described) allows the separation of closely related sugars, avoiding problems caused by glycosylamine formation by aldehydic sugars. By modifying the polarity of acetonitrile-water mobile phases, separations can be achieved in less than 30 min for classes ranging from closely related monosaccharide derivatives to higher oligosaccharides. R_f values are tabulated for over 50 monosaccharides, sugar derivatives and di- and higher saccharides.

Ultrafiltration of sugar juices

D. F. Day, R. S. Patterson and M. F. Hayward. *J. Amer. Soc. Sugar Cane Tech.*, 1985, **4**, 102 - 105

Preliminary experiments are reported in which clarified cane and sorghum juice was treated in an ultrafiltration unit comprising two spirally wound membranes having a total surface area of 110 ft^2; HFL - 100 membranes having a nominal cut-off value of 10,000 M.W. were used in one run, while the remainder of the tests were conducted with HFX-131 membranes of 5000 M. W. cut-off. Operation was continuous at 160°F, 300 - 400 gal of juice being handled per cycle. Whereas washing of the membranes with NaOH restored only 90% of the original flux, washing with NaOH, NaOCl and nitric acid completely restored the original flux. The HFL-100 membranes failed to remove sufficient quantities of starch from sorghum juice to permit boiling, whereas the HFX-131 membranes gave a juice containing no detectable starch. In the case of cane juice, clarity was better and the colour lower than with the control; starch levels were below detection limits, while the syrup produced from the juice was of lower viscosity. The rejected material was very dark and had a slippery feel indicative of polysaccharides and revealing high levels of starch. An average 1% rise in purity was achieved; an average pol loss of 2.7% could be decreased if the amount of rejected material were reduced. Juice pH or temperature did not seem to affect the membranes, and pre-filtration was unnecessary if clarified juice was used.

Computerization of laboratory instruments

C. C. Chou. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 15 pp.

The author outlines the basics of computerization and describes its application to laboratory instrumentation as exemplified by a pH meter, an electronic balance and a polarimeter, each instrument representing a particular class in terms of its ability to interface with microcomputers. Other aspects briefly discussed include data transmission (with mention of optical fibres), choice of programming language and hardware compatibility.

Colour components in sugar refinery processes

M. A. Clarke, R. S. Blanco, M. A. Godshall and W. S. C. Tsang. *Paper presented at 44th Ann. Meeting Sugar Ind. Technol.*, 1985, 27 pp.

After a brief review of the nature of colorants found during processing, details are given of simple tests devised for measurement of phenolics, amino-N compounds, alcohol-precipitable material and colour at different pH values. The significance of the different techniques is indicated, including the indicator value (ratio of colour at pH 9 to that at pH 4) as a guide to the relative level of colour caused by phenolics. Nine series of samples from five refineries using different combinations of clarification and decolorization processes were analysed for total colour, phenolics and amino-N. The behaviour of the colorants in each process is discussed. Comparision of overall decolorization from melt liquor to fine liquor showed a higher degree of colour removal at those refineries using phosphatation by comparison with carbonatation, although phosphatation alone removed less colour than carbonatation. The different refineries used different decolorization techniques, and the best results were obtained using a combination of bone char and resin.

Loss of volatile trace organics during spray drying

M. R. Etzel and K. C. Judson. *Ind. Eng. Chem., Process Res. Dev.*, 1984, **23**, (4), 705 - 710; *through Ref. Zhurn. AN SSSR (Khim.)*, 1985, (8), Abs. 8 R412.

Results are reported of determination of the volatile acetate content in sugar solutions spray-dried by passage at high pressure through nozzles into a hot air atmosphere. The new measuring instrument used for the purpose is described.

Polysaccharides and crystal habit

J. Hormaza M., E. Ramos and A. Leon. *ATAC*, 1984, **43**, (1), 10 - 17 *(Spanish)*.

Polysaccharides were isolated from a *B*-massecuite which contained elongated crystals and were fractionated and the fractions used in crystallization experiments. It was concluded that the polysaccharides did not exercise an appreciable effect on crystal habit, and that the c-axis elongation observed was associated with substances of M.W. below 10,000 or a synergistic effect of these with the polysaccharides.

Work of adherence and coefficient of extension of sucrose solutions on surfaces of copper, stainless steel and aluminium. Effect of temperature and surfactants

R. González Q. and J. Lodos F. *ATAC*, 1984, **43**, (1) 18 - 24 *(Spanish)*.

The two title characteristics were studied for sucrose solutions of 30° - 60°Brix on the three title surfaces, at temperatures between 60 and 100°C, and in the presence of two surfactants. Values of W_{ad} and S were obtained from the surface tension and the solid-liquid contact angle, obtained by the maximum pressure of the bubble and the adjacent drop, respectively. The W_{ad} is substantially benefited by the action of the surfactants but is not much affected by temperature. A notable effect of the surfactants on S was observed, and concentrations required for total extension were measured. Extension of concentrated solutions on stainless steel and aluminium was better than on copper; for dilute solutions they were similar. In the presence of surfactants, diluted solutions spread better on aluminium and stainless steel.

Evaluation of a colorimetric method for determination of reducing sugars in raw sugar

C. Almenares A. , A. Rodríguez A. and A. J. Perdomo M. *ATAC*, 1984, **43**, (2), 21 - 27 *(Spanish)* .

The method of Prasad & Upadhiaya[1], based on the reduction of the optical density of Fehlings solutions A and B in proportion to the reducing sugars quantity present, has been studied using a spectrophotometer, and the results compared with those using the constant volume Lane & Eynon method which is standard in the Cuban industry. The colorimetric method gave good results in respect of precision and repeatability which did not differ significantly from those obtained with the Lane & Eynon method. It is much more rapid and less complex than the Lane & Eynon method, however, and it is recommended that it be adopted for use in the sugar factories after an inter-laboratory experiment to determine its reproducibility.

Behaviour of waxes in the cane sugar manufacturing process

A. Valentín, M. Evora, M. Darias and L. D. Bobrovnik. *ATAC*, 1984, **43**, 34 - 36 *(Spanish)*.

The wax content was extracted, using carbon tetrachloride in a Soxhlet apparatus, from mixed and clear juices, syrup, raw sugar and molasses, and the variations discussed. About 80% of the wax in mixed juice was eliminated during clarification and the content fell between clear juice and syrup. There was an increase in the wax content of sugar and molasses which was due to the concentration of sugar in the latter.

Humectant properties of sucrose solutions over heat transfer surfaces

R. González Q. and J. Lodos F. *CubaAzúcar*, 1983, (July/Sept.), 8 - 13 *(Spanish)*.

The wetting of copper, aluminium and stainless steel surfaces by sugar solutions of 30° - 60° Bx at temperatures of 60° - 100°C was studied by photographing and measuring the contact angle of a drop of the solution on the surface, maintained at constant temperature. The thermal coefficient of the angle in dilute solutions is similar to that of water but becomes progressively negative as the Brix is raised. The addition of surfactants increases wetting remarkably, especially at low concentrations. Extrapolation of the results to the sugar industry indicates the positive effect of surfactants on wetting of heating surfaces.

Solubility of sucrose in pure and impure solutions

M. Wong Q. *CubaAzúcar*, 1983, (July/Sept.), 20 - 24 *(Spanish)*.

The solubility of sucrose was expressed in terms of an equation $S = Ae^{at}$ instead of a polynomial, where S is sucrose concentration, t its temperature and A and a two parameters to be determined. The values of A and a were determined for different purities and the variation found to be uniform. The formula proved to be in accord with existing data.

Inorganic non-sugars and polysaccharides in elongated raw sugar crystals

N. Alvarez, J. A. Cremata and A. Tagle. *CubaAzúcar*, 1983, (July/Sept.), 35 - 41 *(Spanish)*.

Analyses were made of inorganic elements and different polysaccharide fractions in sugar and correlations sought between these and elongation of the c-axis of the crystals. No combined effects were found to cause elongation.

Sugar cane flavonoids

P. Smith and N. H. Paton. *Sugar Tech. Rev.*, 1985, **12**, 117 - 142.

The literature on the chemical structure of the five classes of flavonoids found in sugar cane, on their use as biochemical markers in taxonomy, their behaviour during processing and on measurement of their concentration in cane sugar products is reviewed (51 references). (See also *I.S.J.*, 1983, **85**, 102 - 105, 139 - 145; 1985, **87**, 213 - 215.)

An improved method for the analysis of the composition of polysaccharides by total acid hydrolysis

M. Mochtar, H. J. Delavier and O. B. Liang. *Zuckerind.*, 1985, **110**, 497 - 500.

Samples of polysaccharides, e.g. dextran, were hydrolysed with sulphuric acid in atmospheric oxygen or by bubbling nitrogen through the mixture, after which the hydrolysates were neutralized with barium hydroxide or by passage through a column of weakly basic anion exchange resin, and then analysed by GLC as their trimethylsilyl derivatives. Results of hydrolysis, using glucose, fructose and mannose as standards, showed that use of a nitrogen atmosphere reduced monosaccharide degradation, while treatment of the hydrolysates with anion exchange resin reduced epimerization of glucose to other sugars, thus providing more reliable analysis of polysaccharide composition even where the polysaccharides were readily degraded.

1 *Proc. 43rd Ann. Conv. Sugar. Tech. Assoc. India*, 1979, C37 - C47.

By-products

Ammoniated molasses as a cheaper protein source for animal feed

M. Ishaque. *Pakistan Sugar J.*, 1985, **1**, (1), 35 - 37.

The advantages of ammoniation of cane molasses as a means of increasing its digestible protein content are indicated, and a procedure is described for ammoniation of 9-kg batches of molasses.

Preparation of activated carbon from bagasse and its adsorption characterstics

M. I. Khan and R. Nawaz. *J. Pharmacy* (Univ. Karachi), 1983, **2**, (1), 41 - 44; through *S.I.A.*, 1985, **47**, Abs. 85-794.

