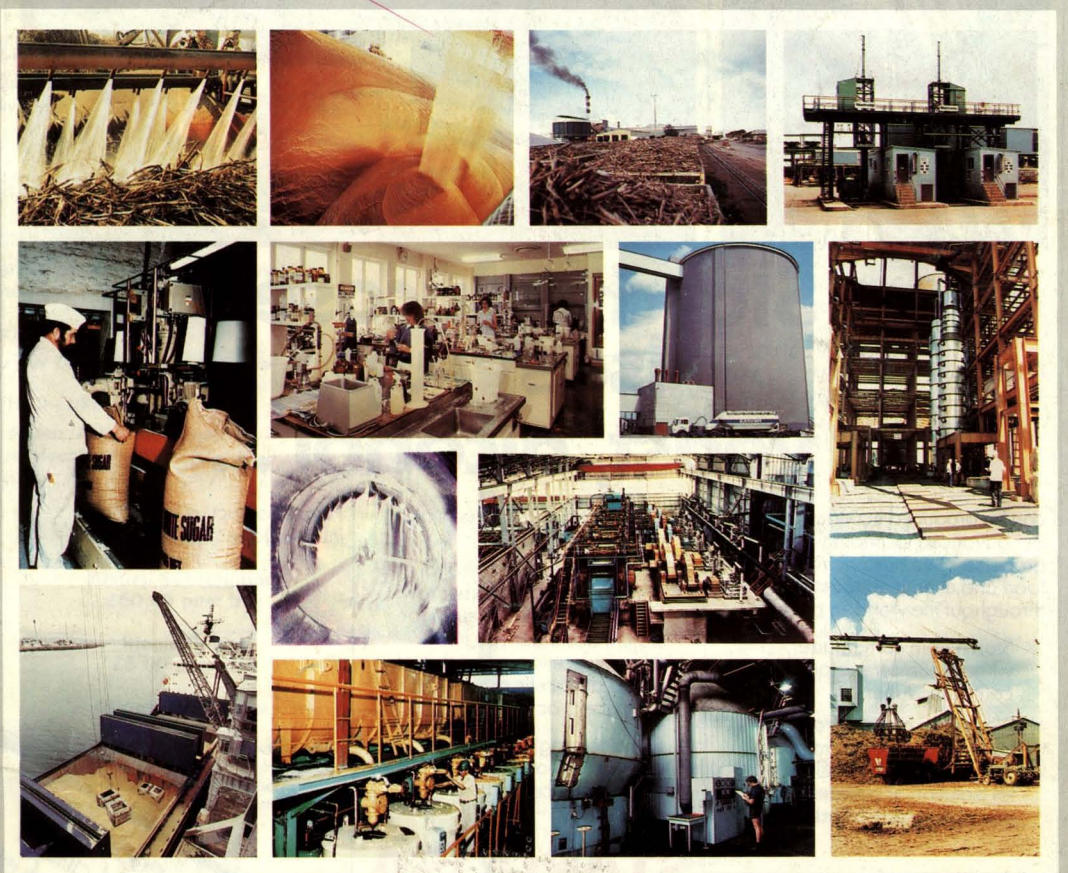
INTERNATIONAL SUGAR JOURNAL



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News and views

EEC sugar exports decline

The EEC is one of the "Big Four" sugar exporters whose participation is essential for the success of any new International Sugar Agreement. The Community has built up its sales over the past ten years by a combination of subsidized production and meeting a demand for white sugar which is not met by the raw sugar exporters. Exports reached a peak in 1982 but have declined each year since then. F. O. Licht has recorded[1] details of exports for the Community's sugar years (July/June) from 1981/82 to 1984/85, noting that there has been a decline of 38% from 5,903,211 to 3,678,785 tonnes, raw value.

Whether this export loss can be recouped will depend on a variety of factors; with the fall in oil prices, producers in the developing world are unlikely to offer any recovery in sugar sales. Oil importers will, of course benefit from the lower prices and may have more money to spend on sugar imports, while lower oil prices will also help to revive the world economy which could also result in higher import requirements. However, efforts are being made to expand production in India, Pakistan and Bangladesh, all important white sugar importers in 1985/86, and this should reduce the white sugar market. Consequently, prospects for a significant increase in demand for EEC white sugar seem to be remote.

British Sugar plc ownership

One of the bids for ownership of the UK beet sugar industry is that of the Ferruzzi group of Italy. Recently, this group has published a brochure entitled "Our commitment to the UK" which provides an account of Agricola Finanziaria which is the publicly quoted Italian holding company for the agricultural and industrial divisions of the group in Europe. It has formed a new subsidiary for its UK activities – Agricola UK – which holds 14.7% of the shares in S. & W. Berisford (another Ferruzzi subsidiary holds a further 9%). The brochure describes Agricola's relations with farmers in Italy and the activities of its Sugar Beet Research Centre, as well as its intention to continue British Sugar's policy of high capital expenditure.

It supports the development of alcohol manufacture from agricultural raw materials and the use of sugar as a chemical raw material. Agricola's record as an employer and its relationship with the management of the Béghin-Say and Eridania sugar companies is discussed and a brief note provided on the circumstances of any reorganization of the UK beet sugar industry which might arise from concentration of production. The brochure considers that the combined resources of the Ferruzzi sugar industries would make cost reduction easier and that there would be no lessening of competition if the Ferruzzi bid were to succeed.

World sugar prices

The London Daily Price for raw sugar declined through the whole of June and from $171.50 on June 2 slid to $143 near the end of the month before recovering to $154.50 on July 1. Similarly, the white sugar price declined from $196 per tonne to $173.50 on June 26 before recovering to $183.50 on July 1. The decline was not so much due to any bearish news as to a lack of bullish factors, and the optimism which had prevailed two or three months earlier appears to have dissipated. The enthusiasm caused by purchases by a number of Asian countries and the USSR in the Spring had caught the attention of speculators who moved into the sugar market out of other commodities; afterwards, owing to the lack of follow-up trading, the speculators moved out of sugar.

The *Czarnikow Sugar Review* notes[2]: "In sugar it is important for producers to recognise how fragile the recovery in prices is. While the underlying fundamentals point to an increasing reduction in the world surplus of sugar, we are still some way from actual shortages being likely to occur. At the same time, the major developed countries which are in a position to push prices upwards by competing for scarce supplies are, because of domestic self-sufficiency policies, largely isolated from the market.

"The isolation of the USA, the EEC and Japan from the effects of moderately higher world market prices has an influence on the perception of the speculative elements in futures markets almost all of which are based in those countries. Over the past decade, the opportunities for speculators from the development of the financial markets has increased greatly, making soft commodities much less interesting. No matter what prospects there are for reducing surpluses in the medium term, it will need a tighter prompt sugar supply before we can expect prices to reach levels that are attractive to producers."

US budget and sugar imports

The US Supreme Court has recently judged a key provision of the budget balancing law to be unconstitutional; it decided that part of the Gramm-Rudman-Hollings Act requiring automatic across-the-board cuts to bring the budget into balance was a violation of the constitutional separation of the powers of the Congress and those of the President. As a result of the Act, farm price supports were cut earlier this year and the Act was a major factor in causing an extension of the sugar import quota period from 10 to 13 months, effectively reducing the quotas for individual suppliers to the US. No changes have been announced, however, as a result of the Court's ruling and the Act's original sponsors are reported to intend introducing a new version which will not fail the test of constitutionality.

EEC sugar levy proposals

The European Commission suggested to member states that the levy on B-quota sugar should be set at its maximum level of 37.5% of the intervention price for the 1986/87 marketing campaign[3] and the Council of Ministers has adopted the proposal[4]. There is also a general levy of 2% of the intervention price on A- and B-sugar quotas. Application of the

1 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 229 - 238.
2 1986, (1750), 81.
3 *Public Ledger's Commodity Week*, June 28, 1986.
4 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 366.

maximum levy is needed to cover obligations arising from export of the EEC sugar surplus. The Commission expects total sugar production in the European regions of the Community to reach 12.46 million tonnes in 1986/87. The A-quota has been set at 10.3 million tonnes and the B-quota at 1.92 million tonnes. With French overseas departments production and carryover stocks, the total quantity of sugar available will be 13.8 million tonnes, while consumption is expected to reach 10.81 million tonnes and exports 1.41 million tonnes.

Another dry fructose product[5]

Staley Continental Inc. has announced the development of a new sweetener, Crystar, which is 99.5% fructose and 0.5% moisture. The product in its purest crystalline form is 80 times as sweet as sugar and 15 times as sweet when used as a 10% solution. Sweetness also varies with temperature and pH. It will be produced at a new plant in Lafayette, Indiana, and will cost 35 - 40 cents/lb. It is expected to be marketed as a partial replacement for sugar in powdered beverage mixes, cereal coatings, dry mixed desserts and confectionery. Its use will be limited by its hygroscopicity, however, and the need for special handling facilities such as closed low-humidity rooms for packaging, shipment and use may cost more than the savings it can afford to potential users.

Argentina sugar production, 1985/86[6]

Sugar production for the 1985 season, which ended in May totalled 1,160,000 tonnes, raw value, the lowest since 1971, according to the US Dept. of Agriculture. Output was slightly below the government-established production quota. Beet sugar production was negligible owing to crop difficulties encountered by the one new sugar factory. For the 1986/87 season, the government has reduced the sugar production quota from the previous year to an equivalent of 1,120,000 tonnes, raw value.

The government is increasingly involved in the sweetener industry; it establishes the minimum cane price which factories must pay the farmers and sets production quotas, export quotas and monthly consumption quotas. It has also established a price for cane used for direct alcohol manufacure and has limited corn sweetener production. Moreover, it is setting ceilings on sugar prices. The result of this intervention is high domestic sugar prices in relation to world prices, and sugar continues to be protected from cheaper imports by complex import regulations.

Sugar factories are in a tight financial situation, particularly the smaller ones in Tucumán; reduced exports, stagnant consumption, low world sugar prices and high interest rates have put them in a critical situation.

US sugar company for sale[7]

Amstar Corporation, the largest US sugar company, has been put up for sale by its owners, Kohlberg Kravis Roberts & Co. It was bought for almost $440 million in early 1984 but the current asking price has not been disclosed. The American Sugar Division has four sugar refineries, in Boston, Brooklyn, Baltimore and Chalmette, with a total melt capacity of 2.24 million short tons of raw sugar per annum, while the Spreckels Sugar Division operates three beet sugar factories in California with a combined slice of 12,000 tons per day.

Barbados sugar situation[8]

Sugar production in Barbados accounts for around 50% of the cultivated area. In common with other Caribbean producers, Barbados has encountered significant difficulties in recent years owing to weak world prices for sugar, competition from beet sugar, and a reduction in export quotas to the historically important US market. Production costs now exceed the guaranteed prices negotiated with the EEC, while the US, whose guaranteed price approaches production costs, has steadily reduced Barbados' quota, from 19,600 tonnes in 1982 to 12,500 tonnes last year. These problems have forced many small-scale farmers out of the industry, have led to mounting debts and have resulted in a reduction in the area under cane from some 24,000 ha in the mid-1960's to around 14,000 ha in 1985. Similarly, production has slumped from a peak of 195,000 tonnes to the current level of around 100,000 tonnes a year.

Although some improvements have been undertaken, notably the introduction of mechanical harvesting, the outlook for the sugar industry remains bleak. Structural problems relating to the predominance of large and inefficient estates need to be eliminated and the world free market price remains depressed. Despite these problems, sugar remains important with export revenues exceeding $26 million in 1984, nearly 7% of total merchandise exports, and production of alternative export crops on a large scale is not feasible in many arid parts of the island. As a result, the government has undertaken significant support programs for the sugar industry; direct grants totalled B$62 million in 1982/85 and in 1986 a further B$10 million is earmarked to support the sector.

The problems with sugar have stimulated agricultural diversification; the island is now virtually self-sufficient in tomatoes, carrots and onions as well as in poultry, meat and eggs. Similarly, Sea Island cotton has been re-introduced and around 320 ha are now under cultivation. Peanut production has risen and marginal cane land has been put under pasture for the expanding beef industry.

International symposium on food industry automatic control

The Food Working Party of the European Federation of Chemical Engineering is organizing an international symposium as above, to be held in Paris during November 12 - 13, 1986. The program will be in three parts, viz. Sensors, Automatic control of processes, and Optimization and control. In the first of these there are no papers specifically concerned with sugar but some are concerned with alcohol fermentation and distillation, while in the second and third parts papers are to be presented concerning multiple effect evaporation in the sugar industry and automation of pan boiling. Further information is obtainable from Salon du G.I.A., B.P. 551, 42 rue du Louvre, 75027 Paris Cedex 01, France.

5 *Dyergram*, 1986, (14 - 86), 3.
6 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 370, 372.
7 *Dyergram*, 1986, (15 - 86), 1.
8 *ABECOR Country Rpt.*, June 1986.

Product news

Motomco Ltd introduces new disposable glue trap

Motomco Ltd introduces Trapper LTD, an economical glue trap specially designed to capture and monitor mice, roaches and other insects.

Constructed of sturdy cardboard and coated with a powerful new adhesive, Trapper LTD is prebaited to enhance the attraction of pests to the glue trap. A special release paper protects the board until it is used.

This disposable glue trap contains no poison, making it ideal for use around farms and commercial establishments where poison is hazardous.

Trapper LTD is easy to use. Simply peel back the release paper and place it flat against walls or in corners. In dusty areas, Trapper LTD may be folded into a covered trap.

Further details: Motomco Ltd.,
29 N. Fort Harrison Ave.,
Clearwater, FL 33515,
U.S.A.

Clean solution to animal feed handling

A conveying application at British Sugar's Newark, Notts. plant has been improved by a revolutionary new product from materials handling specialists, Doncaster based Simon-Macawber Limited.