Bagasse was heated after treatment with various activating agents: pure 4N and 9N H_2SO_4 at a bagasse:acid ratio of 1:4; commercial concentrated H_2SO_4 at a ratio of 1:3, 1:4 and 1:5; 0.1 - 2N $ZnCl_2$ solutions at 1:6 ratio. Activation temperatures were 400, 500 . . . 900°C. With increasing temperature, the yield of activated carbon decreased, but its adsorptive power increased. The maximum adsorption power (25.5g methylene blue decolorized by 100 g of the carbon) was obtained by treatment with commercial H_2SO_4 at a ratio of 1:3 and activation at 900°C.

Analysis of the physico-mechanical properties of the bagasse particle boards from the "Camilo Cienfuegos" plant

R. Almagro and R. Costales. *Revista ICIDCA*, 1983,**17**, (2/3), 26 - 39 (*Spanish*).

Examination of the physico-mechanical properties of boards produced at the title plant serves a number of purposes; it aids research on production and product improvement and it also provides a basis for assessment of the possibility of new uses of the board. Among the characteristics discussed are the modulus of rupture and modulus of elasticity, and the influence on these of other factors (moisture content, density, etc.) are discussed.

Current status of the biodegradation of lignocellulosic materials

N. Fernández and I. Gutiérrez. *Revista ICIDCA*, 1983, **17**, (2/3), 71 - 80 (*Spanish*).

A review is presented, with 17 references up to 1981, of work being done on the biological degradation of lignocellulosic materials by means of micro-organisms, and particularly with enzymes derived from fungi, for obtaining protein, animal fodder and cellulose pulp.

Use of retention agents in the production of paper with a high content of bagasse pulp

A. Abril, R. Suárez, R. Molina, A. Hernández, O. Alvarez and M. Rodríguez. *Revista ICIDCA Supplt.*, 1984, (1), 12 - 19 (*Spanish*).

Five unnamed commercial retention agents were tested on a laboratory scale for their effectiveness in filler retention, drainage improvement and flocculation activity. Polyamide-amines and polyethyleneimines gave better results than a cationic polyacrylamide, and excellent results were then obtained in a mill trial with one of the polyethyleneimines.

Experience in the production of moulded boxes from bagasse

J. L. Valdés and R. Costales. *Revista ICIDCA Supplt.*, 1984, (3), 10 - 15 (*Spanish*).

Cuban bagasse was used for test manufacture of boxes moulded with the addition of organic binding agents by the Werzalit company and then shipped to Cuba for assessment. The agents were urea-formaldehyde resins, alone or mixed with melamine-formaldehyde resins, while the bagasse was depithed, milled so that about 83% was between 1 mm and 5 mm, and dried to 2% moisture content. Results of the tests are reported; they are considered to show the advantage of the process and the desirability of establishing test facilities in Cuba for continuation of the experiments and evaluation of the boxes produced.

Effect of starch and the refining of bagasse pulp on the resistance properties of the paper

A. Hernández and M. Rodríguez. *Revista ICIDCA Supplt.*, 1984, (2), 9 - 16 (*Spanish*).

Starch increases the dry strength of paper and board, basically at the surface. Of the different types of starch, the most effective are the cationic starches because of their greater retention and the greater increase they provide in the resistance properties. The improvement continues up to 0.6 - 1.0% starch but not beyond this level. Addition of starch does not affect the properties improved by pulp refining - brilliance, porosity, etc.

Experiences in the modernization of the Procuba particle board factory

O. Carvajal and R. Almagro. *Revista ICIDCA Supplt.*, 1984, (3), 33 - 41 (*Spanish*).

Equipment from Poland was supplied for the title factory and observations are presented on problems and experience in the modernization. It is emphasized that the bagasse supplied as raw material should be depithed at the sugar factories so as to improve the product quality and reduce storage requirements.

Comparison of the acid prehydrolysis of rice hulls with bagasse pith

I. González and R. López P. *ATAC*, 1984, **43**, (3), 35 - 41 (*Spanish*).

Prehydrolysis with a dilute (0.25N) mixture of sulphuric and nitric acids of rice hulls, and the similarity of their composition to that of bagasse pith, leads the authors to the conclusion that it should be possible to effect a similar prehydrolysis of the pith to obtain soluble sugars which may be fermented to produce single-cell protein.

Patents

Purification of sucrose esters

Tate & Lyle plc, of London, England. **2,101,122.** May 11, 1982; January 12, 1983; January 23, 1985.

Sucrose ester-containing material obtained by base-catalysed transesterification of sucrose with a fatty acid ester is purified by acidifying an aqueous dispersion of the material to a pH between 4 and 7 (4.5 when using a weak organic acid or almost 7 when using a strong mineral acid) to give an aqueous and an organic phase. The organic phase is recovered at or above its melting temperature and is mixed with ethyl acetate containing 0 - 4% water to give, at 0 - 20°C, a liquid and a solid phase, the latter then being recovered as a sucrose ester-rich product.

Production of L- lysine by fermentation with new micro-organisms obtained by protoplast fusion

Kyowa Hakko Kogyo Co. Ltd., of Tokyo, Japan. **2,103,617.** August 6, 1982; February 23, 1983.

L-lysine is produced by fermentation of a medium containing, as carbon source, glucose, fructose, sucrose, starch, molasses, etc., using a micro-organism in the *Corynebacterium* or *Brevibacterium* genus (e.g. *C. glutamicum* or *B. lactofermentum*) which is cultured on the medium at pH 3 - 9 (preferably around neutral) and 20 - 40°C for 1 - 16 days, the lysine then being recovered by conventional means, e.g. ion exchange, concentration, adsorption, salting-out.

Process for making D-fructose

Hydrocarbon Research Inc., of Lawrenceville, NJ, USA. **2,105,336.** August 17, 1982; March 23, 1983; June 12, 1985.

Glucose in a 10 - 70% (50 - 70%) pure aqueous solution or in a crude starch hydrolysate is epimerized to D-glucose and D-mannose, preferably on a fixed catalyst bed (of silico-tungstic acid, molybdic acid, phosphomolybdic acid or similar derivatives of molybdenum or tungsten on a silica gel) at 100 - 125°C and pH 3 - 5 for 30 - 120 minutes. After separation of the D-glucose in a crystallizer, the D-mannose is hydrogenated on the same catalyst bed at 100 - 150°C to yield D-mannitol, which is then subjected to aerobic fermentation in the presence of oxidizing microbes such as *Gluconobacter* (*Acetobacter*) *suboxydans*; the resultant D-fructose solution is crystallized.

Process for making L-sugars and D-fructose

Hydrocarbon Research Inc., of Lawrenceville, NJ, USA. **2,105,337.** August 17, 1982; March 23, 1983; June 19, 1985.

D-fructose and L-sugars are produced from aqueous 10 - 70% (40 - 70%) (65 - 70%) D-glucose solution or crude starch hydrolysate, the procedure and conditions for crystal D-fructose preparation being as described in UK Patent 2,105,336 (see preceding abstract).

The treatment of yeasts, single-cell organisms and casein by heating with sugar and other compounds

Institute for Industrial Research and Standards, of Dublin, Ireland. **2,107,567.** October 6, 1982; May 5, 1983.

A foodstuff or animal fodder is prepared from yeast, single-cell organism or casein by heating to 80 - 145°C (95 - 120°C) in an aqueous medium containing starch or starch derivative, sucrose, dextrose, fructose, lactose, molasses, invert sugar or corn syrup to dissolve the yeast or single-cell organism or disperse the casein but not to caramelize the starch or sugar.

Boiling with air injection

P. A. Moreno, of Madrid, Spain. **2,111,843.** December 21, 1982; July 13, 1983.

The injection of air with or without water vapour into a vacuum pan agitates the massecuite, thereby acting as a substitute for an energy-consuming stirrer and reducing the boiling time by >25% (30%) as well as the purging time in the centrifugals.

Purifying sugar juice

A/S De Danske Sukkerfabrikker, of Copenhagen, Denmark. **2,113,247.** January 18, 1982; August 3, 1983; March 13, 1985.

Raw cane juice (is filtered or clarified and) is treated by ultrafiltration at 20 - 100°C (60 - 100°C) (80°C) and pH <7 using a membrane having a cut-off value of approx. 25,000 (up to 70,000). The treated juice, containing 12 - 15% sugar by weight, may be used directly as a beverage, preferably after sterilization, or as a sweetener for beverages after possible adustment of the concentration, pH and/or Brix. The concentrate from the ultrafiltration, containing e.g. approx. 5% of the sugar in the initial juice and having a dry solids content of 15 - 20% by weight, may be evaporated and dried to yield a product suitable as an animal feed component.

Immobilization of glucose isomerase and isomerization of glucose to fructose

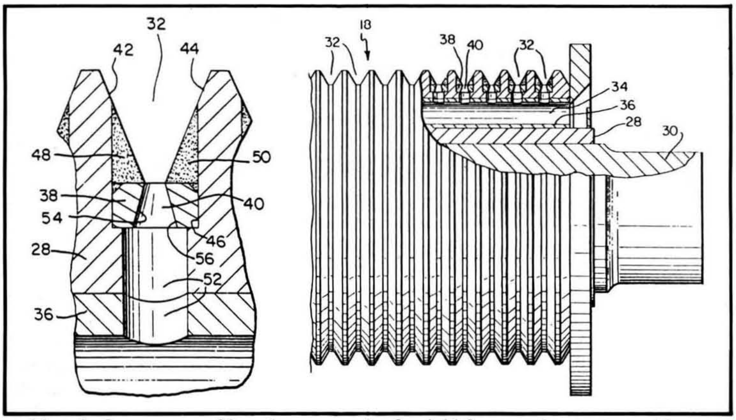
Institute po Microbiologia, of Sofia, Bulgaria. **2,116,560.** March 12, 1982; September 28, 1983; March 6, 1985.

Active microbial cells in glucose isomerase are immobilized by polymerization using glutaric aldehyde to yield a network structure in the presence of proteinaceous carrier (blood serum or plasma). The final product in dry, granular form may be used for isomerization of a 2 - 3M glucose syrup at 45 - 75°C (60 - 65°C) to convert 40 - 50% of the glucose to fructose.

Improved mill roll

Fabcon Inc., of San Francisco, CA, USA. **2,120,125.** May 14, 1982; November 30, 1983; September 11, 1985.

The body 28 of cane mill roller 18 has a number of preferably V-shaped grooves 32 extending around its entire periphery. A number of channels 34 extend axially throughout the entire length of body 28 at

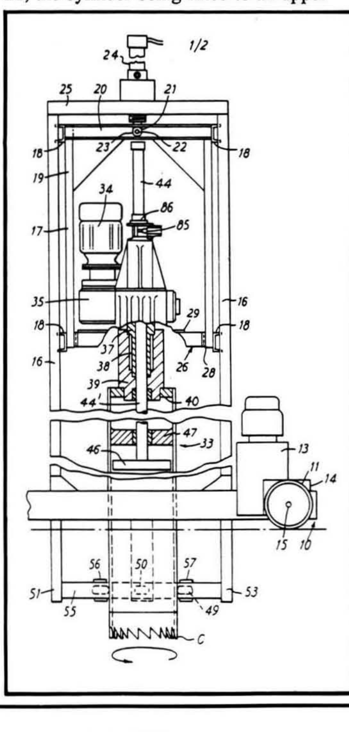


positions in from grooves 32, and are preferably formed by tubes 36 integrally cast in the roller body. Each of a number of inserts 38 within body 28 at the radial bottoms of grooves 32 has an opening 40 connecting the respective groove 32 with a corresponding channel 34. Each opening has an elongated, substantially circumferential rectangular cross-section sloping outwards away from the bottom of the groove so as to reduce clogging. Each groove 32 has a pair of facing flank surfaces that converge in towards body 28, and for each insert 38 there is a radially extending (preferably circular) recess formed in parts of the facing flank surfaces; each insert 38 (of a corrosion- and abrasion-resistant material such as a hard, high chrome alloy steel) fits in its respective recess and is held there by welding. A circular hole extends in from each recess through roller body 28 and tube 36 to a corresponding channel 34, the diameter of the hole being less than that of the recess. During operation of the mill, juice at the upper part of the cane blanket between the upper and lower rollers will enter openings 40 and pass through channels 34.

Cane sampler

Cocksedge & Co. Ltd., of Ipswich, England. **2,120,207.** April 27, 1982; November 30, 1983; September 25, 1985.

A hydraulically-operated, laterally moving framework 10 is mounted on flanged wheels 11 which engage in the guide rails of a rigid framework so as to position framework 10 sufficiently above the ground for a cane-carrying truck to be driven beneath. A pair of vertical rails 16 mounted on framework 10 serve as guides for a vertically movable carriage 17 connected at its upper end to a piston rod 21, the cylinder being fixed to an upper



member 25 of framework 10. The lower end of carriage 17 is provided with a base 26 surmounted by a base plate 29 on which is the electric drive for a sampling tube 33. The drive is connected by shaft 37 to a sleeve 30, to which is welded a plate 40 attached to the inside of tube 33, which may be about 8 - 20 inches (20 - 50 cm) in diameter and 5 - 11 ft (125 - 335 cm) long. A rod 44' of the hydraulic ram 44 passes through shaft 37 and sleeve 39, and the lower end of rod 44' carries an ejector plate 46 that moves vertically within the sampling tube and is guided by an apertured plate 47 welded to the inside of tube 33. Rollers 49, 50 engage the outside of the sampling tube at or near its lower end when it is in raised position and keep it in this position; the tube, the lower end of which is provided with an annular cutter C, is raised and lowered by movement of carriage 17 under the power of the piston and cylinder 24, while the sampling tube is rotated by electric motor 34. Under control by one operator provided with joystick controller to position the unit above the vehicle, the sampling tube will start to descend at high speed; the controller is released when the tube enters the load, and the tube continues to descend at low speed, cutting through the cane until it reaches a preset depth. The tube then automatically retracts. Once the unit is in discharge position, ram 44 is automatically operated, causing ejector plate 46 to discharge the sample into a receiving hopper.

Glucose isomerase immobilization

Novo Industri A/S, of Bagsvaerd, Denmark. **2,128,620.** October 5, 1983; May 2, 1984.

Glucose isomerase is immobilized by attaching it to the surface of a carrier formed by combining a continuous phase consisting of water-soluble binder (e.g. a protein, polysaccharide, cellulose, synthetic material such as PVA or PVP or sodium silicate) with a discontinuous phase consisting of an inert filler material (e.g. kieselguhr, sand, brick dust, clay, etc.).

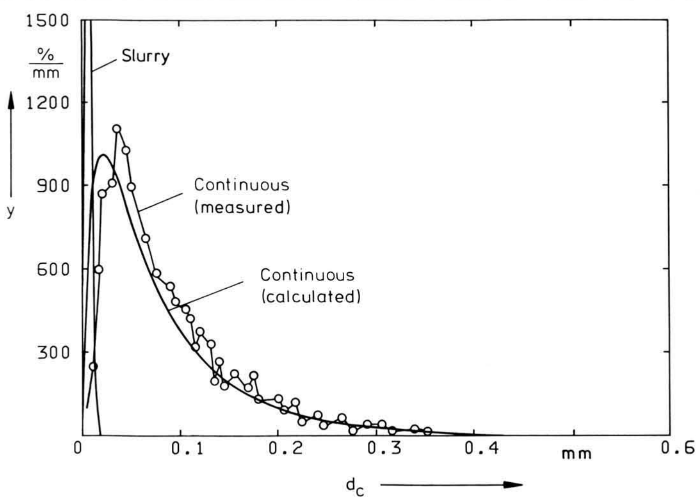


Fig. 3. Number-density distribution for seed slurry and product from continuous after product boiling

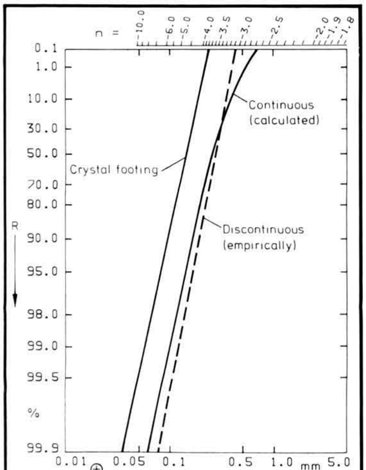


Fig. 4. Cumulative mass distribution for crystal footing and product from continuous after product boiling

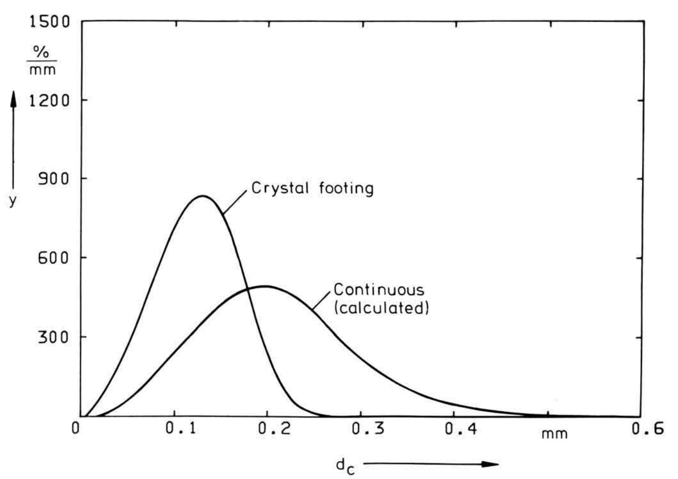


Fig. 5. Number-density distribution for crystal footing and product from continuous after product boiling

The stirrers of the two upper cells shown in Figure 6 are designed as high-speed mixing-stirrers. The stirrers of the two lower cells have to assist the magma circulation and are slower rotating turbine stirrers of the Kaplan type.

The apparatus is suitable for outdoor location; there are no building costs as a result and the local requirements are small. The dimensions of the evapo-crystallizers are almost the same as those of the vertical cooling crystallizers which are becoming fairly common.

The concept developed by the Braunschweig Institute is based on the idea that the total prevention of incrustation when crystallizing white sugar by evaporation is a too difficult and possibly insoluble task. So, if formation of incrustation cannot be prevented, it should be made possible to remove it without a great expenditure of energy and without shutting down the whole apparatus. For this purpose a cleaning scheme, capable of automation, was proposed which ensures a permanent high availability of the crystallizer shown in Fig. 7 for a tower consisting of 3 chambers.

If a chamber is to be cleaned because of sugar incrustation the contents are stored in a lower storage bin A; the chamber is then boiled out with a suitable sugar solution, perhaps a mixture of thin and thick juice for example. During this time the chamber being cleaned is isolated and the stored magma pumped from the lower vessel A up to the upper vessel B. The throughput capacity is thus reduced to the value (N-1)/N during this time in the most unfavourable case. If steam pressure can be increased it is possible to operate at normal capacity even during cleaning.

After cleaning, the stored magma is returned to the original chamber. The

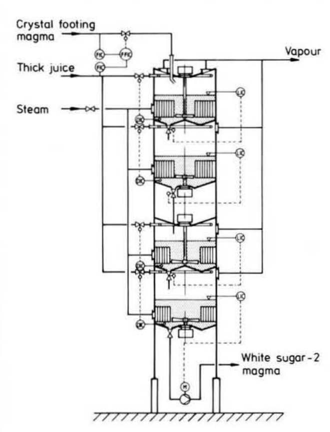


Fig. 6. Scheme of the Braunschweig Evaporative Crystallization Tower (ECT) built by BMA (Braunschweigische Maschinenbauanstalt AG)

primary set point (for the density, consistency and level) is therefore reached immediately and the whole apparatus returns to operation at full efficiency.