Simon-Macawber were called in to retrofit the "Cleanveyor" to one existing belt conveyor and two transfer points, used to convey shredded molassed beet pulp from production areas to machines where the product is pelletized. A further conveyor and two transfer points handling the pelletized product have also been retrofitted. A total of 70 metres was converted to a cleanveyor system with the result that spillage has been eliminated.

Cleanveyor is a new design of totally enclosed mechanical conveying sytem which can be offered as a new installation or as a retrofit to existing conveyors. Its special features include a top cover with Neoprene seal which forms a completely waterproof, dust and wind tight arrangement, and a low friction polyethylene forming seal which carries the edges of the conveyor belt totally preventing spillage. A particular advantage of the concept is that the belt troughing angle can be adjusted to suit the individual specification of the material being carried.

The cleanveyor design also allows it to carry without spillage on substantial incline angles. At Newark, for example, the Cleanveyors are carrying the animal feed at a total gradient of 20°. In tests, the Cleanveyor has been shown to convey without problems up to 29° without the need for flighted belts.

Further details: Simon-Macawber Ltd.,
Shaw Lane Ind. Est.,
Doncaster, U.K.

IBC filling system with high-accuracy weighing

Webster Griffin have introduced a new IBC filling station for all single and multi-trip intermediate bulk containers, pallet boxes and rigid bins. The standard equipment will fill containers from 250 kg to $1^1/_2$ t, handling a wide range of flowing materials.

Low headroom requirement is one of the system's features which also include a filling cycle time of about 35 sec/tonne, reliable PLC control and high-accuracy electronic weighing. During the filling operation the IBC sits on a conveyor mounted on a heavy-duty, single loadcell weigh platform. Weighing control is by the company's own system 2000 programmable self-optimizing unit which is driven by software specially written for the purpose, and standard specifiction includes main and fine feed set-point adjustment, auto tare, and automatic 'in-flight' to compensate for slight variations in product flow characteristics and bulk density.

Further details: Webster Griffin Ltd,
Webster House,
Dudley Road,
Tunbridge Wells,
Kent TN1 1LE, U.K.

Knife gate valve offers in-line maintenance

The Von Roll range of cast iron knife gate valves in all sizes up to 400 mm is now available off-the-shelf from NAF Valves Ltd in Stevenage, England.

This one-piece bodied valve has a unique rubber sealing system which gives a flush bore when the valve is open. The robust moulded seal has a large bearing surface to resist damage from solid particles. It is held in shape by two support plates and this combination seal unit can be removed or inserted without taking the valve out of the line and without the need for skilled fitting procedures. In this way downtime is reduced to a minimum.

Von Roll knife gate valves can handle many forms of slurries and flowing solids, a stainless steel version being available where corrosion or product contamination need to be avoided. As well as the standard orifice shape, a Vee orifice design can be supplied for control applications and power operation by pneumatic, hydraulic or electric actuators are available as alternatives to the usual handwheel or lever-operated versions.

Further details: NAF Valves Ltd.,
61 London Road,
Woolmer Green,
Knebworth,
Herts., UK.

Stork - Werkspoor Sugar and ALKO

Under a licence agreement with ALKO of Finland, Stork-Werkspoor Sugar designs and supplies modern alcohol and yeast plants, including commissioning and training of staff. A new brochure in English, French and Spanish is available, outlining the scope of their activities in all types of alcohol production.

Further details: Stork-Werkspoor Sugar BV,
P.O. Box 147,
7550 AC Hengelo (OV),
Holland.

Free guide to dust control

Every process and conveying system engineer will welcome the practical guidance on dust control given in a new 30-page guide book from an

engineer with 25 years' experience with the world's leading manufacturer of industrial dust control equipment.

David Chambers is business development manager of DCE Group of Leicester, UK, which has worldwide sales and manufacturing operations. For sixty years DCE has specialized in designing dust control systems for a wide range of applications in industries as different as pharmacetuticals, cement, asbestos and bulk handling throughout the world.

The book is exceptionally well illustrated with clear, concise coverage of the subject together with useful formulae, data, etc. It is available free from DCE Group Ltd., Humberstone Lane, Thurmaston, Leicester, U.K.

Continuous viscosity measurement in mixing processes

Viscosity analysis in mixing vessels is often difficult to carry out by conventional means. This is especially so when the viscosity of mixing liquids has to be checked under difficult conditions. In these circumstances the mixer itself can be used for viscosity measurement.

Based upon many years of experience in speed torque measurement, EKATO have succeeded in developing a compact and reasonably priced electronic instrument called "VISCOMON" which, with the help of these parameters, calculates continuously the viscosity during mixing. All measured units such as speed, torque and viscosity are available in analogue form for further technical analysis. The measurement procedure is carried out in intrinsic safety so that the mixer can be installed even in an explosion risk area. Mixers already in use can be adapted to the system.

Further details: Ekato Rühr- und Mischtechnik GmbH, Postfach 1110/1120, D- 7860 Schopfheim, Germany.

New generation of DMN-Westinghouse diverter valves

De Machinefabriek Noordwykerhout B.V. has developed and placed on the market a completely new range of diverter valves for pneumatic conveying systems for powdered and granular products. The diverter valves form a logical complement to the broad and versatile assortment of rotary airlocks and blowing seals which the company already markets for the bulk handling industry.

The new DMN-Westinghouse diverter valves are supplied in three types, namely with pneumatic operation (CAD-P), with electric operation (CAD-E) and with manual operation (CAD-M). Each type is available in two sizes, one with a flange connexion of 65 mm and the other with a flange connexion of 100 mm.

The new DMN-Westinghouse diverter valves have a housing and flap (the actual valve) made of anodized aluminium. Owing to the low weight of this material the pipework is subject to less severe loading and installation is simplified . The flap is fitted with a seal edge of high-grade polyurethane rubber, and rotates in PTFE plain bearings. The shaft extensions are sealed with a combination of profiled plastic washers. Air leakage over the flap has been reduced to the absolute minimum, by careful design and precision manufacture.

The maximum pressure difference relative to the atmosphere is 2 bar and the maximum pressure difference over the flap is 0.5 bar.

The design chosen allows the flap to be switched while the installation is operating, but the product flow switched off. The absence of dead spots prevents any of the product from remaining in the valve housing.

Further details: De Machinefabriek Noordwykerhout B.V., P.O. Box 6, 2210 AA Noordwykerhout, Holland.

Abay alcohol plant for Cameroons

Abay's technology has been selected for a distillation unit which will produce 50 hectolitres of potable alcohol per day. The distillery, which will be run by the Cameroon company FERMENCAM, will be located at M'Bandjock near Yaoundé and will use cane molasses from the local sugar factory. Abay also participated in the construction of the sugar factory itself a few years ago.

This contract covers the designs and studies, the supply of equipment and spare parts, supervision of the construction, technical assistance with start-up and operations, and training the local personnel.

The commissioning of the distillery is scheduled for September 1987.

Initial steps in thermal degradation of sucrose

By G. N. Richards
(Wood Chemistry Laboratory, University of Montana, Missoula, Montana 59812, U.S.A.)

Introduction

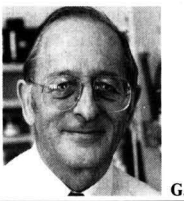
There has been considerable progress recently in the understanding of mechanisms of thermal degradation of sucrose and the understanding of the mechanisms has made possible the utilization of such reactions for novel syntheses, especially of fructofuranosides[1]. Such studies, however, have mostly been carried out in solution in an inert solvent such as methyl sulphoxide in order to facilitate accurate kinetics. This type of system obviously differs from the many situations in manufacture and use of sucrose where thermal degradation may be important. Such situations include cane fires before harvesting, heating of molasses, high temperature for long storage periods in raw sugars, and many food process operations, such as cooking. In most of these situations the sucrose is accompanied by other chemicals (impurities) and frequently there is little water present in the system. The sucrose is also frequently non-crystalline, although the temperatures of concern are well below its melting point (ca. 190°C). We have attempted to design experimental procedures to study the initial stages of sucrose degradation in such systems.

Experimental

Materials and methods

Sucrose and all other substrates were Analytical Grade reagents used as received. All water was purified by distillation followed by ion exchange treatment.

Unreacted sucrose and the reaction products were analysed by HPLC on a Waters Bonded Amine Column eluted with 20% water in acetonitrile at 4 ml/min using a differential refractive index detector. Typical retention times were: fructose, 2.8 min, glucose, 3.3 min, sucrose, 4.7 min, other disaccharides, 6.0 min, and trisaccharides, 7.8 min. The amounts present were derived from peak areas averaged from triplicate injections, and related to values from same-day injections of standard solutions, using sucrose as standard for other disaccharides and raffinose for trisaccharides. In reactions where inorganic salts were added,



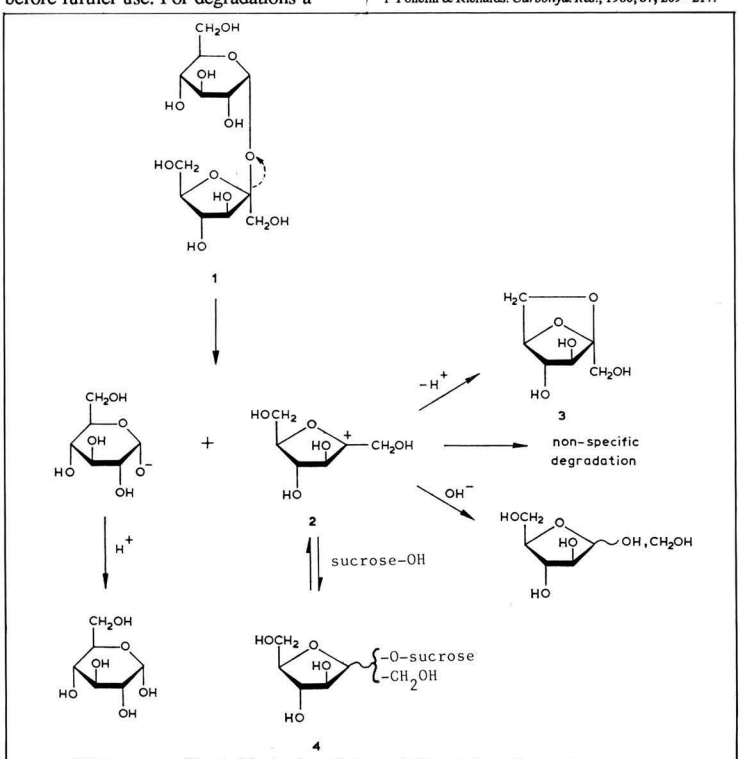
G. N. Richards

the salt chromatographed close to the fructose peak and in such experiments only the sucrose was measured.

Degradation experiments

A stock solution was prepared from sucrose (6 g) and water (4 ml), held at 60°C for 30 min after apparent completion of dissolution, then stored at 4°C. The resultant colourless clear syrup normally remained free from crystals for several days, but if any crystallization was observed, the heating process was repeated before further use. For degradations a weighed amount of stock solution (ca. 0.2 ml) was transferred into a small test tube. If necessary, an aqueous solution of impurity of known concentration was added and mixed. The tube was then immersed in an oil bath held by a thermostat at the required temperature (±0.1°C) for the required time. In preliminary experiments involving the weighing of tubes it was established that all water was lost in less than 15 min at 150 °C to leave a clear sucrose melt. The drying time could be shortened by flushing the tube with dry nitrogen, but this procedure appeared to increase the possibility of nucleation and hence crystallization of the sucrose melt. When any crystallization was observed before or after the degradation, that tube was discarded. After removal from the oil bath, water (2 ml) was added, solution

1 Poncini & Richards: *Carbohyd. Res.*, 1980, **87**, 209 - 217.



Scheme 1 **Fig. 1. Mechanism of thermal degradation of sucrose**

completed by ultrasonication and the product analysed by HPLC.

Results and discussion

The predominant mechanisms of thermal degradation of sucrose (1) are shown in Figure 1. It has been unequivocally shown that in methyl sulphoxide solution α-D-glucopyranose is an initial product which subsequently anomerizes[1]. The same initial reaction occurs in melts of sucrose at 190°C[2]. The first step in the degradation is very sensitive to catalysis by traces of acid and there is no doubt that this catalysis occurs by protonation of the glycosidic oxygen in (1)[3]. The fructose carbocation (2) is lost rapidly by several reaction channels. It may cyclize to form the anhydride (3), undergo non-specific degradation to a wide range of products such as hydroxymethylfurfural, add hydroxyl ion to produce fructose, or it may add to one of the hydroxyl oxygens of another sucrose molecule to produce a trisaccharide (the kestoses). To a lesser extent (2) may also add to one of the hydroxyl oxygens of any other product such as glucose or (3) to produce a disaccharide.

In the present work we were concerned with temperatures more frequently encountered in sucrose processing which are much lower than the melting point (ca. 190°C) of sucrose. It has previously been reported[4] that the heating of powdered sucrose at 170°C for 15 min produces kestoses, but we have been unable to repeat this result using powdered pure sucrose. In fact, in preliminary experiments it was observed that powdered pure sucrose crystals would survive for many hours at (say) 150°C without any detectable degradation beyond slight darkening and evidently this stability is associated with relative absence of molecular mobility in the crystalline lattice. In practice, however, sucrose will not always be crystalline when subjected to heat. The experimental procedure was therefore designed to produce amorphous sucrose (a melt) at temperatures well below its crystal melting point and under these conditions the sucrose degrades very much more rapidly than the crystalline material. The loss of sucrose in the melts is shown in Figure 2. The rates are too rapid for meaningful analysis at the higher temperatures, but at temperatures of 150°C and lower the most dramatic conclusion from these curves is that there is an unequivocal lag phase in the degradation. There is some ambiguity in the exact duration of the lag because of the time taken to remove water from the solution at the onset of heating. The time required is less than 15 min at 150°C, however, and this time has been deducted

2 Richards & Shafizadeh: *Aust. J. Chem.*, 1978, **31**, 1825 - 1832.
3 Moody & Richards: *Carbohyd. Res.*, 1982, **108**, 13 - 22.
4 Bollman & Schmidt-Berg: *Z. Zuckerind. Boehm.*, 1965, **15**, 179 - 184, 259 - 265.

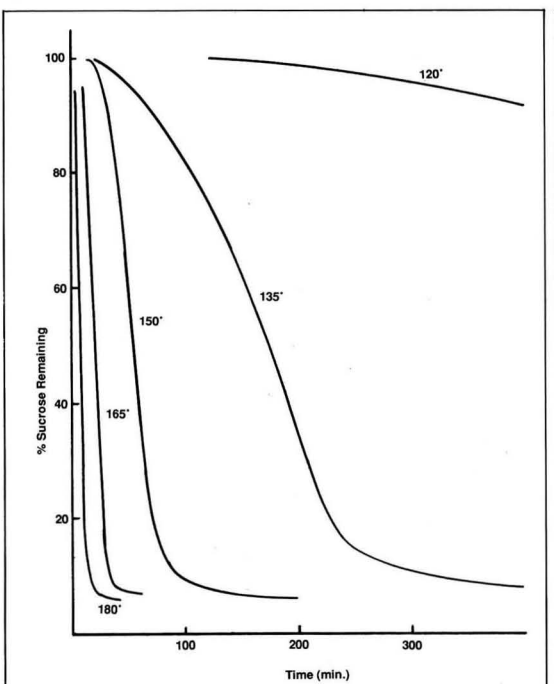


Fig. 2. Degradation of sucrose melts at various temperatures

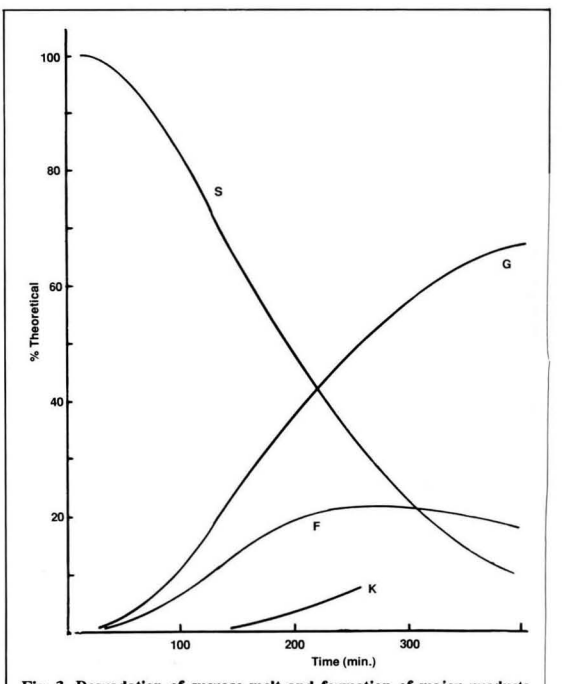


Fig. 3. Degradation of sucrose melt and formation of major products at 135°C: S = sucrose, G = glucose, F = fructose and K = kestoses

in plotting all results. There is no doubt therefore, about the reality of the lag phase, nor about the subsequent acceleration in the sucrose loss curve.

The products of the degradation of pure sucrose at 135°C are shown in Figure 3. Glucose was formed in relatively high yield, while fructose was always produced in lesser amount and was itself more subject to further thermal degradation than glucose, thus producing the maximum in the fructose curve. Trisaccharides (kestoses) were formed in smaller yield and traces of anhydrofructose (3) and of disaccharides other than sucrose were also observed, but are not plotted on Figure 3.

The effects of impurities on the rate of loss of sucrose were studied at 120°C and are shown in Figure 4. Of the impurities used, only sodium carbonate had the effect of reducing the rate of thermal decomposition of sucrose. The presence of 10% glucose in the sucrose melt shortened the lag phase and accelerated the degradation. With 5% glucose plus 5% fructose, both effects were increased and 10% fructose (not shown in Fig. 4) was even more potent in accelerating the degradation. Addition of a neutral salt (sodium chloride) to the sucrose melt was also remarkably effective, at less than 1% concentration, in reducing the lag phase and accelerating the decomposition.

In interpreting the above results it is necessary to address the questions of the basis of the lag phase in the degradation and also of the mechanism of the effects of the impurities. It is known that the first step in the degradation (Fig. 1) is very much faster in presence of a trace of acid which will protonate the glycosidic oxygen[3]. A possible explanation of the lag phase is that the initial degradation of pure sucrose is extremely slow, in fact too slow to be detected by the methods used in this study. However, traces of initial degradation products formed during this phase may themselves be subject to more rapid degradation reacions and some products of such secondary reactions may be acidic. Such products (e.g. acetic, formic, laevulinic acids) could be extremely small in amount, yet could result in protonation of sucrose and hence

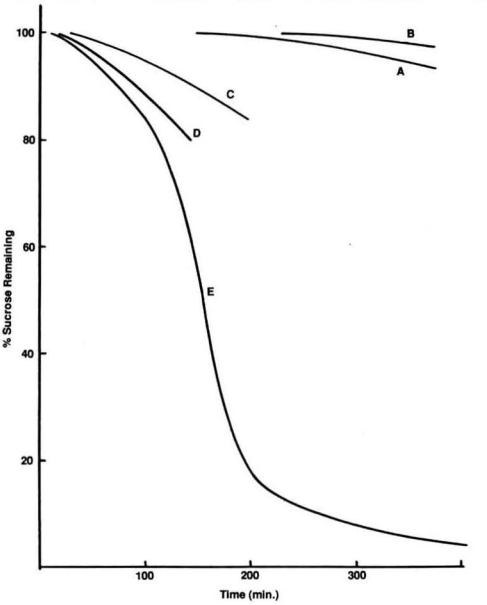


Fig. 4. Effect of impurities on the rate of degradation of sucrose melts at 120°C: A = pure sucrose, B = sodium carbonate (0.04 mole/mole sucrose) C = glucose (10%), D = glucose (5%) + fructose (5%) and E = sodium chloride (0.05 mole/mole sucrose)

in an increasing rate of degradation. As the degradation proceeds the carbocation (2) would be increasingly produced and would partly undergo non-specific degradation reactions to produce more acid catalysts. The same non-specific degradations would also include reactions which generate water which would provide the hydrogen and hydroxyl ions required for further reaction as shown in Fig. 1.

When reducing sugars are present in the sucrose melt they undergo thermal degradation much more rapidly than sucrose. The degradation of pure glucose and fructose melts at 150°C has been studied and results are shown in Tables I and II. The disaccharides formed from fructose are assumed to be dianhydrides of fructose. Some of the products of the degradation from both glucose and fructose are assumed to be acidic and hence to catalyse the sucrose degradation, thus decreasing the lag phase compared with pure sucrose. Because fructose degrades much more rapidly than glucose it is much more potent as an impurity in reducing the lag phase in the sucrose degradation. In confirmation of this, it was found that the 30-min fructose melt from Table II, when dissolved in water, showed pH 4.5.

Table I. Decomposition in a glucose melt at 150°C

Time, min	Glucose remaining, %
15	97
30	93
90	74

Table II. Decomposition in a fructose melt at 150°C

Time, min	Fructose remaining, %	Disaccharide(s), %
15	83	4
30	27	.8
45	13	9
90	10	10

The above hypotheses all require the initial slow formation of acidic degradation products which increasingly catalyse the sucrose degradation and result

in accelerating decomposition. The stabilization of sucrose by the presence of a small amount of sodium carbonate (Fig. 4) is therefore interpreted as due to neutralization of the traces of the secondary acidic products. The dramatic influence of very low levels of sodium chloride in degradation of sucrose is more difficult to explain. An acceleration and change of mechanism of thermal decomposition of a polysaccharide by small amounts of sodium chloride has recently been reported[5]. In this instance it was speculated that the sodium chloride might function by increasing the dielectric constant of the solid polysaccharide and hence favouring heterolytic mechanisms of reaction at the expense of competing homolytic mechanisms. All of the mechanisms involved in Fig. 1 are heterolytic and it is conceivable that the effects of a small amount of sodium chloride may operate through increase in the dielectric constant of the sucrose melt.

The demonstrated autocatalytic nature of sucrose decomposition and the catalysis by neutral salts may both help to explain the earlier observation of explosive decomposition of heated molasses[6]. In discussion of such effects, Foster[6] has also noted that the lag phase in the decomposition is shorter with impure molasses and has referred to the likely formation of acids from thermal degradation of sucrose.

Summary

Pure crystalline sucrose is stable for long periods at relatively high temperatures (e.g. several hours at 150°C). When molecular mobility is permitted, however, by creating a non-crystalline melt at such temperatures, the sucrose rapidly degrades to produce mainly glucose with smaller amounts of fructose and trisaccharides (kestoses). Experimental procedures have been devised to permit study of such systems and the effects have been studied of low levels of impurity in the sucrose melt. With pure sucrose (e.g. at 135°C) no loss is observed for about 30 min (the lag phase) and then sucrose is lost at an accelerating rate. The lag phase is reduced and subsequent rate of sucrose degradation increased by the presence of 10% glucose, both effects are more influenced by a similar content of fructose, and an even greater effect is caused by less than 1% of sodium chloride in the melt. On the other hand, however, the sucrose melt is stabilized by presence of less than 1% of sodium carbonate.

These effects are attributed to autocatalysis of sucrose degradation by traces of secondary acidic products arising by an initial very slow primary thermal decomposition. In the presence of reducing sugars, especially fructose, the initial degradation of the reducing sugar is very much faster than that of sucrose and the acids from this source catalyse the sucrose degradation. The sodium carbonate neutralizes the traces of acid necessary for the catalysis and the sodium chloride may facilitate the sucrose degradation by increasing the dielectric constant of the melt, thus favouring the degradation reactions.

Acknowledgements

Financial support was provided by the Sugar Research Institute, Mackay, and experimental assistance by G. B. Hawes and J. G. Kelly. This project was initiated and partly completed at the Department of Chemistry and Biochemistry of the James Cook University of North Queensland, Townsville, Australia.

5 Richards & Shafizadeh: *Carbohyd. Res.*, 1982, **106**, 83 - 91.

6 Foster: *Proc. 15th Congr. I.S.S.C.T.*, 1974, 1196 - 1205.

PROCESSING

Acrylic resin and styrene resin for decolorization - a full scale comparison*

By Nils G. H. Hindefelt & Kaj A. Lilja
(Sockerbolaget, Arlöv Division, Arlöv, Sweden)

Introduction

In recent decades, greater and greater use has been made of ion exchange resins for sugar decolorization in refinery processes, frequently as a substitute for bone char. Those resins which have here proved most suitable are strongly basic anion active resins in which the active groups are quaternary ammonium groups which are regenerated with an alkaline common salt solution.

Initially, the only resins available were styrene-based, but acrylic-based resins later also became available. The general opinion has hitherto been that acrylic resins are best suited for gross decolorization, since these resins are capable of taking up quite a large amount of colour and are easy to regenerate. Styrene resins have been considered most appropriate for polishing, since they are more precise in the decolorization process

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

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than are acrylic resins, but are generally felt to be more difficult to regenerate.

The experiment which was carried out in Arlöv is a direct parallel comparison on a factory scale of acrylic and styrene resins under the same operational conditions in a gross decolorization station for refinery juice.

Refining processes at the Arlöv refinery

At the S.I.T. meeting in 1984, a detailed presentation was made of the refurbishment of the refinery in Arlöv. Consequently, but a brief outline of our refining processes will be given here. They are illustrated in Figure 1. The nominal melting capacity is 600 tonnes/day. The raw sugar is affined and then spun in continuously operating centrifugals. The liquor from the melter is limed and carbonatated and the precipitate filtered using two presses.

Since there are no safety filters after the presses, it is of crucial importance that these operate with a minimum of chalk carry-over. After tests with different filter cloths, precoat agents and filtering processes, the turbidity of the filtrate from the presses is often very low (approximately 5 ICU, measured by filtration through 0.45 μm filter paper). However, chalk carry-over has taken place on odd occasions.

The filtrate is decolorized in one of our decolorization plants (Resin I) and is then evaporated in a triple-effect evaporator. The crystallization is effected in three white sugar strikes and three recovery strikes. The sugar from the three white sugar strikes is mixed after the centrifugals, dried and employed for the manufacture of our special products: cube sugar, pearl sugar, icing sugar, liquid sugar, etc., but can also be packed in sacks as granulated sugar.

The sugar from the recovery classes is dissolved, filtered and decolorized in our second decolorization plant (Resin II). The resultant is liquor employed for the manufacture of golden syrup or recirculated to the carbonatation stage.

The Resin I plant

This plant comprises three filters each holding 7 m³ of resin. The filters (see Figure 2) have a diameter of 2.4 m and a cylinder height of 2.6 m and are fitted with rounded heads. The construction material employed is rubber-lined soft iron. The juice is led in through Johnson tubes at the top of the filters whence the backwashing water is also removed.

The sweetening-off water and regenerant solution are taken in through a distributor in the form of perforated plastic tubes which are positioned just above the surface of the resin. During the filtration, the surface of the juice is maintained slightly above the level of the resin. The resin rests on a welded baseplate in which are disposed 150 Johnson nozzles.

The filters operate in parallel, with two filters in operation and the third stopped for regeneration or standing by.