If the capital expenditure for a system according to Fig. 6 seems to be too high, another solution can be envisaged and has been realized at Lehrte factory; the volume of the magma of the chamber which is to be cleaned can be stored in the chamber below, which then works with a worse heat transfer (see Part II). In any case provision must be made so that the chamber being cleaned can be by-passed.

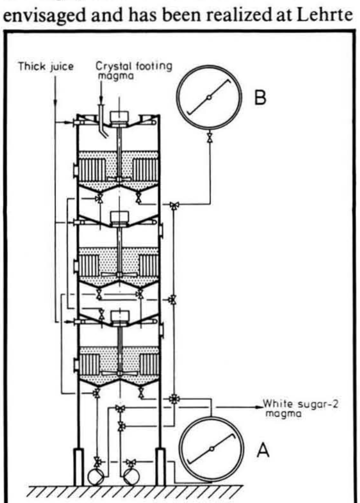


Fig. 7. ECT with two storage bins

In continuous crystallizers, the crystals do not have a uniform duration of stay but are subject to a residence time distribution. The residence time behaviour in a number of technical reactors gives a good approximation to the mathematically analysed model of ideal stirrer vessels[4].

Figure 8 shows the product-sugar grain size distributions for various chamber numbers N and various seed-crystal sizes $d_{c,cf}$ and varying relative mass of seed M_{cf}. These are the result of operation of a crystallization plant constructed as a stirred vessel cascade. The calculation for the expected grain size distribution of the crystal product is based on the assumption that a constantly RRSB-distributed seed stream is led into the first chamber. The grain size-dependent law of crystal growth determined for this case was also considered on the basis of the velocity coefficient of material transport k_D as a function of the root of the median grain size d_c[4]. The single representation in Figure 8 show mass frequency-histograms as well as the appropriate RRSB-distributions. The granulation of comparable discontinuously-produced crystals (d_c' $=0.83$ mm, $n=4$) was included in the RRSB-graticules. The grain size distributions of the crystals produced continuously do not obey the RRSB-mathematical inter-relationship because of the influence of the residence time distribution.

In the upper part of Figure 8 is shown the dependence on the chamber number N, in the lower part the dependence on the relative seed mass M_{cf}. In the median line the basic model is shown, which is suitable for a common analysis. Factors used to establish the basic model are: $N=3$, $d_{c,cf}=0.08$ mm and $M_{cf}=0.08\%$.

The significant positive inclination of this product grain size distribution is conspicuous, and means that the coarse crystalline fraction (>1 mm) is considerable. If the sales fraction were reduced to the range 0.2 mm-1.0 mm (scanning field in the histogram), according to this method of operation only the two shaded fractions, totalling 58.64% of the whole product, would come into this category.

As the fine component ($d_c<0.2$ mm) of 2.97% would complicate the centrifugal work, the basic case seems to be technically unpractical. Worse results are to be expected with the method of operation shown to the left of the basic model ($N<3$) or $M_{cf}<0.08\%$).

The histograms to the right of the basic model show how the grain size distribution can be improved by changing the chamber number N or the seed crystal size $d_{c,cf}$ (or the relative seed mass M_{cf}). It may be seen that increasing the number of chambers from 3 to 7 brings about an evidently smaller effect than increasing the seed grain size of the discontinuous footing from 0.08 mm to 0.45 mm. When operating with the evapo-crystallization tower system, use of a larger grain size would save considerable expense. The significance of the footing becomes evident when comparing the histograms shown at the extreme right of Figure 8; for achieving almost identical grain size distributions of the product crystals there are 15 chambers required at low footing charge ($M_{cf}=0.08\%$) whereas 3 chambers are sufficient when using raw sugar ($M_{cf}=42.2\%$) as a footing for producing standard white sugar. As may be seen by comparison with the discontinuously produced crystals ($n=4$) in the inserted RRSB-diagrams, the grain quality achieved by continuous operation is high.

Figure 9 shows the mass of the various fractions as a function of the chamber number for the special case

4 Austmeyer: *Chem. Ing. Tech.*, 1981, **53**, 716.

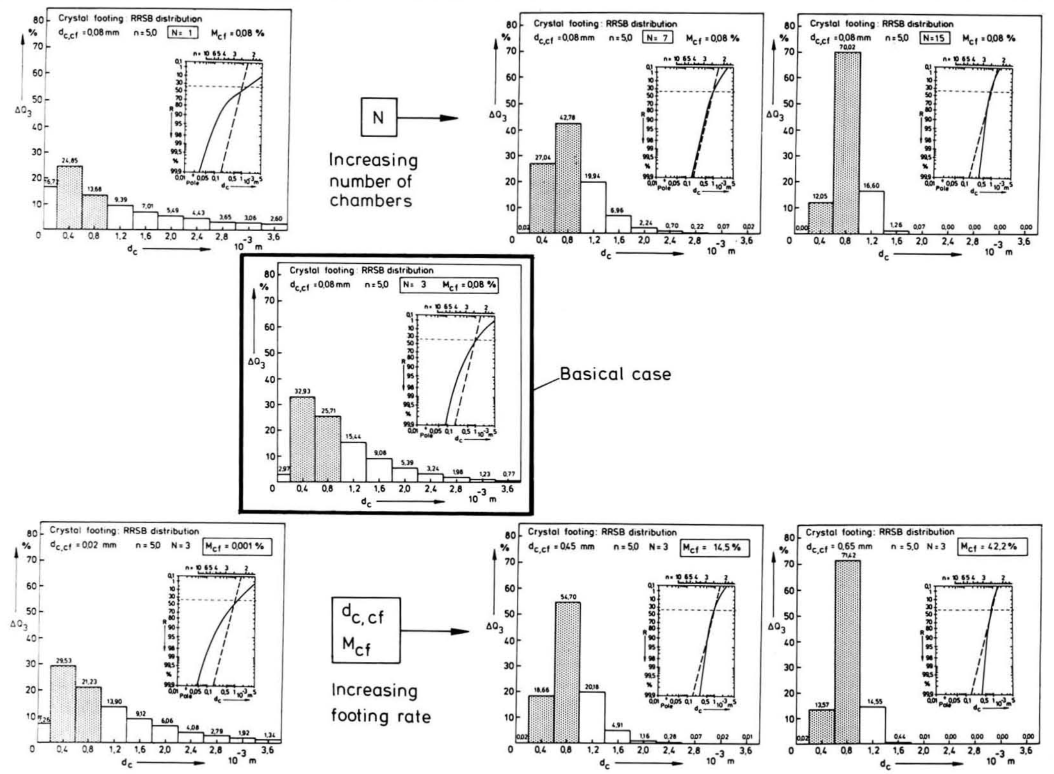


Fig. 8. Dependence of fraction sizes on the number of chambers for two crystal footing mass components

where: $m_{cf}/m_{p,c}=14.5\%$, $d'_{c,cf}=0.45$ mm, and $d_{p,c,50}=0.83$ mm. From this figure it is clear, too, that increasing the chamber number N influences the grain size distribution only to a small extent if there is enough footing mass.

Figure 10 illustrates how well the mathematical model developed at the Braunschweig Institute comes close to the grain size distribution of the product crystals achieved in the evapo-crystallization tower in the sugar factory at Wabern.

A comparison of the investments, which for the continuous crystallization cascade rise with increasing number of chambers, and the savings which arise from the resulting reduction of false grain in the product which has to be screened and redissolved, makes optimization of the chamber number possible. Quality and quantity of the footing are of special importance in this connexion, though.

The advantages of the evapo-crystallization tower (ECT)-system by comparison with other well-known systems characterized by a horizontal cylindrical form may be summarized as follows:

(a) Technological

(i) mechanical stirring is possible because of the use of vertical cylindrical chambers (i.e. the empirically established vacuum pan concept is adopted) and forced heat transfer and material transport are available

(ii) low $\Delta\vartheta$ (for example operation with vapour 6 from the evaporation plant); small compression ratio ($\pi\geqslant2.5$ for white sugar) is required for vapour recompression[1]

(iii) relative close grain size distribution is obtained with only a few chambers in which the magma state is controlled exactly (this is not possible from an economic point of view when there are a lot of chambers) and a footing rate between 10 and 20% (Fig. 8)

(iv) circulation is maintained in the absence of steam heating e.g. when

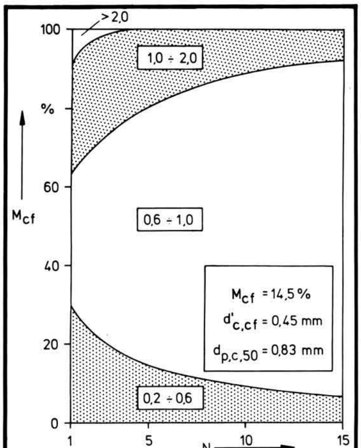


Fig. 9. Crystal size distributions (mass fraction histograms) of continuously produced crystals ($d_{c,50}$ = 0.83 mm) for various chambers N and various seed grain sizes $d_{c,cf}$ and various relative seed mass M_{cf} (= $m_{cf}/m_{p,c}$)

disturbances occur in the vapour supply or the vacuum system or during a weekend standstill in a refinery

(v) separate chambers allow cleaning at almost constant throughput by by-passing of individual chambers, individual steam pressure and vapour pressure, and elimination

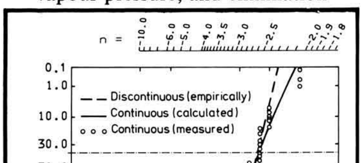


Fig. 10. Grain size distribution for the evapo-crystallization tower at Wabern

of remixing

(b) Constructional

(i) small local requirements

(ii) no expensive steel construction and only a simple concrete foundation

(iii) a building is unnecessary (this is especially convenient when increasing the processing capacity)