The cycle comprises the following phases:

(1) decolorization: juice volume per cycle is approx. 100 bed volumes(B.V.) for beet raw sugar and approx. 50 B.V. for cane raw sugar,
(2) sweetening-off with approx. 25 m³ water,
(3) agitation with water and air,
(4) backwashing with 35 m³ water,
(5) regeneration with 10 m³ recovered

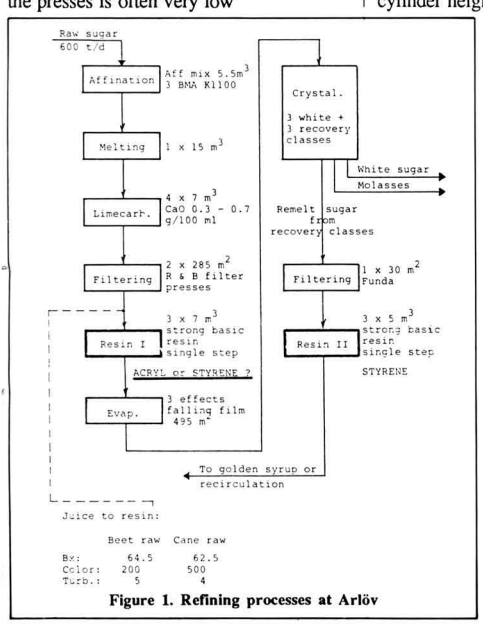


Figure 1. Refining processes at Arlöv

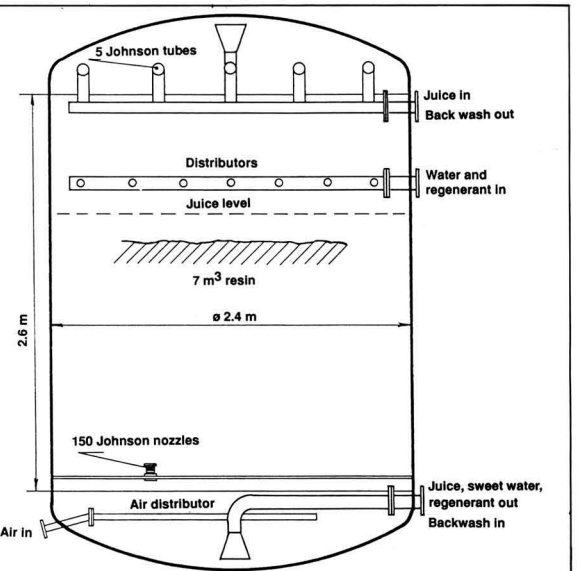


Figure 2. Filter columns in Resin I

brine solution,
(6) regeneration with 12 m³ fresh 10% NaCl + 0.5% NaOH,
(7) washing with approx. 40 m³ water, partially recovered, and
(8) sweetening-on with sweet water and juice.

After every tenth alkaline regeneration, an acidic regeneration is carried out with 2 B.V. of 2% HCl, which is immediately followed by a further alkaline regeneration.

Decolorization and alkaline regeneration are carried out at 80°C and the acidic regeneration at 70°C. The total juice flow rate is approx. 30 m³/hr i.e approx. 2.1 B.V./hr per filter. The regeneration, etc. of the filters is fully automated and controlled by a computer system.

During the summer break of 1981, the filters were filled with Rohm and Haas Amberlite IRA 958, which was in use until the begining of 1984. During this time, the decolorizing effect was attained which is apparent from Figure 3.

The average decolorizing rate declines surprisingly uniformly despite widely varying operational conditions, above all in the form of differing raw sugar qualities. The colour in the juice to the filters is indicated.

With a juice volume of approx. 100 B.V. for beet sugar and approx. 50 B.V. for cane raw sugar, the filters have been loaded with colour volume of approx. 15,000† per cycle, which is clearly quite a low level. Rohm and Haas are of the opinion that it is possible to employ double the amount or more. Naturally, a lower degree of decolorization would then be obtained.

The volume of colour which may suitably load the ion exchanger during one cycle is greatly dependent upon the degree of decolorization required. In its turn, the requisite degree of decolorization is dependent upon whether there is some form of further decolorization in the system or not. If a polishing stage is provided after the gross decolorization stage, or perhaps even a bone char filter, it will be possible to run a greater volume of colour per cycle in the gross decolorization stage and still attain an acceptable colour in the finished liquor. With single-stage decolorization, and a colour limit of 100 ICU, the volume of liquor per cycle must be kept at a low level in order to be able to satisfy the colour requirement.

The Resin II plant

The Resin II plant was made operational in 1969 as a supplement to our then operative bone char decolorization. The construction of the filters may be seen in Figure 4.

The filters contain one upper and one lower nozzle plate. The juice is pumped in from beneath (Bayer's Schwebebett), and the regeneration is effected in counterflow. The regeneration of the filters is semi-automatic.

In 1969, styrene resin was, generally speaking, the only resin available for the decolorization of sugar juices in particular when the resin was to be used in a polishing stage, the styrene resin was considered suitable. Bayer's Lewatit MP 500 AWS was selected for this station, and this resin type has been used almost exclusively in Resin II.

† The term colour volume or colour loading is here taken to mean tonnes DS × colour (ICU)/m³ of resin.

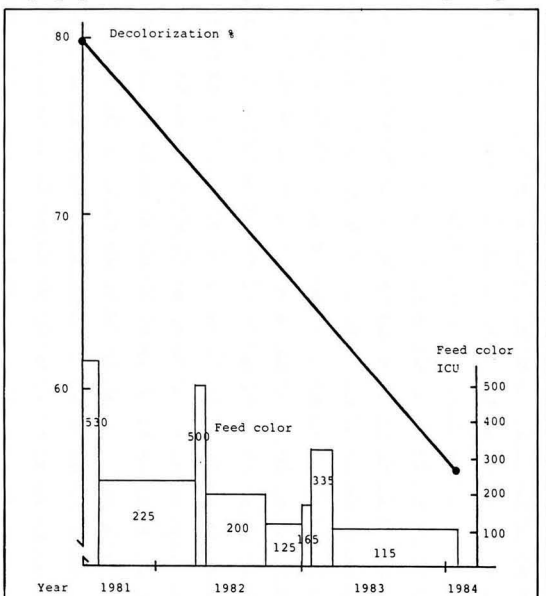


Figure 3. Decolorization with IRA 958 in Resin I

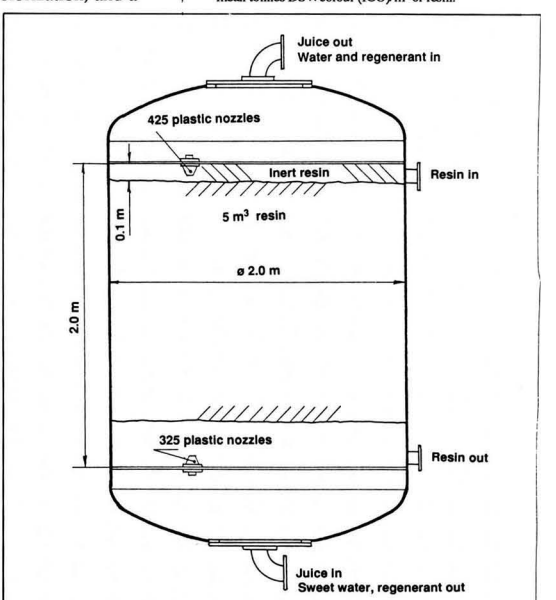


Figure 4. Filter columns in Resin II

ISJ Abstracts

Cane sugar manufacture

Investigation of the coefficient of friction in the top bearings of cane mills. II. Influence of the thickness of the Babbitt metal

C. Rodriguez M. and J. Diaz D. *ATAC*, 1984, (4), 13 - 15 (*Spanish*).

Increasing the thickness of Babbitt metal increases the coefficient of friction under conditions applying in the bearings of cane mills. Use of Babbitt metal for reconditioning of worn bronzes is not recommended as the thickness necessary is 15 - 20 mm and the reduction of the coefficient of friction is small and uneconomical by comparison with the use of BrSnPb 5-12 bronze.

Computerization of calculations for material balances of the boiling house for a 2-massecuite system

K. T. K. F. Kong Win Chang. *Rev. Agric. Sucr. Maurice*, 1985, **64,** 51 - 57.

The author presents an algorithm for calculation of the material balances of a 2-massecuite boiling system and explains how a computer program can be easily written to solve the 16 unknowns involved.

Cane cleaning using diffuser press water

J. P. Lamusse. *Sugar y Azúcar*, 1985, **80,** (7), 17 - 19.

A proposed scheme for cane washing on an inclined feed table with press water (of 2 - 3°Bx) from a diffuser bagasse dewatering mill is described. It assumes application of 2.3 m^3 of water per tonne of cane (as used on a 29° sloping table at Riche-en-Eau factory in Mauritius), and quantitative parameters and heat requirements are calculated for a crushing rate of 150 tch. The water is sprayed at 60 - 70°C, and the juice draining from the table is screened to remove trash followed by collection in a funnel-shaped hopper where sand is separated. Some of the water is recycled to the feeder table so as to provide the requisite volume of liquid at the spray nozzles. The temperature of the non-recirculated water is raised to 100°C in a direct-contact heater using low-pressure steam or vapour, after which it is limed and treated with flocculants, clarified and the overflow transferred to the diffuser; the underflow is filtered, possibly washed (depending on the pol of the filtrate and the cost of evaporation), and the filtrate fed to the diffuser at a point intermediate between the recycled press water entry and imbibition water feed. Losses and how they may be reduced are indicated.

Microprocessors in process control

W. Keenliside. *Sugar Bull.*, 1985, **64,** (1), 7.

The advantages of the microprocessor in sugar factory process control are discussed, particularly the elimination of rapid fluctuations by signal averaging and the ease with which control variables may be changed. The author briefly explains how a process control loop functions on the basis of mathematical programs provided by the microprocessor, and how the logical decisions made by the processor are of value in monitoring levels and flows and providing alarm signals when necessary. It is pointed out that where, as is normal, the control sequence for a process is held in a non-erasable memory, the program will be retained even in the event of power failures.

Screening of clarified juice

W. Keenliside and S. Clarke. *Sugar Bull.*, 1985, **63,** (23), 8.

During the 1985 Louisiana crop, tests were conducted at several factories to determine the amount of suspended solids in clarified juice using a series of fine-mesh screens built into a column with the largest screen size at the top and the smallest at the bottom; each compartment had an overflow to prevent upward contamination in the event of blockage of any screen. The total suspended solids collected was determined as well as the fraction on each screen. After drying, the samples were ashed to determine the quantity of combustible material. The amount of material collected ranged from 2.3×10^{-3} to 5.0×10^{-2} g/gal of juice; the non-combustible content ranged from 6.6 to 21% of the suspended solids, indicating that most of the carry-over from the clarifier was bagacillo, especially that portion floating on the top of the clear juice. This effect was evident at one factory (not involved in the studies) where the screens became blocked within 1 hr as a result of excessive carry-over of bagacillo. Analysis of scale in the first two evaporator effects at one factory included in the studies showed bagacillo in the tubes as well as extreme accumulation of very soft scale 4 - 5 mm thick. Although, in almost all cases, the amount of suspended solids did not seem high enough to warrant installation of juice screens, increases in crushing rates and reduction in clarifier residence times could mean that screens would have to be considered in the future to reduce bagacillo and scale deposition.

Microbiological and chemico-physical investigations of cane raw sugar

G. Müller, E. Gutknecht and E. Richter. *Lebensmittelind.*, 1985, **32,** 225 - 227 (*German*).

Ten samples of raw sugar imported into East Germany from Cuba were analysed for pol, Brix, reducing matter, total acids and pH and their bacterial counts determined. Three of the samples were found to contain an osmophilic yeast population greater than 100,000/10 g sugar, i.e. above the permissible limit set in some raw sugar quality standards, and even in the other samples of relatively low microbial populations the bacterial activity was excessive and conversion to metabolic products had already occurred. Analyses, including determination of the safety factor and dilution number, confirmed deterioration of the samples in storage, which should not be carried out in the open and should be in piles of small surface area and as tall as practical, offering one single smooth surface; this would exclude the moist, warm aerobic conditions that favour osmophilic yeast growth.

Beet sugar manufacture

Effect of CaO solubility on the raw juice purification process

V. A. Loseva, I. S. Naumchenko and V. M. Perelygin. *Rpt. Voronezh Technol. Inst.*, 1985, 4 pp; through *Ref. Zhurn. AN. SSSR* (*Khim.*), 1985, Abs. 18 R437.

When milk-of-lime used for juice purification was obtained by slaking CaO with water to which KOH, MgO or $Ca(OH)_2$ had been added at 0.00133 - 0.02014% on CaO by weight, 2nd carbonatation juice purity was 0.5 - 1.5 units higher than in normal treatment, mainly as a consequence of increased CaO solubility

Recrystallization during boiling of sugar suspension on a plane, horizontal heating surface

S. I. Potapenko, A. I. Ukrainets and S. A. Bogatyrev. *Rpt. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1985, 10 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (18), Abs. 18 R441.

Experimental investigations have shown that the rate of mass transfer during recrystallization of massecuite on a plane heating surface is a function of level, effective temperature difference and flow rate. The occurrence of an optimum level and an effective temperature difference at which recrystallization rate is maximum is indicated. The extent of the influence of the flow rate on changes in the optimum crystallization conditions was determined, and the results are valid for developing new continuous vacuum pan designs and establishing optimum conditions for crystallization under direct-flow conditions.

Massecuite colorant and sugar quality

G. Rousseau. *Ind. Alim. Agric*, 1985, **102,** 665 - 670 (*French*).

Statistical analysis was made of the results of 39 massecuites boiled and cured in a pilot plant under standard conditions simulating factory processing as closely as possible. Regression equations were derived for liquid and solid products obtained by single and double affination relating (i) the EEC points system for sugar quality and colour with the colour of unfiltered massecuite at 420 nm, and (ii) sugar quality with its colour. (Affination consisted of 10 minutes' agitation at 50 rpm of a mixture of 400 g crystal sugar and 400 g saturated liquid sugar followed by spinning in a laboratory centrifuge at 3000 rpm.) Good correlation was obtained, with regression coefficients greater than 0.94 for (i) and greater than 0.95 for (ii). Massecuite purity had relatively little influence, and the solid products behaved differently from the liquid products. The increase in quality due to the second spinning demonstrated that the impurities were to be found on the outside of the crystal. At a normal factory level, affination gives values between the regression points found for 1st and 2nd affination in the experiments.