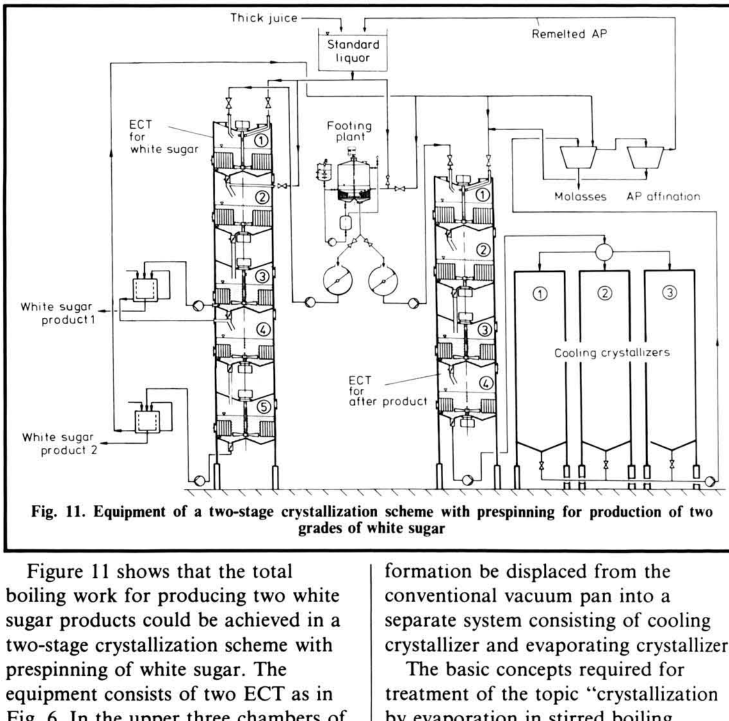


Fig. 11. Equipment of a two-stage crystallization scheme with prespinning for production of two grades of white sugar

Figure 11 shows that the total boiling work for producing two white sugar products could be achieved in a two-stage crystallization scheme with prespinning of white sugar. The equipment consists of two ECT as in Fig. 6. In the upper three chambers of the white sugar ECT, crystal footing (made in a vacuum pan and used both for white sugar and after-product), thick juice and after-product remelt are used for making white sugar of superior quality. Part of the first white sugar magma is used as seeding magma for the lower ECT-chambers. With this crystal footing, a part of the thick juice and the run-off from the first stage a white sugar of lower quality is made and, with the second run-off, the after-product magma. The after-product is affined and remelted; then it is used for white sugar boiling.

Summary

In an introduction the inadequacies of conventional crystallization by evaporation are discussed. These find expression in disturbances of the stability of heat- and material-transfer. To avoid formation of conglomerates it is suggested that the stage of crystal formation be displaced from the conventional vacuum pan into a separate system consisting of cooling crystallizer and evaporating crystallizer.

The basic concepts required for treatment of the topic "crystallization by evaporation in stirred boiling apparatus" for processing, heat transfer and stirring are dealt with. Conventional stirrer equipment is described; the calculations for stirrer power demands are given. Furthermore the mathematical and experimental balancing for the determination of the apparent heat transfer coefficient k* are treated in detail. Several empirically obtained results for white sugar and after-product crystallization by evaporation are discussed. The advantage of continuous processing for improved

heat transfer is indicated. A short consideration of stirrer economy in boiling apparatus is provided.

The plant for continuous low-grade crystallization developed jointly by the Braunschweig Institute and Lage sugar factory is described. The unit consists of five vacuum pans arranged in a series. Grain size distribution of the crystal sugar product was unsatisfactory when slurry was used as seed. Consequently, footing is now fed into the continuous unit instead of slurry so as to obtain better uniformity. Stirrers located above the calandria are used with the aim of improving heat transfer and controlling magma consistency with the aid of the temperature gradient.

The new evapo-crystallization tower (ECT) developed at the Braunschweig Institute and built by BMA is described. This system enables the optimum design and construction of calandrias and stirrers for all cells in the cascade. As the individual cells can be by-passed and cleaned separately, high availability of the proposed plant is always ensured. Some considerations on the crystal size distributions obtained with the use of the footing technique are discussed.

Calculation of the composition of technical sugar solutions

By J. Dobrzycki and A. Dobrzycki

Introduction

The determination of molasses exhaustibility developed by Wagnerowski and coworkers (also called the "Polish test") has found application in many countries. For the interpretation of its results and for the control of *C*-massecuite crystallization some time-consuming calculations are necessary. This "algebra" of the composition of sugar solutions is based on a few simple equations, from which many formulae can be deduced. It seems useful to list the relations between the analytical indices characterizing the composition of technical sugar solutions.

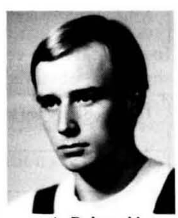
From the general equation:

$$S + NS + W = 100$$

Nomenclature

- S — Sugar, %
- NS — Non-sugar, %
- W — Water, %
- TS — Total solids, %
- H — Sugar concentration = S/W
- A — Soluble non-sugar concentration = NS/W
- Q — Purity quotient = 100 S/TS
- r — Solubility of sucrose in water = $H_{saturation}$

J. Dobrzycki



A. Dobrzycki

and from the definitions: TS = S + NS, H = S/W, A = NS/W and Q = 100 S/TS, values of TS, S, Q, H and A can be calculated when any two of them are given. The required algebraic formulae, compiled in Figure 1, are valid for any solution or mixture of sugar crystals and syrup[1].

1 Dobrzycki: "Chemical analysis in the sugar industry" (WNT, Warsaw) 1978.

Given:	Calculation of				
	TS	S	Q	H	A
TS, S	–	–	$\frac{100\,S}{TS}$	$\frac{S}{100 - TS}$	$\frac{TS - S}{100 - TS}$
TS, Q	–	$0.01\,TS \times Q$	–	$\frac{0.01\,TS \times Q}{100 - TS}$	$\frac{TS}{100} \times \frac{100 - Q}{100 - TS}$
TS, H	–	$H(100 - TS)$	$100\,H\,\frac{100 - TS}{TS}$	–	$\frac{TS}{100 - TS} - H$
TS, A	–	$TS(1 + A) - 100\,A$	$100\left(A + 1 - \frac{100\,A}{TS}\right)$	$\frac{TS}{100 - TS} - A$	–
S, Q	$\frac{100\,S}{Q}$	–	–	$\frac{S}{100} \times \frac{Q}{Q - S}$	$\frac{S}{100} \times \frac{100 - Q}{Q - S}$
S, H	$100 - \frac{S}{H}$	–	$\frac{100\,S \times H}{100\,H - S}$	–	$100\frac{H}{S} - H - 1$
S, A	$\frac{100\,A + S}{A + 1}$	–	$100\,S\,\frac{A + 1}{100\,A + S}$	$S\,\frac{A + 1}{100 - S}$	–
Q, H	$H\,\frac{100}{0.01\,Q + H}$	$H\,\frac{Q}{0.01\,Q + H}$	–	–	$H\,\frac{100 - Q}{Q}$
Q, A	$A\,\frac{100}{A + 1 - 0.01\,Q}$	$A\,\frac{Q}{A + 1 - 0.01\,Q}$	–	$A\,\frac{Q}{100 - Q}$	–
H, A	$100\,\frac{A + H}{A + H + 1}$	$100\,\frac{H}{A + H + 1}$	$100\,\frac{H}{A + H}$	–	–

Fig. 1. Relations between main analytical values characterising technical sugar solutions[1]

In the case of syrups saturated at temperature t, with non-sugar concentration $A \geqslant 1.5$, Wagnerowski *et al.* found the relationship:

$$H = r(m\,A + b)$$

where the coefficients m and b are independent of temperature, $H = S/W$ is the sugar:water ratio and r the solubility of sucrose in pure solution at temperature t (to be found in the table of Vavrinecz[2]).

The determination of m and b by means of the Polish test permits calculation of the composition of saturated solutions in the temperature range 30 to 80°C with only one analytical value given.

Example:

If t = 50°C, m = 0.18 and b = 0.79, calculate the purity Q if TS = 85% and $r_{50} = 2.5863$ (from Vavrinecz's table).

$$H = r(m\,A + b) \qquad (1)$$

$$H = \frac{S}{W} = \frac{0.01\,Q \times TS}{100 - TS} \qquad (2)$$

$$A = \frac{NS}{W} = \frac{TS - S}{W} = \frac{TS - 0.01\,Q \times TS}{100 - TS} \qquad (3)$$

Thus,

$$\frac{0.01\,Q \times TS}{100 - TS} = rm\,\frac{TS - 0.01\,Q \times TS}{100 - TS} + rb$$

or

$$Q = 100\,\frac{\left(\frac{100}{TS} - 1\right) b + m}{\frac{1}{r} + m}$$

$$Q = 100\,\frac{\left(\frac{100}{85} - 1\right) 0.79 + 0.18}{\frac{1}{2.5863} + 0.18} = 56.4\%$$

Table I. Solubility of sucrose in a sample of molasses (from the Polish test m = 0.19 and b = 0.82)

A =	*1.5*	*1.6*	*1.7*	*1.8*	*1.9*	*2.0*	*2.5*	*3.0*
	Solubility of sucrose S/W							
t = 45°C	2.72	2.77	2.81	2.86	2.91	2.95	3.19	3.42
46	2.75	2.79	2.84	2.89	2.94	2.98	3.22	3.45
47	2.77	2.82	2.87	2.92	2.96	3.01	3.25	3.49
48	2.80	2.85	2.90	2.95	2.99	3.04	3.28	3.52
49	2.83	2.88	2.93	2.98	3.02	3.07	3.32	3.56
50	2.86	2.91	2.96	3.00	3.05	3.10	3.35	3.60
70	3.59	3.65	3.71	3.77	3.83	3.90	4.20	4.51

Similar equations are listed in Figure 2. The calculations can be programmed on a calculator or a personal (micro-) computer. In the range of $40 \leqslant t \leqslant 75$°C the following approximate functions can be used:

$$t = 148.4 - 254.5\,\frac{1}{r} \qquad \text{(error less than 0.2°C)}$$

$$r = \frac{254.5}{148.4 - t} \qquad \text{(relative error less than 0.2\%)}$$

In each case the condition $A \geqslant 1.5$ should be observed.