Mechanical recompression of pan vapours and sextuple-effect evaporation at Bucy-le-Long sugar factory

D. Brot. *Ind. Alim. Agric.*, 1985, **102,** 681 - 684 (*French*).

Details are given of the Neu 3-stage centrifugal compressor installed at Bucy-le-Long to treat vapour from the continuous *A*-pan at a rated hourly throughput of 11 tonnes and raise its pressure from 0.3 to 1.5 bar. The sextuple-effect climbing-film evaporator is also described, and the heat efficiency of the factory discussed. (See also Giorgi: *I.S.J.*, 1983, **85,** 378; Giorgi *et al.*: *ibid.*, 1985, **87,** 116A.)

Modernization of Aarberg sugar factory and of its multi-energy scheme

H. R. Brunner, H. Kimmich, K. Geckert, R. Michel and D. Bourée. *Ind. Alim. Agric.*, 1985, **102,** 699 - 705 (*French*).

See *I.S.J.*, 1986, **88,** 4A.

Reduce energy costs by using electricity

P. Giraud. *Ind. Alim. Agric.*, 1985, **102,** 707 - 710 (*French*).

It is shown that using electricity in place of steam or vapour in a number of modified schemes can reduce the overall energy costs of a sugar factory. For a factory slicing 7200 tonnes of beet per day, an initial reduction in fuel consumption is obtained by various measures in the boiling house, including reducing massecuite Brix and using (saturated moist) air instead of steam for filter cake sweetening-off. Vapour bleed requirements may be reduced by mechanical compression of 80% of the *A*-pan vapours, while the evaporator balance can then be restored by compressing the vapour from the first three effects and using the 3rd effect vapour for pan boiling. Further decrease in vapour consumption is possible by lowering the diffusion temperature and using, for diffusion, condensate and hot water that has had carbonatation flue gas bubbled through it. Installation of a sextuple-effect climbing-film evaporator, a high-pressure coal-fired boiler and a high-pressure turbo-alternator would permit a substantial reduction in fuel consumption without the use of pan vapour compression. The positive effects of the various measures are calculated.

The Langreney continuous pan at Marle sugar factory

Anon. *Ind. Alim. Agric.*, 1985, **102,** 713 - 717 (*French*).

A Langreney continuous pan was installed for low-grade massecuite boiling at a rated hourly throughput of 17 tonnes. Details are given of the pan construction and layout and of the scheme of operation as well as control of the various operational parameters. The pan has performed satisfactorily during two post-campaign thick juice processing periods and one beet campaign.

Decolorization by active carbon in the food industry

R. Pavie. *Ind. Alim. Agric.*, 1985, **102,** 719 - 721 (*French*).

The use of active carbon for decolorization

of products including beet and cane juices and glucose solutions is discussed generally.

Beet pulp pressing and drying: factors in cost reduction

M. Demaux. *Ind. Alim. Agric.*, 1985, **102**, 723 - 730 (*French*).

Various aspects of beet pulp pressing are discussed, including recent developments in the use and design of presses, e.g. the Ferriani perforated scroll and Stord self-draining scroll and the use of pressing aids such as aluminium sulphate which has led to increased moisture extraction and reduced fuel consumption. While pressing is the more economically efficient of the two processes, drying has also undergone a number of changes leading to a fall in consumption; these are well documented and include flue gas recycling, 2-stage drying, low-temperature drying and use of superheated steam with mechanical vapour compression.

Process synthesis and energy improvement in the sugar factory process

D. Depeyre and P. Lucas. *Ind. Alim. Agric.*, 1985, **102**, 743 - 748 (*French*).

The energy system of a typical beet sugar factory is analysed, and the combination of individual measures in the various processes to form an overall optimum scheme is discussed, including choice of criterion for evaluation of scheme effectiveness, controllable variables, constraints, simulation and specific application to the operation of an evaporator. Improvements in energy consumption and process optimization measures suggested by various authors are described, including references to the use of computers.

La Société Coopérative Agricole de la Sucrerie-Distillerie d'Artenay

Anon. *Ind. Alim. Agric*, 1985, **102**, 757 - 777 (*French*).

A brief historical account is given of this French company by illustrated descriptions of the operations and equipment at the beet end of the factory and of the new diffuser/pulp press station, the low-temperature pulp dryer, sugar conditioning, computerized remote process control and alcohol fermentation of beet juice and molasses. The performances of the various stations are analysed.

Combined adaptive automatic control of the temperature conditions in an inclined scroll diffuser

A. P. Ladanyuk, F. V. Negoda and A. A. Sushchenko. *Rpt. Kiev. Tekhnol. Inst., Pishch. Prom.*, 1985, 8 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (19), Abs. 19 R425.

Investigation of a linear mathematical model of the diffusion process is reported. The non-stationary characteristic of the process is disclosed, whereby the dynamic properties alter considerably with change in the loading and in the heat transfer coefficient. With change in the cossettes load from -50 to +10% and in the heat transfer coefficient from 0.2 to 0.5 kW/m^2/°C, the time constants alter by 100 - 200%. An automatic control system has been developed for the temperature conditions in a sloping diffuser which ensures invariance of the output coordinates relative to change in the basic controlled disturbances and in the dynamic properties of the diffuser. Qualitative parameters of transient processes in temperature control have been evaluated, and the system tested at a Ukrainian sugar factory.

Control of the operation of twin-scroll diffusers

V. N. Karmaev and T. S. Kornienko. *Rpt. Voronezh Technol. Inst.*, 1985, 11 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (19), Abs. 19 R427.

A method for calculating the time of contact between cossettes and extractant in a continuous diffuser is proposed which guarantees no sugar losses in the pulp above the norm for cossettes of known characteristics (sugar content and length per 100 g, and coefficient of sugar diffusion). The method has been used for control of the diffusion process based on the geometry of a twin-scroll DS-12 inclined diffuser and its internal diffusion parameters. An algorithm is presented as well as nomograms calculated by computer.

When frost threatens!

R. Vanstallen and J. P. Vandergeten. *Le Betteravier*, 1985, **19**, (201), 15, 18 (*French*).

While beet in the ground are relatively well protected from frost, when lifted and in windrows they are highly susceptible and, at the first warning of frost, should be clamped. No time should be lost in covering the clamps as soon as frost is predicted; even if covering is too late to prevent the effects of frost, it should still be done, since it stops the clamp reheating too rapidly with thawing and prevents further sugar losses resulting from this. Polyethylene film 0.15 mm thick and in sheets 6 m wide are effective and economical; 12 m wide sheets with a central 1 m perforated band are easier to place in position and less susceptible to wind. All types of cover must be weighted to prevent tearing and give maximum protection. A Spiragel instrument for determining the extent of frost damage by measuring the conductivity of the cell juice and estimating the level of cell tissue degradation was to be tested under practical conditions.

Introduction of K-4 flocculant at Petrovsk No. 2 sugar factory

I. A. Oleinik and R. M. Polishchuk. *Sakhar. Prom.*, 1985, (10), 18 - 21 (*Russian*).

In 1st carbonatation juice settling and filtration experiments, K-4 flocculant proved somewhat superior to hydrolysed polyacrylamide (both used at 0.001% on beet) in terms of increased settling rate and 2nd carbonatation juice purity and reduced filtration coefficient, mud volume and 2nd carbonatation juice colour. Both flocculants improved efficiencies.

Examination of the

performance and computer-based optimum control of a FiLS filter-thickener

E. I. Vorob'ev, N. E. Zevtsov-Lobanov, V. N. Shurbovanyi, B. A. Eremenko and Yu. V. Anikeev. *Sakhar. Prom.*, 1985, (10), 23 - 26 (*Russian*).

Investigations of automatic control of filter-thickeners used for 1st carbonatation juice demonstrated the vulnerability to a fall in beet processing quality and to fluctuations in factory processing rates of a system based on a constant time cycle regardless of juice quality and filter cloth resistance, and in which absence of pressure stabilization led to variations in mud volume. A new computerized real time adaptive scheme in which the time was a function of filtrate volume and pressure was maintained constant proved suitable, and data obtained from experiments can be used to develop a system for complete station.

Use of a direct-flow film vacuum evaporator to concentrate sulphitated beet juice

V. P. Shchutskii, I. Ya. Sirik, P. P. Moskalenko and V. N. Usychenko. *Sakhar. Prom.*, 1985, (10), 26 - 28 (*Russian*).

A triple-effect falling-film Rudis-Leben evaporator station (designed to concentrate skimmed milk) was tested on concentration of sulphitation juice as an alternative to a conventional calandria-type multiple-effect evaporator in which the colour content usually increases markedly. Results for treatment of 5 - 6.5 tonnes of juice/hr showed a colour rise of only 8 - 12% with concentration from 13 - 14° to 57 - 60°Bx. For stable operation over a period of 5 - 7 days, the evaporators were cleaned with 3% NaOH for 1 hr each day.

Experience in operation on reduced consumption of fuel and energy resources at Aleksandriiskii sugar factory

L. P. Ignat'ev *et al. Sakhar Prom.*, 1985, (10), 32 - 35 (*Russian*).

Details are given of the measures embodied in a 3-stage program for rationalization of power and steam usage that started in 1979 and was to be concluded by 1985. Two features given prominence are a cylindrical furnace to produce the heat for beet pulp drying, a horizontal raw juice heater based on the use of pan vapour, and a heat exchanger in which 2nd carbonatation juice is heated by condensate before the latter passes, at 105°C, to the boiler house for use as feed water. Fuel consumption at the factory has fallen from 6.56% on beet in 1979 to 5.95% in 1984.

Means of and experience in reducing the metal and energy consumption in sugar equipment

V. G. Belik. *Sakhar. Prom.*, 1985, (10), 35 - 37 (*Russian*).

The title subject is discussed in regard to Soviet sugar factory equipment construction, design and operation and use of structural materials.

Investigation of the sugar drying process in an experimental gravity dryer

J. Blacha-Jurkiewicz, A. Jezowska and M. Styczynska. *Pr. Nauk. AE Wroclaw.*, 1984, (278), 175 - 180; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (20), Abs. 20 R444.

Results are reported of laboratory investigations of the possibility of pre-drying moist sugar (discharged from the centrifugals) with air in a gravity dryer before final fludized bed drying. It is shown that the low costs of dryer and the simplicity of its design make the pre-drying process a practical proposition.

The French sugar industry

Anon. *Sucr. Franç.*, 1985, **126,** 413 - 416, 419 - 436, 439 - 454, 457 - 460, 463 - 468, 471 - 496, 499 - 515, 517 - 521, 523 (*French*).

A short historical account and a general survey are presented of sugar marketing in France and of the French sugar manufacturing and refining industries of Réunion and the French West Indies. The article is divided into nine sections: the sugar extraction process and its by-products (pulp and molasses); beet farming; organization of sugar production on an economic plan and trade agreements between manufacturers and farmers; the sugar market; the sugar industry of French overseas departments; sugar refining in France; and the National Asssociation of Sugar Manufacturers (Syndicat National des Fabricants de Sucre).

The different filtration processes. Theoretical bases and survey of the types of equipment

R. Ben Aim and A. Davin. *Ind. Alim. Agric.*, 1985, **102,** 895 - 901 (*French*).

The fundamentals of filtration theory are expounded, and applications of filtration and the types of equipment used are surveyed. The role of filtration in the sugar industry is explained, and the view expressed that, although water is traditionally separated by thermal means, there could come a time when part of the evaporation process is replaced by reverse osmosis, although this would depend on the availability of more efficient and reliable membranes than currently available.

Brix as a criterion of the rheological properties of *C*-massecuite in crystallizers

K. Wagnerowski. *Gaz. Cukr.*, 1985, **93,** 73 - 78 (*Polish*).

A method is described for calculation of low-grade massecuite viscosity as a function of Brix and temperature. The general formula takes the form: $\log \eta_c = [B - \log (100 - Brix)].[g - a \log (t + 50)] \pm c$, where η_c is massecuite viscosity (Pa/sec), t is temperature (°C), and B, g, a and c have empirical values of 1.6948, 30.891, 12.106 and 3.349, respectively, for Polish conditions.

Mass flow control at Chelmza sugar factory

P. Slugocki. *Gaz. Cukr.*, 1985, **93,** 79 - 81 (*Polish*).

An account is given of on-line control by mini-computer of beet end parameters, including cossettes supply to the two diffusers, juice feed to subsequent stations, buffer tank levels, milk-of-lime density, carbonatation gas pressure and CO_2 content, pH in preliming and 1st and 2nd carbonatation, and the pressure and temperature of steam fed to the evaporator. The technological and monetary effects of improvements brought about by the system in the 1983/84 campaign are indicated.

The effect of agronomic measures on the processing quality of sugar beet

M. Pawluczuk. *Gaz. Cukr.*, 1985, **93,** 85 - 87 (*Polish*).

The effects of various farming practices on beet processing quality are examined, including storage losses, particularly in unripe beet of low sugar content.

Machines for beet knife regeneration. An offer from the engineering industry

S. Araszkiewicz. *Gaz. Cukr.*, 1985, **93,** 88 - 93 (*Polish*).

Descriptions and diagrams are given of Polish machinery for beet knife straightening, trimming and sharpening.

100 years of crystallization in motion – a contribution to the history of sugar technology

G. Bruhns. *Zuckerind.*, 1985, **110,** 867 - 873 (*German*).

A brief account is given of the history of massecuite crystallization since the discovery by Wulff (who never worked in a sugar factory) that crystals grow faster in motion than under static conditions; this finding formed the basis of a patent, the rights to which were later acquired by a sugar technologist, Bock, who ultimately managed to introduce the process into the industry. As a result of numerous lawsuits against German sugar factories and the official body representing the German beet sugar industry to protect his rights, Bock gained a certain notoriety and is nowadays virtually forgotten.