Examples:

(1) Calculate the solubility H at given and A (m = 0.19, b = 0.82).

Solubility in impure saturated solution:

$$H = r(m\,A + b) \text{ and } r = \frac{254.5}{148.4 - t}$$

$$\therefore H = \frac{254.5\,(0.19\,A + 0.82)}{148.4 - t}$$

From this equation values of H are calculated and recorded for different values of A and t in Table I.

(2) Calculate the saturation temperature of a molasses at given TS and Q (m = 0.25, b = 0.764). From Figure 2:

$$TS = \frac{100\,b}{\left(\frac{1}{r} + m\right)\frac{Q}{100} + b - m} \qquad (4)$$

$$t = 148.4 - 254.5\frac{1}{r}$$

and from (4)

$$\frac{1}{r} = \frac{100\frac{b}{TS} - b + m}{0.01\,Q} - m$$

The results are shown in Table II.

Table II. Saturation temperature of a molasses as a function of total solids TS and purity quotient Q (from the Polish test m = 0.25 and b = 0.764)

TS =	*84*	*85*	*86*	*87*	*88*	*89*	
	Saturation temperature, °C						
Q = 60%	44.3	48.8	53.2	57.6	61.8	66.0	etc.
61	47.0	51.5	55.8	60.1	64.3	etc.	
62	49.7	54.1	58.4	62.5	etc.		
63	52.3	56.6	60.8	etc.			
64	54.7	59.0	etc.				
65	57.2	etc.					

Limiting $A \geqslant 1.5$ or $Q \leqslant 250 - \frac{15{,}000}{TS}$

(3) Calculate a full table (analogous to the table of Grut) presenting the

Given	Calculation of TS	S	Q	H	A
TS	–	$\frac{100\,b - TS(b - m)}{\frac{1}{r} + m}$	$100\,\frac{\left(\frac{100}{TS} - 1\right) b + m}{\frac{1}{r} + m}$	$\frac{\frac{TS}{100 - TS}m + b}{\frac{1}{r} + m}$	$\frac{\frac{100}{100 - TS} - rb - 1}{rm + 1}$
S	$\frac{100\,b - \left(\frac{1}{r} + m\right) S}{b - m}$	–	$\frac{100(b - m)}{\frac{100\,b}{S} - m - \frac{1}{r}}$	$\frac{b - m}{\frac{1}{r} - 100\frac{m}{S} + m}$	$\frac{100\,b - \left(\frac{1}{r} + b\right) S}{\left(\frac{1}{r} + m\right) S - 100\,m}$
Q	$\frac{100\,b}{\left(\frac{1}{r} + m\right)\frac{Q}{100} + b - m}$	$\frac{100\,b}{\frac{1}{r} + m + 100\frac{b - m}{Q}}$	–	$\frac{b}{\frac{1}{r} - m\left(\frac{100}{Q} - 1\right)}$	$\frac{rb}{\frac{100}{100 - Q} - rm - 1}$
H	$100 - \frac{100\,m}{\left(\frac{1}{r} + m\right) H - b + m}$	$\frac{100\,m}{\frac{1}{r} + m - \frac{b - m}{H}}$	$\frac{100\,m}{\frac{1}{r} - \frac{b}{H} + m}$	–	$\frac{\frac{H}{r} - b}{m}$
A	$100 - \frac{100}{(rm + 1)A + rb + 1}$	$100\,\frac{mA + b}{\frac{1}{r}(A + 1) + mA + b}$	$100 - \frac{100}{\left(\frac{b}{A} + m\right) r + 1}$	$r(mA + b)$	–

Fig. 2. Formulae for calculation of the composition of saturated syrups with a non-sugars:water ratio $A \geqslant 1.5$; m and b are the coefficients from the Wagnerowski equation and r is the solubility of sucrose in pure solution

2 "Sugar analysis — ICUMSA methods" Ed. Schneider (ICUMSA, Peterborough) 1979.

solubility H in saturated solution as a function of purity Q and temperature t in the range $55 \leqslant Q \leqslant 70\%$ and $35 \leqslant t \leqslant 80°C$, when $m = 0.25$ and $b = 0.764$ (condition: $A \geqslant 1.5$). The result of a computer calculation is shown in Table III.

molasses

$$A = \frac{88.3 \times 0.395}{100 - 88.3} = 2.98$$

(b) Sugar:water ratio of the molasses

$$H = \frac{0.01 \times 60.5 \times 88.3}{100 - 88.3} = 4.566$$

Table III

		Temperature, °C									
		35	*40*	*45*	*50*	*55*	*60*	*65*	*70*	*75*	*80*
	70	—	—	—	—	—	—	—	3.81	4.20	4.66
	69	—	—	—	—	—	—	3.56	3.91	4.33	4.81
	68	—	—	—	—	—	3.34	3.65	4.02	4.46	4.98
	67	—	—	—	—	3.14	3.42	3.75	4.14	4.61	5.17
P	66	—	—	—	2.96	3.21	3.51	3.86	4.27	4.77	5.37
u	65	—	—	2.81	3.03	3.29	3.60	3.97	4.42	4.95	5.60
r	64	—	2.67	2.87	3.11	3.38	3.71	4.10	4.58	5.15	5.86
i	63	2.56	2.73	2.94	3.19	3.48	3.83	4.24	4.75	5.38	6.15
t	62	2.61	2.80	3.01	3.27	3.58	3.95	4.40	4.95	5.63	6.49
y,	61	2.67	2.87	3.09	3.37	3.70	4.09	4.57	5.17	5.92	6.87
	60	2.74	2.94	3.18	3.47	3.82	4.25	4.77	5.42	6.25	7.32
%	59	2.81	3.02	3.28	3.59	3.96	4.42	4.99	5.71	6.63	7.85
	58	2.89	3.11	3.39	3.72	4.12	4.62	5.24	6.04	7.08	8.49
	57	2.97	3.21	3.50	3.86	4.29	4.84	5.53	6.42	7.62	9.27
	56	3.06	3.32	3.63	4.02	4.49	5.09	5.86	6.88	8.26	10.24
	55	3.17	3.44	3.78	4.20	4.72	5.38	6.25	7.42	9.06	11.49

(4) Calculate and draw a diagram of TS in saturated solution as a function of Q for temperatures 35, 40, 45 . . . 60°C (omit points if $A < 1.5$); $m = 0.25$, $b = 0.764$. The diagram plotted with a computer is shown in Figure 3.

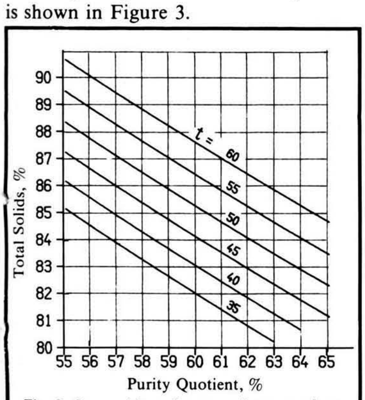


Fig. 3. Composition of saturated syrups where m = 0.25 and b = 0.764 (diagram plotted by computer)

(5) Calculate the supersaturation Ss of the molasses if $TS = 88.3\%$, $Q = 60.5\%$, $t = 53°C$ ($r = 2.6696$), $m = 0.25$ and $b = 0.764$.

(a) Non-sugar:water ratio of the molasses

(c) At this same $A = 2.98$ in a saturated syrup at 53°C the solubility is

$$H_{sat} = r(m\,A + b) = 2.6696(0.25 \times 2.98 + 0.764) = 4.028$$

Thus the supersaturation coefficient is

$$Ss = 4.566 \div 4.028 = 1.13$$

It should be noted that, in such calculations, the definition of supersaturation adopted officially by ICUMSA in 1962 must be used[2].

Summary

From fundamental equations: $S + NS + W = 100$ and $H = r(m\,A + b)$ (the Wagnerowski rule) relations between the contents of components in sugar solutions have been deduced. Application of the formulae is illustrated by examples connected with the control of crystallization. The equations can be applied to the calculations by means of a computer.

Calcul de la composition des solutions sucrières

En partant des équations: $S + NS + W = 100$ (sucre, non-sucre et eau) et de $H = r(m\ A + b)$ (équation de Wagnerowski) les formules exprimant les principales quantités analytiques ont été deduites. Leur utilité pratique est demontrée à l'aide des exemples, aussi avec l'usage d'un ordinateur.

Berechnungen der Zusammensetzung von technischen Zuckerlösungen

Von den Gleichungen: $S + NS + W = 100$ (Zucker-, Nichtzucker- und Wassergehalt) und $H = r(m\,A + b)$ (die Gleichung von Wagnerowski) werden Formeln abgeleitet, welche die wichtigsten analytischen Grössen verbinden. Die Anwendbarkeit der Formeln zur Kristallisationskontrolle — auch mit Hilfe von Computer — wird anhand der Beispiele erläutert.

Cálculo de la composición de soluciones técnicas de azúcar

De ecuaciones fundamentales — $S + NS + W = 100$, y $H = r(m\,A + b)$ (la ecuación de Wagnerowski) — se ha deducido relaciones entre los contenidos de componentes en soluciones de azúcar. Aplicación de las fórmulas se ilustre con el ayudo de ejemplos relatado al control de cristalización. Las ecuaciones pueden aplicarse a las calculaciones por medio de un computador.

International Sweetener Colloquium, 1986

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

New distillery for Ecuador[1]

A contract has been signed under which Codistil of Brazil is to supply a 30,000 litres/day distillery to Azucarera Tropical Americana S.A. of Ecuador. Current alcohol production in Ecuador is only 3 million litres/year against industrial demand of 15 million; it is planned first to eliminate imports and then to use further alcohol production to use as a fuel additive. The program will require expansion of Ecuador 's cane area, improvement of sugar factory operation and adoption of appropriate technology, particularly from Brazil.