Crystallization in motion – physical fundamentals and technical development

K. E. Austmeyer. *Zuckerind.*, 1985, **110,** 875 - 883 (*German*).

The fundamentals of crystal growth in motion are explained, starting with the basic effect of movement in overcoming the main resistance (that of transport) to incorporation of molecules in the crystal lattice; the resistance to "fitting" in the lattice is only temperature-dependent. Experimental work, particularly that of Schliephake on the use of a fluidized bed to impart crystal movement, is examined, followed by descriptions of various types of crystallizer and vacuum pan, including massecuite stirrer arrangements and tower crystallizers.

Reorganization of data gathering at the beet yard of Wierthe sugar factory, Braunschweig

E. Naywald. *Zuckerind.*, 1985, **110,** 899 - 902 (*German*).

Details are given of the rebuilding of the beet yard at Wierthe and of the computerized system installed for gathering of beet reception data and sample analyses. The reorganization has cut the turn-round time of road trucks by some 25%.

A visit to sugar factories in Denmark and East Germany

Z. Hurtova. *Listy Cukr.*, 1985, **101,** 234 - 238 (*Czech*).

Illustrated descriptions are given of equipment and processes at Nakskov factory in Denmark and at Güstrow factory in East Germany.

The 1984/85 campaign (in Hungary)

K. Hangyál. *Cukoripar*, 1985, **38,** 98 - 108 (*Hungarian*).

The results of the 1984/85 campaign at the 12 Hungarian sugar factories are summarized with the aid of tabulated data and graphs, covering beet quality and storage; diffusion, in which losses averaged 0.37% (0.28 - 0.42%) at an average juice draft of 116% (109 - 122%); juice purification; evaporation; sugar house operations; energy (showing a rise in fuel and steam consumption of only 9.4 and 9.7%, respectively, despite a 10.4% increase in the quantity of processed beet); automation and computer technology; and water usage.

Low-grade massecuite centrifugalling

F. Túri. *Cukoripar*, 1985, **38,** 109 - 114 (*Hungarian*).

The need to reduce *C*-massecuite viscosity by reheating and dilution so as to facilitate spinning is discussed, and the benefit indicated of reheating with molasses in order to achieve the desired effect without dissolving crystals.

The raffinose content in Hungarian sugar beet

M. Polacsek-Rácz, R. Schotter-Gonda, E. Szép-Spuller, L. Vámos-Vigyázó and K. Vukov. *Cukoripar*, 1985, **38,** 114 - 117 (*Hungarian*).

After a brief discussion of the adverse effect of raffinose on sugar measurement by polarimetry and on crystal growth, the minimum and maximum raffinose contents found in beet at each Hungarian sugar factory in the period 1967/73 are tabulated and the average values for the industry compared with those in other countries. Results are then reported of raffinose determination in molasses (using the modified enzymatic photometric method of Schiweck & Büsching[1]) at the start and finish of the 1980/81 and 1981/82 campaigns at each factory, and the values converted to beet values on the basis of calculated molasses yield. It was found that the beet raffinose content reached a critical level of 0.1% in only one case, although in two other cases it was only slightly below it. However, even at this level, raffinose is easily eliminated by the use of α-galactosidase.

1 "Sugar analysis - ICUMSA methods" Ed. Schneider (ICUMSA, Peterborough) 1979, 70 - 74.

Starch based sweeteners

Properties of granulated glucose products

V. V. Ananskikh, N. D. Lukin and N. G. Gulyuk. *Sakhar. Prom.*, 1985, (7), 43 45 (*Russian*).

Granular glucose concentrate can be obtained by spraying glucose solution onto a moving bed of glucose particles. The resultant spherical granules have an average size of 3 - 5 mm. Studies on their structure, visual appearance, dissolving rate and hygroscopicity are reported.

Some effects of the minor components of wheat starch on glucose syrup production

P. Bowler, P. J. Towersey and T. Galliard. *Starch/Stärke*, 1985, **37**, 351 - 356.

The effects of the minor components in commercial, unfractionated wheat starch on the processing of the starch to yield glucose syrup and on the properties of the syrup itself have been assessed, and techniques for selective removal of the components developed. Procedures for syrup production from the treated starch are described.

Investigation of the effect of quantity and quality of added seed on fructose crystallization in aqueous solutions

N. I. Odorod'ko *et al. Rpt. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1985, 11 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (18), Abs. 18 R459.

The effect of the quantity and quality of seed in the form of crystals measuring 0.4, 0.315 and 0.2 mm on fructose crystallization was investigated. The saturation and supersaturation concentrations of fructose syrups required for crystallization were determined by cooling in the temperature range 55 - 25°C. It was found that the seed considerably affected yield and granulometry of the crystal product. Complete desugaring of the mother liquor and regular granulometry were obtained by adding seed of 0.315 mm at 10 - 12% on 95 purity syrup by weight.

Spinning fructose massecuite

N. I. Odorod'ko *et al. Rpt. Tekhnol. Inst. Pishch. Prom.*, 1985, 14 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (18), Abs. 18 R460.

Optimum purging of fructose massecuite in a centrifugal was studied, whereby it was found that the basic quantity of non-sugars, particularly colouring matter, was concentrated on the surface of the crystals. The relationship between the number of layers at the crystal surface and purity was linear. The non-sugars were distributed regularly within the crystals, those of higher molecular weight being nearer to the nucleus. Predominant among the colorants in fructose crystals were hydroxymethylfurfural and its polymerization products. Washing of the crystals in the centrifugal with 97, 70 or 30% alcohol and cold water showed that crystal losses increased with the amount of water in the wash solution.

Some features of glucose crystallization in fructose manufacture

N. I. Odorod'ko, A. A. Ostrovskaya and N. A. Arkhipovich. *Rpt. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1985, 13 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (18), Abs. 18 R461.

Examination of glucose monohydrate crystallization from the glucose fraction obtained during fructose manufacture from sucrose showed that it was better to use lower temperatures than used in conventional glucose manufacture and to add seed as crystalline powder at 8% by weight. The composition and quantity of fructose as major impurity considerably affected solubility of the glucose, while optimum pH of the syrup for crystallization was 3.5 - 4.2. Cooling of the glucose was also studied.

Production of immobilized glucoamylase and its use in the starch syrup industry

G. Klamár, B. Szajáni and L. Ludvig. *Szeszipar*, 1984, **32**, (2), 41 - 43; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (19), Abs. 19 R365.

The production of immobilized glucoamylase by formation of a covalent bond between the functional groups in the enzyme and its support was examined. Using Acrylex Ts-100 as support, an immobilized glucoamylase was obtained which may be used in industry; 50% of its initial activity was retained after 110 days' storage.

Investigation of a process for purification of fructose solutions by mixed-bed ion exchange

L. I. Tanashchuk, N. A. Arkhipovich and T. V. Lopato. *Rpt. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1985, 10 pp; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (20), Abs. 20 R466.

During fructose and glucose production from sucrose, a study was made of purification of the fructose solution by cation, anion and colorant adsorption on ion exchange resins. Optimum parameters were determined for mixed-bed ion exchange; the optimum cation exchanger:anion exchanger ratio required to produce solutions having a pH close to the isocatalytic point was found to be 3:4.5. The specific loading was 12 ml/g/min.

Enzyme engineering in the starch syrup industry

K. Hollo, K. Laszlo and A. Hoschke. *Acta Aliment. Pol.*, 1984, **10**, (1/2), 33 - 49; through *Ref. Zhurn. AN SSSR* (*Khim.*), 1985, (20), Abs. 20 R472.

A review is presented in which the starch syrup industry is characterized as a major enzyme consumer in the processing of glucose, fructose and alcohol. The properties and structural features of amylase and glucoamylase are examined and shown to depend on their sources. Knowledge of enzyme structure and active centres offers a guide to amylase modification. Enzyme immobilization and use as catalyst in this form are discussed, and the characteristics of glucose isomerases produced by the industry are presented.

Laboratory studies

Investigation of colorants removed by AV-17-2P anion exchanger during sugar refining

I. F. Bugaenko, M. Garcia F., J. Hoque and V. I. Gorbatyuk. *Sakhar. Prom.*, 1985, (9), 36 - 38 (*Russian*).

Colouring matter in the eluate from an anion exchanger column after regeneration was fractionated by micro-filtration and then studied by chromatography on Acrylex gel and spectrophotometry at 540 nm. The spectra of the different fractions, which had molecular weights ranging from <5000 to 150,000, are discussed in terms of their maxima, but none of the compounds are identified.

Volatile constituents of sugar cane juice during processing and storage

P. O. Jimenez. *Crystallizer*, 1985, **8,** (3), 14 - 15.

Changes in the volatile constituents of cane juice were investigated after their isolation by vacuum distillation, solvent extraction with methylene chloride and concentration, followed by gas chromatography. Of eight peaks appearing in the chromatogram, only one was identified (benzoic aldehyde). Gas chromatography-mass spectrometry of certain extracts gave tentative identification of other compounds, including methyl-*n*-tetradecanoate, L-ionone, *n*-octadecane, β-methyl-*p*-isopropyl phenylpropionaldehyde and syringaldehyde. The presence of these depended on the length of storage of the juice samples.

Kinetics of sucrose crystallization at low supersaturation

V. Maurandi. *Ind. Alim. Agric.*, 1985, **102,** 687 - 693 (*French*).

The literature on the theory of sucrose crystal growth is reviewed, covering bulk diffusion and the surface reaction occurring separately or combined. Differences between data found in the literature are attributed to difficulties in examination of the crystallization process. References are made to the more important pieces of research conducted on crystallization in pure and impure solutions, highlighting points of agreement and disagreement between experimental results and theoretical calculations. For impure syrups having increasing non-sugar:water (NS:W) ratios, it is shown that, at low supersaturation, the growth rates fall at an increasing rate, passing from 2nd order kinetics at intermediate NS:W values to exponential kinetics at higher values. The adverse effect of falls in crystallization rates on exhaustion, particularly of low-grade massecuite, and the resultant protraction of the crystallization process are briefly discussed.

Coloration of sugar crystals as a function of some industrial crystallization parameters

G. Mantovani, G. Vaccari, G. Sgualdino, D. Aquilano and M. Rubbo. *Ind. Sacc. Ital.*, 1985, **78,** 79 - 86 (*Italian, English*).

Continuing the experiments reported earlier[1], the authors demonstrate the contributory effect of crystallization parameters on colouring matter inclusion, including temperature, supersaturation, impurities concentration, viscosity and surface tension. Three distinct colour zones have been identified in raw sugar crystals: an inner zone containing less than 20% of the total colouring matter in the crystal, a very thin outer zone that is almost colourless, and an intermediate, highly coloured zone that constitutes about 25% of the total weight of the crystal. From the experimental results it is concluded that the colouring matter is not uniformly distributed in the zones. The inner zone corresponds to initial growth of seed crystals, the intermediate zone corresponds to the final boiling stage when some 70% of the total crystal colour is included, while the almost colourless zone corresponds to slow crystallization in the mixers. In contrast to the raw sugar crystal, the white sugar crystal has only one (outer) zone of colour inclusion representing about 25% of the total crystal weight and containing more than 20% of the total colour, most of which is included in the final boiling stage. The difference between raw and white sugar colour inclusion is attributed to the shorter period spent by white sugar massecuite in the mixers. The difference in the amount of colour included in the final boiling stage between the two sugars is a result of a difference in viscosity change between the start and finish of boiling — in the case of white sugar, this change is only 10% of that in low-grade boiling. The high molecular weight of the colouring matter in the inner zone of the raw sugar crystal arises from the fact that the colorant droplets trapped during the initial boiling stage are exposed to high temperatures throughout the entire boiling process, whereas the mother liquor surrounding the crystals in the final stage is composed of fresher fractions that have not been subjected to polymerization. The significance of these findings for sugar storage is noted[2].

High performance liquid-chromatographic determination of sucrose, glucose and fructose in complex products of distilleries

A. C. Duarte-Coelho, E. D. Dumoulin and J. T. Guerain. *J. Liquid Chromatogr.*, 1985, **8,** (1), 59 - 73; through *Anal. Abs.*, 1985, **47,** Abs. 10F59.

The cited sugars, plus ethanol and glycerol, were separated from various juices, and residues obtained from beet and molasses in a distillery, by HPLC with use of a Waters Sugar-Pak I column (30 cm × 4 mm, in Ca^{++} form) at 90°C, with 20 ppm aqueous Ca acetate as mobile phase (0.5 ml/min) and refractive index detection. Retention times and peak heights were compared with those for standard solution. Total analysis time was approx. 35 min. The sample preparation methods proposed were reproducible and could be automated. The results agreed with those for total reducing sugars by chemical determination and by GC of trimethylsilyl derivatives.

1 *I.S.J.*, 1985, **87,** 119A.
2 Shore *et al.*: *ibid.*, 30A.

By-products

Selection of yeast strains grown on enzymatic hydrolysates of sugar bagasse

L. Lara. *Rev. Ciencias Biologicas*, 1982, **13**, (1), 25 - 36; through *S.I.A.*, 1985, **47**, Abs. 85-1300.

With the aim of producing single-cell protein, media based on enzymatic hydrolysates of bagasse were used for the culture of eight yeast strains at 30° and 37°C and pH 4 and 5. One of these strains was considered the best on the basis of its biomass yield and specific growth rate at the higher temperature and lower pH, which would decrease the risk of contamination and the cooling required. It contained 45% protein, with a good amino-acid profile.

Composite hardboard from pith- and depithed-bagasse-filled plastics

F. Mobarak and H. Augustin. *Res. and Ind.*, 1984, **29**, (2), 108 - 113; through *S.I.A.*, 1985, **47**, Abs. 85-1329.

Composite hardboard was produced by sodium bisulphite-initiated polymerization of methyl methacrylate monomer in water at 25°C in the presence of bagasse pith or depithed bagasse. The polymer content increased with time and was raised by the presence of bagasse; board properties (water resistance and bending strength) improved with increasing polymer content in the range 8 - 30%. Board prepared from depithed bagasse and containing about 30% polymer was of good quality. Pretreatment of pith with acid or alkali did not lead to any improvement in the board properties, although use of non-dried alkali-treated pith enhanced polymerization.