1 *GEPLACEA Bull.*, 1985, **2**, (7-Sugar Inf.), 6.

Brevities

Poland sugar rationing ended[1]

After nine years, the Polish government has lifted sugar rationing from December last. In line with its policy of reducing subsidies, it is raising the retail price by 20% to 90 zloty per kilogram. According to I.S.O. figures, sugar consumption in Poland reached 2.01 million tonnes, raw value, in 1984 while production in the 1985/86 campaign was expected to reach at least the same level of 1.88 million tonnes produced in 1984/85.

Distillery project for Jamaica[2]

Tropicana International is intending to build a 4 million gallons/year fermentation plant in Jamaica in addition to that it plans for the Dominican Republic[3]. The hydrous ethanol from both plants will be upgraded to anhydrous alcohol at Tropicana's installation in Kingston, Jamaica, and then exported to the US where it will enter duty-free under the Caribbean Basin Initiative. Tropicana is seeking to acquire sufficient area to provide cane, including 13,000 acres in Innswood. This cane will be delivered to the Bernard Lodge mill for crushing for production of both sugar and alcohol. Tropicana will most likely have to invest some $1 million in Bernard Lodge and also work to reduce current production costs by proper farming practices and mechanization. The fermentation/distillation unit at Bernard Lodge will cost about $5 million and design, engineering and construction will require about 18 months.

Brazilian alcohol technology for Kenya[4]

Brazil is to sell Kenya technology for the manufacture of fuel alcohol from cane in a transfer financed 70% by the UN Organization for Industrial Development and 30% by the Brazilian government. A number of micro-distilleries will be installed in various locations, starting at the end of 1986, with one producing 250 litres of alcohol a day.

New sugar factories for India[5]

The sugar industry in Punjab is expected to expand from the existing 11 sugar factories by a further twelve during the Seventh Plan period (1986/90). It is proposed that two factories be built in each of the Amritsar, Ludhiana, Bhatinda and Ferozepur districts and one each in the districts of Hoshiarpur, Kapurthala, Sangrur and Faridkot. Five of the new factories are currently under construction and sites identified for the remainder, although these have yet to be approved.

Guatemala alcohol program[6]

Guatemala has begun a small but progressive ethanol blending program. In March 1985 a new law was passed to authorize production and blending of fuel alcohol, and several of the larger sugar factories are already in production or are planning to build plants.

Flavonoid compounds in sugar cane colorants

We regret that in Figure 1 of the article on this subject, published in our November 1985 issue, the caption to the illustration was omitted. The illustration is reproduced herewith, together with the caption. We further apologise to the first author, Miss Nancy H. Paton, for the misspelling of her name under the title of the paper.

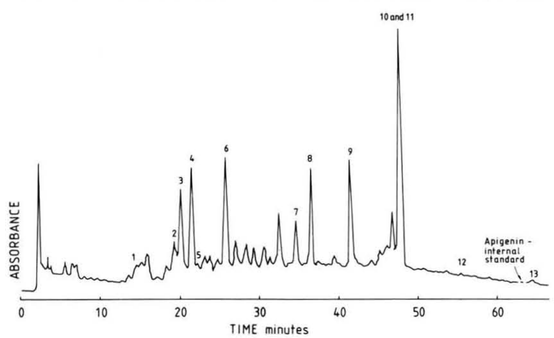


Fig. 1. HPLC profile of flavonoid colorants in mill syrup. Conditions as given in the text. Peak constituents:

1. Vicenin 2
2. Orientin
3. Isoschaftoside
4. Schaftoside
5. Iso-orientin
6. Swertiajaponin
7. Swertisin
8. Iso-orientin 7,3'-dimethyl ether
9. Tricin 7-glucoside sulphate
10. Tricin 7-O-glucoside
11. Tricin 7-O-rhamnosyl-O-galacturonide
12. 6-Methoxyluteolin
13. Tricin

Italy beet area expansion[7]

Italian beet plantings in 1986 are expected to rise to around 245,000 hectares, up from 225,000 ha in 1985 and 215,000 ha in 1984. This could raise sugar production to about 1.3 million tonnes against the 1.25 million tonnes expected from the 1985/86 campaign and 1.27 million tonnes produced in 1984/85 when favourable weather boosted the outturn. Italian sugar consumption is expected to be around 1.6 million tonnes so that sugar imports are likely to be reduced slightly in 1986/87.

Paraguay alcohol program[8]

The national program for alcohol manufacture intends expansion of capacity to 75 million litres/year of which 24% will be anhydrous and 76% hydrous alcohol. Three private distilleries are under construction, while the sugar cane industries association has requested a credit of $1.5 million to finance its program for increasing cane acreage and yields so that the cost of alcohol will be competitive with that of oil.

Ethiopia sugar expansion[9]

Ethiopia produced 191,000 tonnes of white sugar in 1984/85 and expects a slight increase in production in 1985/86. The government plans to invest $130 million on increasing the cane area and sugar output, with the aim of raising exports. Sugar is now one among Ethiopia's chief export commodities. The new Ten-Year Plan envisages construction of a new sugar factory at Fincha in Wellega province, to produce 120,000 tonnes of sugar annually; the necessary documents for tenders for the project have already been prepared.

New sugar factory for Pakistan

The 40th cane sugar factory in Pakistan, which started a trial run in January 1986, is the 2000 t.c.d. plant built for Sind Abadgar Sugar Mills Ltd., by the state-owned Heavy Mechanical Complex Ltd. of Taxila. The factory is owned by 300 abadgars (growers) of Sind Province and cost 340 million rupees. Teething troubles over, the plant is expected to crush about 500,000 tonnes of cane in a season and to make about 40,000 tonnes of white sugar, using a modern defecation-remelt-Talofloc process. The factory adds a modest 4% to national sugar production and 2.5% to cane crushing capacity. It is located at Deenpur, about 150 km from Karachi, and is located in the best cane growing area in the country.

1 *GEPLACEA Bull.*, 1985, **2**, (7-Sugar Inf.), 3 - 4.
2 *Alcohol Week*, 1985, **6**, (44), 1, 6.
3 *I.S.J.*, 1985, **87**, 215.
4 *Latin American Commodities Rpt.*, November 22, 1985.
5 *Sugar Scene*, 1985, **3**, (11), 5.
6 *Amerop-Westway Newsletter*, 1985, (145), 11.
7 F.O.Licht, *Int. Sugar Rpt.*, 1985, **117**, 691.
8 *Amerop-Westway Newsletter*, 1985, (145), 12.
9 F.O.Licht, *Int. Sugar Rpt.*, 1985, **117**, 713.

New books

Sugar year book 1984

337 pp; 10 × 14 cm. (International Sugar Organization, 28 Haymarket, London SW1Y 4SP, England.) 1985. Price: £10.00.

The 38th issue of this publication (the sixth under the International Sugar Agreement of 1977) contains statistics for centrifugal sugar production, consumption, imports, exports, stocks, etc. in 124 countries as well as the EEC and French Territories. The data have been supplied by member countries of the ISA under the rules of the Agreement, or have been provided by governments of non-member countries, extracted from statistical publications or estimated. Unless otherwwise stated, the tables are on a calendar year basis and are expressed, as far as possible, in terms of 96°S raw sugar. In addition to the national statistics, there are a number of world tables. As in the case of previous editions, the printing is clear and reference is relatively easy, although there is a slight tendency for the pages to refuse to stay flat.

Zuckerwirtschaft (Sugar economy)

K. Dankowski, R. Barth and G. Bruhns. 259 pp; 10 × 14.5 cm (Verlag Dr. Albert Bartens, P.O. Box 380250, D-1000 Berlin 38, Germany.) 1985. Price: DM 32.00.

This is the 32nd annual edition of this pocket book on the sugar economy and follows a similar pattern to previous editions, all the data having been revised and the latest available figures included, i.e. 1983/84 and 1984 substantive figures and estimates for 1984/85. There are 60 tables and three maps; the statistics grouped in sections covering the world, Europe and West Germany occupy 87 pages, while the second part of the book provides notes on the International Sugar Agreements up to that of 1977, and on world sugar prices and terminal markets. These are in German as is a lengthy section on the EEC basic sugar regulations, although a summary of these is provided in English. This part of the book concludes with an account of trade conditions and rules under German law relating to pulp and molasses. The third part of the book is a useful collection of addresses including those of international bodies concerned with sugar, EEC addresses, West European addresses and those specifically of West Germany. The printing is small but clear, and the binding in a strong plastic material. While it will clearly be of most value to readers of German, the use of English for subheadings in the tables and elsewhere, and an English index, make it of value to others of our readers seeking a conveniently small collection of data and information, particularly on the European sugar economy.

F. O. Licht International Sugar Economic Yearbook and Directory 1985.

Ed. H. Ahlfeld. 550 pp; 20.4 × 29.1 cm. (F. O. Licht GmbH, P.O. Box 1220, D-2418 Ratzeburg, Germany.) 1984. Price: DM 139.00.

The familiar size and shape of the Licht Yearbook, this time in a maroon cloth binding, is welcome, presenting as it does a comprehensive and up-to-date survey of the sugar economies of sugar producing and trading countries around the world. It follows a standard patttern with sections that are continued in each edition, but brought up to date, that on international organizations including this time the text of the 1984 International Sugar Agreement. The directory of sugar factories and organizations, etc., by individual countries, is now reproduced in smaller type but still clearly, and the opportunity has been taken of correcting errors in the previous edition. A large number of sugar factories were introduced in the section on Iran a year or so ago and we experienced difficulty in trying to correspond with them; many have now been deleted. The changed ownership of the former Great Western Sugar Company factories in the US is noted as is the demise of Revere Sugar Corporation. Two economic articles are included, one on the EEC sugar regime and the other on fuel alcohol in the USA, while Dr. Krause of the Berlin Technical University continues his series of reviews of new equipment and processes in the sugar industry. Papers are included on the beet crop and its environment, and sugar cane mechanization. A series of reports are presented by advertisers on their products, and a classified Buyer's Guide is included. Four clear maps show the locations of sugar facilities in France, Mexico, Italy and Great Britain, while a separate booklet, held by a pocket in the rear of the Directory, presents Licht's world sugar statistics for 1984/85. The yearbook is a remarkably comprehensive source of valuable information not available in any other single publication.