Pressed pulp in Europe: forms of use and current trends

J. P. Vandergeten and R. Vanstallen. *Le Betteravier*, 1985, **19**, (201), 16 - 18 (*French*).

The proportions of beet pulp in pressed, dried and wet form in a number of Western European countries are discussed. In Belgium, 39% of the pulp (as dry solids) is left wet and, because of its low cost and the small distance between sugar factory and consumer, is fed directly to cattle; in Denmark, none of the pulp is pressed, and 76% is left wet. However, pressed pulp silage offers a number of advantages, and the authors discuss various aspects of pulp ensilage and supplementation with protein, phosphorus and trace elements.

Use of fuel alcohol: where are we in this?

L. Rigo. *Le Betteravier*, 1985, **19**, (201), 8 - 9, 20 - 22 (*French*).

The author discusses various aspects of motor fuel, particularly atmospheric pollution caused by its exhaust gases and the question of reducing the amount of lead added to gasoline, and examines the pros and cons of ethanol as motor fuel and its manufacture from e.g. beet, cane and molasses.

Fermentation ethanol - its possibilities and limits

S. Tourlière. *Ind. Alim. Agric.*, 1985, **102**, 749 - 753 (*French*).

Technico-economic aspects of ethanol fermentation of sugar beet and corn under French conditions are discussed.

Review of the waste water treatment plant of Pingtung pulp factory

J. S. I. Wang and C. K. H. Lu. *Taiwan Sugar*, 1985, **32**, (4), 15 - 21.

An illustrated description is given of the activated sludge treatment of waste water, totalling 62,000 tonnes/day, at the world's largest bleached bagasse pulp factory.

Production of glucose from bagasse

M. Ramzan, M. Iqbal, M. Yaqub and M. R. Sabir. *Pakistan Sugar J.*, 1985, **1**, (2), 12 - 13.

Cellulase immobilized on charcoal was used to produce glucose from bagasse after delignification with 4% NaOH. At an optimum temperature of 38°C, pH 5.0, enzyme concentration of 9.006 g/ml and substrate concentration of 0.025 g/ml, 1 hour's incubation yielded 4.4% glucose.

Recycling vinasses or their evaporation condensates in alcoholic fermentation of heavy sugar products (molasses and raw syrups)

G. Alard and M. de Miniac. *Ind. Alim. Agric.*, 1985, **102**, 877 - 882 (*French*).

The biological action of vinasse constituents on yeast metabolism was studied in 10°GL ethanol production from beet molasses and raw syrups. Where final molasses was used as substrate and the condensate from vinasse evaporation was recycled, fermentation productivity remained relatively stable during the period up to day 41, after which there was marked fluctuation up to day 72 and a fall in the average daily alcohol yield. However, maximum organic acid loading occurred between days 30 and 44 and between 47 and 60, while volatile acid production was comparatively stable with progressive reduction during days 6 - 41, after which it rose, but with noticeable fluctuation up to day 72. It is suggested that this turbulence was the result of poor molasses quality rather than of acidity in the form of the recycled condensate. Vinasse from raw syrup was of lower dry solids content (5%) than that from molasses (13%), so that it and not its evaporation condensate was recycled (in view of the energy needed to evaporate the greater amount of water). However, the alcohol yield was about 50% greater than from molasses, and the vinasse non-sugars had a greater positive biological effect on the yeast than the non-sugars in molasses or raw syrup. By comparison with 40 hours' molasses fermentation needed for alcohol production, raw syrup required only 28 hours (corresponding to 30% availability of fermenter space) and was preferred to molasses as substrate; however, despite the better performance of raw syrup with recycling of vinasse, condensate recycling is considered easier and therefore preferable. Vinasse storage tanks were not recommended because of bacterial contamination of the vinasse as a result of cold spots.

Patents

UNITED STATES

Glucose isomerization to fructose

T. Yoshioka, K. Teramoto and M. Shimamura, of Ohtsu, Japan, *assrs.* Toray Industries Inc. **4,347,316.** May 22, 1981; August 31, 1982.

Glucose is isomerized to fructose with an enzymatically active product (in fibrous, particulate or film form) consisting of an organic polymeric material containing at least 50% by weight of a monovinyl aromatic compound having a β-amino propionamidomethyl group as a side chain which immobilizes the glucose isomerase.

Glucose isomerase preparation

M. S. Popov, G. M. Djedjeva, I. O. Todorov and N. S. Stoeva, of Sofia, Bulgaria, *assrs.* Institute po Microbiologia. **4,348,481.** December 2, 1980; September 7, 1982.

Glucose isomerase is obtained by cultivating *Streptomyces* sp. N.765 on a medium containing 1 - 2% (1%) xylose, 1.5 - 4.0% (2%) maize extract (by dry weight) and 0.23 - 1.0% (0.5%) sodium acetate by weight at 24 - 36 °C (30°C) for 36 - 72 hr (60 hr) and an initial pH of 8.5 (6.5 - 9.0). A shaker is used at 180 - 320 rpm (240 rpm) for the cultivation.

Alcoholic fermentation

M. English, D. P. Pym and L. G. Dawson, *assrs.* Kins Developments Ltd. **4,349,628.** July 15, 1980; September 14, 1982.

A carbohydrate-containing material such as cane juice, beet juice or molasses is fermented with *Saccharomyces cerevisiae* at 15 - 45°C (35 - 41°C) and some of the fermentation medium (containing typically 6% ethanol w/w) continuously transfered via a heat exchanger (which raises the temperature to 40°C) to a separator where the ethanol is evaporated under reduced pressure (0.09 bar) so that the temperature is sufficiently low as to prevent rapid inactivation of the yeast. The residual liquor is then returned (at 35 - 37°C) to the fermenter. The vapour from the separator, containing 15 - 50% (40%) ethanol by weight is then distilled to yield 96% purity ethanol.

Glucose separation from fructose

R. W. Neuzil and J. W. Priegnitz, *assrs.* UOP Inc. **4,349,668.** October 17, 1980; September 14, 1982.

Glucose and fructose are continuously separated by countercurrent flow at 20 - 200°C and a pressure between atmospheric and 500 psig through a moving bed of a cation exchange resin in K^+ form, the glucose then being recovered by desorption.

Alcohol manufacture

I. Chibata, J. Kato and M. Wada, of Japan, *assrs.* Tanabe Seiyaku Co. Ltd. **4,350,765.** June 5, 1980; September 21, 1982.

Ethanol is produced within 5 hr (3 hr) in a high concentration (not less than 75% w/v) (100 - 200% w/v) by fermentation of e.g. aqueous molasses solution with a micro-organism from the *Saccharomyces* or *Zymomonas* genus which has been immobilized in a sulphated polysaccharide gel. When 80% of the initial fermentable sugar (not more than 100% w/v) has been converted to ethanol, additional fresh culture is introduced at not less than 100% w/v until ethanol is produced at a concentration not less than 75% w/v.

Syrup production from bagasse hemicellulose

R. L. Mehlberg, of West Lafayette, IN, USA, *assr.* Purdue Research Foundation. **4,350,766.** August 1, 1980; September 21, 1982.

Bagasse is hydrolysed with 1 - 15% sulphuric or hydrochloric acid at a liquid:solid ratio of 0.1 - 4.0 at 90 - 120°C to convert essentially all of the hemicellulose, after which the hydrolysate is leached at 15 - 100°C with an aqueous medium at 0.016 - 0.83 mm/sec velocity to yield a syrup containing not less than 5% pentoses and of low pH which is suitable for prolonged storage without risk of microbial degradation and may be subsequently used for alcoholic fermentation.

Glucose isomerase preparation

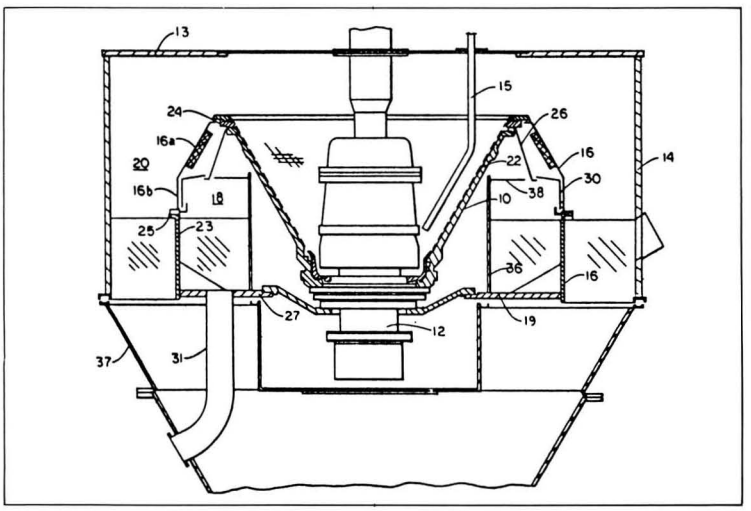
N. Ll. Agudo, M. F. Elia M., M. A. Arangurén E., E. Pares O. and J. M. Fernández G., of Madrid, Spain, *assrs.* Compañía Española de Petróleos S. A. **4,351,903.** October 31, 1980; September 28, 1982.

Glucose isomerase is produced by continuous or batchwise aerobic cultivation of a strain of *Streptomyces griseoflavus* A-40 (NCIB-11542) on a medium containing 0.1 - 10% (0.25 - 1.5%) (0.4 - 0.6%) soy flour and/or 0.01 - 2% (1.5%) tryptone and/or 0.1 - 2% xylans plus an ammonium salt. Cultivation takes place at 20 - 50°C (30 - 35°C), pH 3 - 10 (7.2) (6.5 - 7.5) (7.2 - 7.5) and a mixing speed of 40 rpm (750

Continuous centrifugal

G. Journet, of Lille, France, *assr.* Fives-Cail Babcock. **4,352,451.** September 25, 1980; October 5, 1982.

In a continuous centrifugal, a conical basket 10 is surrounded by a circular wall 16 which separates the chamber formed between the basket and cylindrical housing 14 into a first compartment 18 that receives the liquid from the rotating basket, and a second compartment 20 that receives the solids. A skirt 26 in the form of a downwardly and outwardly tapering frusto-conical imperforate element has, as its lower end, an annular ledge; an annular baffle 30 fixed to wall 16 consists of a very slightly inclined frusto-conical section, the inner part of which extends to a short distance above the ledge of skirt 26 to form a gap. The bottom of the cylindrical support section, by means of which the baffle is attached to wall 16, ends in an annular trough, so that wall 16, skirt 26 and baffle 30 define an annular space communicating with compartment 18 via the gap between the frusto-conical section of the baffle and the ledge of the skirt. When the basket rotates, the liquid component of the massecuite is forced



through discharge nozzle 24 into compartment 18 where it is atomized into fine droplets which are entrained towards wall 16 and trapped by a fibrous mat attached to the wall. From the mat, the liquid flows down in the gap between baffle 30 and wall 16 to the annular trough whence it spills over into compartment 18 and is discharged via pipe 31.

Glucose isomerase

G. Boguslawski and M. J. Rynski, of Elkhart, IN, USA, *assrs.* Miles Laboratories Inc. **4,355,103.** January 23, 1981; October 19, 1982.

Glucose isomerase is produced by aerobic cultivation of a non-pathogenic mutant from the *Bacillus* genus, e.g. *B. licheniformis* ATCC 31667, *B. coagulans* NRRL 5656, *B. subtilis*, *B. pumilus* or *B. cereus* on a medium containing no xylose (which is too expensive for use in commercial fermentation).

Enzyme immobilization

O. J. Lantero, of Goshen, IN, USA, *assr.* Miles Laboratories Inc. **4,355,105.** March 30, 1981; October 19, 1982.

Sucrose mutase or glucose isomerase is immobilized by adding glutaric aldehyde to an aqueous medium containing the enzyme and recovering the product by flocculating it with polyethyleneimine. The glutaric aldehyde facilitates separation of the flocculated cells.

HFS and ethanol manufacture

R. E. Heady, of Park Forest, IL, USA, *assr.* CPC International Inc. **4,356,262.** June 3, 1980; October 26, 1982.

Glucose in cane raw sugar or blackstrap molasses is simultaneously converted by fructosyl transferase (obtained from *Pullularia pullulans*) to ethanol and fructose polymers using a yeast (e.g. *Saccharomyces bailii* or *S. cerevisiae*) that does not ferment the polymers which are of use in the manufacture of HFS. The process takes place at 20 - 35°C (24 - 32°C) and pH 4 - 6.5 (5 - 5.5).

Cane mill

W. A. Nurse, of Bickley, Kent, England. **4,357,171.** February 9, 1981; November 2, 1982.

See UK Patent Application 2,069,869[1].

Utilization of waste heat from geothermal energy

P. N. La Mori and R. L. Zahradnik, *assrs.* Occidental Research Corporation. **4,357,214.** February 8, 1980; November 2, 1982.

Waste heat in the form of waste brine and/or exhaust steam from a turbine powered by geothermal energy can be used to provide heat in a beet diffuser and to ferment the juice to alcohol.

Continuous alcohol fermentation

J. D. Bu'Lock, of Marple, England, *assr.* Sim-Chem Ltd. **4,357,424.** December 2, 1980; November 2, 1982

An aquous glucose solution is fermented with a suitable micro-organism suspension in a column where the suspension is maintained in a well-mixed state and passes from the upper region into a degassing zone whence some of the mixture flows to a settling zone. The settled biomass is returned to the bottom of the column to assist in the continuation of the process. Gases evolving from the top of the column and from the tops of the degassing and settling zones are removed, and at least part of them reintroduced at the bottom of the column to maintain the mixed state of the substrate, while clarified liquor containing ethanol is removed from the top of the settling zone.