Copersucar international symposium on sugar and alcohol

554 pp; 15.8 × 32 cm. (Copersucar, Caixa Postal 5691, 01014 São Paulo, SP, Brazil.) 1985.

The international symposium was held in Brazil in June 1985 and, in only half a year, Copersucar have produced a well-printed and bound hardback volume of the Proceedings in English (we suppose that the companion volume in Portuguese is also available, possibly earlier). This fact alone demonstrates the dynamism of Copersucar, whose enterprise in organizing the symposium in the first place caught the imagination and earned the admiration of the world's cane sugar industry. We have already recorded the events[1] and themes discussed during the symposium and now will only congratulate Copersucar on their fine achievement.

Tropical Science

This journal, with its origin under another title in 1985, was until recently published as a house journal of the Tropical Products Institute in Britain. It has now completed a year under the management of Blackwells Scientific Publications and is a fully international publication in its sources of papers as well as its readership. It provides information on making better use of plant and animal resources in hotter climates and is published four times a year. The subscription is US $50.00 or £25.00. A descriptive leaflet, specimen copy and a guide for authors are available from Blackwell Scientific Publications Ltd., P.O. Box 88, Oxford, England.

1 *I.S.J.*, 1985, **87**, 40, 84 - 86, 180.

Trade notices

Flegstil distillation process

Codistil Construtora de Destilarias Dedini S.A., Caixa Postal 1249, CEP 13400, Piracicaba, São Paulo, Brazil.

In conventional distillation, the highest losses occur in the stillage and in the exhaust phlegm, with smaller losses in degassing of the condensers. In the Flegstil process, the loss in the exhaust phleghm is eliminated by returning the exhausted phlegm to the stripping column. In addition, steam consumption is reduced by some 40% when hydrous alcohol is being produced, or by about 25% with anhydrous alcohol, since heating is confined to the distillation column. Optimization of the condensers has resulted in a reduction in cooling water consumption by about 30-40% by comparison with conventional units, while other design improvements have decreased the risk of corrosion. The use of newly designed contact devices minimizes scale deposition, so that occasional simple washing of the columns with 10% soda solution is the only requirement to keep the plant clean. The amount of welding used in the new plant is about 60% less than with conventional distillation plant.

PUBLICATIONS RECEIVED

KSB pumps

Klein, Schanzlin & Becker AG, Process & Environmental Pump Division, P.O. Box 1360, D-8570 Pegnitz, Germany.

KSB pumps featured in brochures available from the above address include the CPK-Bloc chemical pumps, the KWP-Block non-clogging impeller pumps for e.g. effluent handling, the KRTU submersible motor pumps for effluent disposal as well as industrial and chemical applications, and the CPK.D/KWP.D pumps with hydrodynamic shaft seal; a KWP.D unit is shown in a sugar factory evaporation station, where it continuously pumps thick juice without the slightest trace of leakage.

Sack fillers

Darenth Ltd., Unit 14, Belvedere Industrial Estate, off Crabtree Manorway, Belvedere, Kent.

The 2550 range of electronic and pneumatic open-mouth sack fillers manufactured by Darenth and recently introduced are the subject of a colour leaflet, 502.0585, available from the company. The weigh-filling machines are available for filling capacities in the range 10-52 kg for sack circumferences of 800-1150 mm.

Dedini

Dedini S.A., P.O. Box 373, Piracicaba, São Paulo, Brazil 13400.

The activities are outlined in a 4-colour brochure of the Dedini Group of companies which includes M.Dedini S.A. Metalúrgica (manufacturers of equipment for sugar factories and distilleries), Codistil Construtora de Destilarias Dedini S.A. (manufacturers and designers of distilleries and equipment for alcohol manufacture), Dedini S.A. Siderúrgica (steel manufacturers), Dedini S.A. Máquinas e Sistemas (manufacturers of cane equipment), Açúcar e Álcool São Luiz S.A. (which operates a sugar factory and distillery to produce up to 1.1 million bags of sugar and 32 million litres of anhydrous alcohol per year), Destilaria São João Ltda. (an autonomous distillery producing nearly 30 million litres of alcohol per crop), Dedini Refractórios Ltda. (manufacturers of refractories) and Dedini Equipamentos Elétricos Ltda. (manufacturers of transformers).

Alcohol manufacture by Biostil process

Codistil Construtora de Destilarias Dedini S.A., P.O. Box 373, Piracicaba, São Paulo, Brazil 13400.

Details are given of the well-known Biostil continuous process of alcohol manufacture, in which fermentation and distillation are carried out simultaneously as an integrated system, which was developed by Alfa Laval and is now available from Codistil as licence holders. Since the system ferments concentrated substrates, the stillage (vinasse) is of high concentration and requires little or no additional energy for its subsequent processing or disposal.

Moisture meters

Shaw Moisture Meters, Rawson Road, Westgate, Bradford, West Yorks. BD1 3SQ, England.

Catalogue 185 from Shaw Moisture Meters illustrates and describes their equipment for measuring small amounts of water vapour in "dry" air or gas; the high-capacitance sensor acts as a variable capacitor and consists of a metal core, coated with a hygroscopic dielectric and finally covered with a porous gold film. Equilibrium with the surrounding water vapour pressure is rapidly achieved because of the small thickness of the dielectric layer, and the corresponding capacitance value is computed by the hygrometer for display on the indicator as dewpoint temperature. A range of sensors is available, each having a specific measuring range.

Uniglide pumps

Weir Pumps Ltd., Sales & Marketing Division, Cathcart, Glasgow G44 4EX, Scotland.

Their rotating assembly of the Uniglide range of single-stage, double-entry, split-casing pumps is easily removed without disturbing the pump alignment or pipework; the pumps have a minimum of parts for ease of maintenance, are provided with a double volute on larger frames so as to reduce hydraulic radial thrust, and are available in horizontal or vertical arrangements, with over 100 frame sizes assuring all duties at near optimum efficiency. Publication WPL94/4 gives details. Uniglide pumps find wide application in e.g. water supply and effluent treatment.

Electrodialysis

Portals Water Treatment Ltd., 632-652 London Road, Isleworth, Middx., England.

A comprehensive information package available from Portals Water Treatment describes the range of electrodialysis equipment available from the company for applications such as molasses treatment for sugar recovery. The 5/5 electrodialysis stack can be arranged in a number of ways to suit particular applications, while the 3/3 pilot plant has been specially developed to allow process engineers a low-cost method of testing the application of the system to a particular requirement.

Conveyors

Universal Conveyor Co. Ltd., Humberstone Lane, Leicester LE4 7JT, England.

A new 58-page catalogue gives details of more than 300 types and sizes of conveyor idlers, drums, belt covers and roller track available from the company at the above address.

Small-diameter hydrocyclones

Larox Oy., P.O. Box 29, SF-53101 Lappeenranta 10, Finland.

Larox Oy., better known for its automatic pressure and chamber filters, has recently begun to market hydrocyclones of 25, 50, 80 and 100 mm diameter, and can now offer hydrocyclones of up to 1 m diameter, with separation limits ranging from 10 to 250 μm. The units are suitable for a wide variety of processes. A 6-page brochure gives details of the hydrocyclones.

Cooling towers

Carter Industrial Products Ltd., Bedford Road, Birmingham B11 1AY, England.

A leaflet available from Carter Cooling Towers (a division of Carter Industrial Products Ltd.) describes the recently introduced range of CL-type towers, which are centrifugal fan towers of low height and low noise level specifically designed for refrigeration and air conditioning.

Brevities

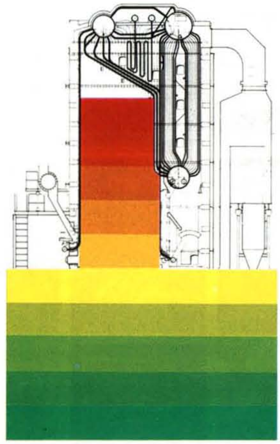
US HFS plant closure[1]

A. E. Staley Co., the second largest producer of HFS and ethanol in the US, has announced it is to close its plamt in Morrisville, Pennsylvania, for an indefinite period owing to "seasonal slack in demand". The facility has an estimated HFS capacity of more than 225,000 short tons/year, dry weight, but does not have a capability of swinging to alcohol manufacture.

1 *Dyergram*, January 3, 1986.

Bagatex 20

CONVERTS YOUR EXCESS BAGASSE INTO ENERGY



Producers of Cane Sugar and Cane Alcohol :
After every crop, you are left with a large amount of **surplus bagasse,** generally unused, economically untransportable, quick-rotting and therefore pollutive, a fire hazard.

The **BAGATEX 20** process turns your bagasse surplus containing 50 % water into bagasse with only 20 % water, called B.20.

- without any costly thermal dehydration which would use a large part of the fuel obtained,
- with no other losses apart from the controlled natural evaporation of approximately 30 % of the weight of the bagasse.

With **BAGATEX 20,** a simple process the investment in which can be amortized on a very short term and which preserves your surpluses and those you will get through additional economy savings.

- you will be able to produce and sell KW all year round for irrigation and the local electrical grid (civil or industrial).
- you will also be able to produce alcohol, refined sugar, cattlefeed between crops.

1 ton of bagasse surplus with 50 % water turned into B.20 = 1,5 oils barrels.
Can be preserved more than 1 year in a storing area.

Bagatex 20

The process which turns **biomass** into solid fuel, renewable every year.

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