Glucose and fructose separation

R. W. Neuzil and J. W. Priegnitz, *assrs.* UOP Inc. **4,358,322.** September 13, 1979; November 9, 1982.

Fructose is separated from glucose by treatment of a mixture of the sugars with a crystalline aluminosilicate or zeolite (containing one or more selected cations at exchangeable cationic sites) under countercurrent flow through three zones (desorption, purification and adsorption zones), each of which is divided into a number of beds. Feed is introduced into the first bed of the adsorption zone, water is supplied to the first bed of the desorption zone, and some of the desorption effluent (containing the more easily adsorbed fructose) withdrawn from the zone, while some of the raffinate stream (containing the less easily adsorbed glucose) is withdrawn from a point such

1 *I.S.J.*, 1984, **86**, 61.

that a zone remains between the raffinate outlet stream and the desorbent inlet stream. The inlet and outlet liquid streams are simultaneously shifted one bed at a time at preset intervals (0.5 - 10 minutes), and the number of beds ranges from 4 to 50.

Betaine recovery

H. O. Heikkilä, J. A. Melaja, D. E. D. Millner and J. J. Virtanan, of Finland, *assrs.* Suomen Sokeri Oy. **4,359,430.** February 24, 1981; November 16, 1982.

Betaine is recovered from beet molasses (possibly enzymatically inverted) or vinasse by diluting the material to 25 - 50% (30%) (39.5%) solids and subjecting it to column chromatography using a salt of a sulphonated cation exchange resin formed from a polystyrene crosslinked with 2 - 12% divinylbenzene by weight. The column is eluted with water and the betaine fraction collected from the eluate. When successive feeds are made at preset intervals, the feeds may be partly overlapped, and the betaine from the preceding feed eluted by dilute molasses from the following feed. The betaine fraction is evaporated under vacuum and crystallized as anhydrous crystals or as betaine monohydrate.

Alcoholic fermentation

C. R. Wilke, B. L. Maiorella, H. W. Blanch and G. R. Cysewski, *assrs.* US Department of Energy. **4,359,533.** November 26, 1980; November 16, 1982.

A combination of vacuum fermentation and vacuum distillation is applied to alcohol preparation from a sugar-containing material, e.g. beet juice or bagasse hydrolysate. The fermentation is conducted at 10 - 100°C (18 - 20°C) (≤75°C) when a bacterium is used, but 15 - 35°C (≤40°C) when a yeast (*Saccharomyces cerevisiae anamensis*, *Clostridium thermosaccharolyticum* or *Fusarium oxysporum*) is used.

D-xylose conversion to ethanol

C. P. Kurtzman, R. J. Bothast and J. E. VanCauwenberge, *assrs.* US Secretary of Agriculture. **4,359,534.** April 28, 1981; November 16, 1982.

D-xylose, as contained in e.g. bagasse hydrolysate, is converted to ethanol by fermentation with a strain of *Pachysolen tannophilus* (without the use of added enzymes) at 10 - 35°C (32°C) and pH 2 - 7 (2.5); the xylose concentration in the medium should be initially <150 g/litre (50 g/litre).

Sugar refining

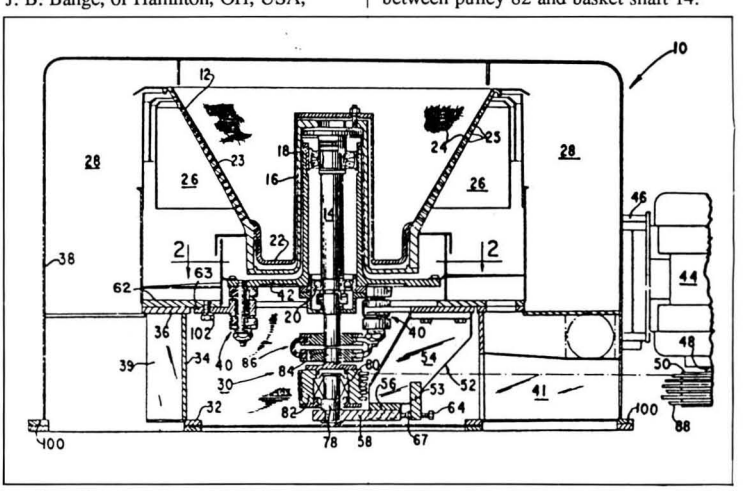
Y. Ikari, S. Yokoyama, K. Katoh, R. Itaya and T. Kaga, *assrs.* Agency of Industrial Science & Technology, Sumitomo Jukikai Envirotech Inc., Hokkaido Soda Co. Ltd. and Mitsui Sugar Co. Ltd. **4,362,571.** May 27, 1981; December 7, 1982.

Raw sugar liquor is clarified with approx. 0.5% of magnesium oxide on liquor solids. The MgO is obtained by calcining a magnesium compound together with an identical weight of perlite and/or kieselguhr at 400 - 600°C (450 - 550°C) for 30 min - several hours (30 min - 3 hours), at least 98% of the product having a size smaller than 100-mesh (<300-mesh). After each clarification cycle, the MgO is recalcined.

Continuous centrifugal

J. B. Bange, of Hamilton, OH, USA, *assr.* The Western States Machine Co. **4,362,619.** January 21, 1980; December 7, 1982.

In order to allow the conical basket of a continuous centrifugal to gyrate, when imbalance occurs as a result of non-uniformity in massecuite distribution, without imposing stress on the flexible mounting of the basket, a drive pulley 50 on shaft 48 of the electric motor drives a V-belt 88 which extends through belt tunnel 41 to and about a driven pulley 82 coupled with basket shaft 14. Pulley 82, mounted below and coaxially with shaft 14 is fixed on a non-rotary support shaft 78 through bearings 80 and is flexibly coupled with the end of shaft 14 through a flexible coupling 86 which joins the shaft end with an upward protruding stub shaft 84 mounted on pulley 82 and rotating with it. Coupling 86 directly transmits torque between pulley 82 and shaft 14 while permitting angular and parallel misalignments between the axes of the basket shaft and stub shaft. An adjustable mounting and positioning arrangement is provided for effecting fine adjustments of the position of support shaft 78 of the driven pulley relative to the axis of rotation of the basket shaft so as to establish and maintain alignment of shaft 14 with stub shaft 84 and thus ensure balanced operation of the coupling between pulley 82 and basket shaft 14.



When the bone char was taken out of operation in 1979 and replaced by Resin I, Resin II was employed as polishing station *after* Resin I. Initially, Resin II decolorization was only a fraction of that in Resin I; the latter removed approx. 500 colour units and Resin II only approx. 50 in the processing of cane raw sugar. When, in due course, the decolorizing effect declined in resin I, the decolorizing effect increased somewhat in Resin II, but not to the extent we had expected.

Since we were, at the same time, experiencing difficulties with the colour in the remelt juices, Resin II was coupled over to the decolorization of these juices. This switch was carried out during the summer break of 1981.

Decolorization of melt juice

During the period from August 1981 to October 1985, Resin II was used for the decolorization of melt juice V, in which the colour varied widely, from approx. 1000 to approx. 3000 ICU. The mean value was approx. 1800 ICU in input juice and approx. 500 ICU after the filters; thus, the degree of decolorization was approx. 72%.

The colour loading per cycle was approx. 30,000 with peak values of more than twice this figure. The ash content varied between approx. 0.1 and 1.0% but mainly lay at 0.3 - 0.5%. Despite these unfavourable operational conditions, this styrene resin gave the decolorizing effect which is apparent from Figure 5.

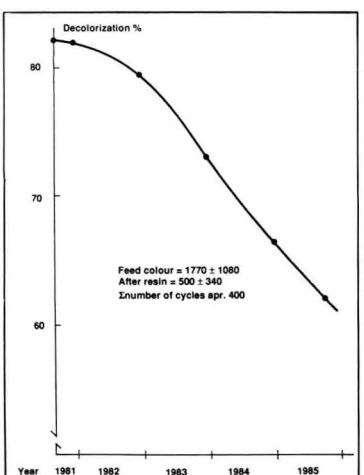


Figure 5. Decolorization with MP 500 AWS in Resin II Remelt sugar from recovery classes

Hence, we have been able to ascertain that, despite high input colour and other unfavourable operational conditions, a styrene resin has functioned here for more than four years and during approx. 400 cycles, the degree of decolorization falling from approx. 80% to approx. 60%.

Quite contrary to the prevailing opinion that styrene resin is not suitable as a gross decolorizer, and that it is difficult to regenerate, our styrene resin has, in this operation, received large volumes of colour but has nonetheless functioned for a long period of time.

This prompted us to pose the question whether a styrene resin could function well also in our gross decolorization stage for refinery liquor. As a result, the decision was taken to carry out a parallel experiment on a factory scale with acrylic resin and styrene resin.

Parallel experiment with acrylic and styrene resins

Our Resin I plant was replenished with decolorizing resin as in Table I., and tested during an experimental period from February 1984 to December 1985, i.e. 69 operation weeks. The three filters worked in parallel in the normal manner and underwent regeneration, etc., according to our standard procedure.

Table I.

	Resins
Filter 1	Acryl IRA 958RF
Filter 2	Acryl IRA 958
Filter 3	Styrene MP 500AWS

Normal operational test sampling and analyses provided a continuous monitoring of the decolorizing effect of the entire station. Sample series were also taken from the second and seventh cycles of each filter after acidic regeneration. Snap samples were taken from each such experiment cycle of juice before and after the filters for each 50 or 100 m³ of juice for cane and beet raw sugar melts, respectively. The colour, ash, pH and invert sugar were determined from these samples.

Results

Mean decolorization values

The mean values for decolorization for the whole station during the 69 operational weeks of the experiment period are apparent from Figure 6. Up to and including week 29, the decolorization was uniform and at a high level. Thereafter, we experienced certain difficulties in the carbonatation and filtration of the carbonatated juice, which resulted in a deterioration in the degree of decolorization. The decolorization was particularly poor in Filter 2, for which reason the resin mass in this filter was replaced in experiment week 41. Thereafter, we enjoyed a manifest improvement of the degree of decolorization, but only for a few weeks.

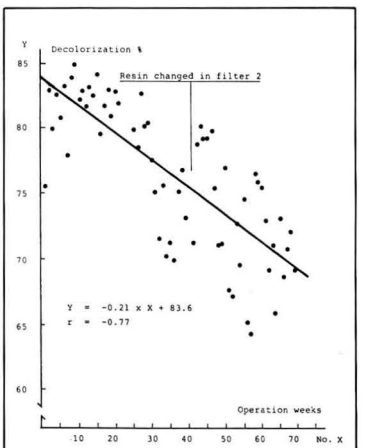


Figure 6. Decolorization during test period. Week mean values. Normal control analyses

Even though the experiment was disrupted by the conditions in Filter 2, it may be of interest to illustrate the work of the station by assuming a rectilinear relationship between the decolorizing effect and time. This relationship entails that one week of operation gives a reduction of the decolorizing effect of approx. 0.21% points.

If the decolorization for the whole station is instead correlated with the cumulative volume of colour which is pumped into the filters, the situation of

Figure 7 is obtained. The relationship line drawn into the Figure for the entire experiment period means that, for each 10^6 tonnes DS × colour/m³ resin, the degree of decolorization is reduced by 5.4%.

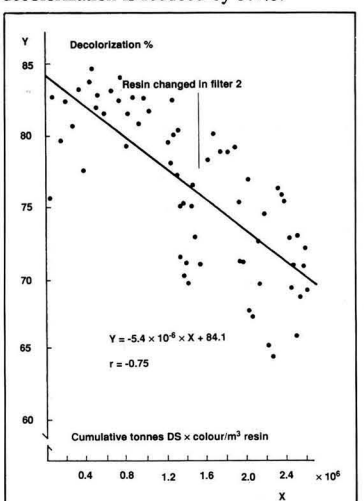


Figure 7. Decolorization during test period. Week mean values. Normal control analyses

A colour volume of approx. 2.5 × 10^6 is roughly half of the assumed maximum colour volume which a resin may tolerate in total. If there are two decolorizing stages, it may be permissible to run longer and obtain a lower degree of decolorization in stage 1. We have only one stage, however, and cannot allow the degree of decolorization to fall below approx. 70% in the processing of cane raw sugar.

The mean decolorization values in the separate filters during the individual test cycles have been set out in Figure 8 as a function of the total amount of colour supplied to each filter. A rectilinear relationship has been assumed and the regression line has been entered. The values for Filter 2 are included up to the replacement of the resin in this filter. Consequently, it is of greatest relevance to compare the results from Filters 1 and 3 alone.

The degree of decolorization by the styrene resin is considerable higher than that of the acrylic resin at the beginning of the experiment period. However, the effect of the styrene resin fades more rapidly than that of the acrylic resin. The point of intersection of the regression lines where the two resins have the same decolorizing effect, lies at approx. 4.8 × 10^6 colour volume.

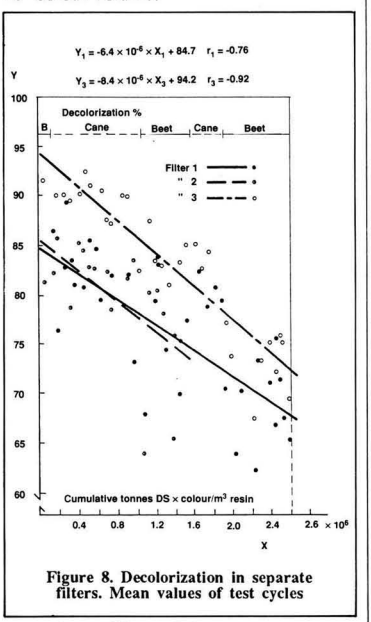


Figure 8. Decolorization in separate filters. Mean values of test cycles

The positions of the measurement points at the end of the experiment period deviate quite considerably from the straight line for both the filters. If we had continued with the experiment, the point of intersection would have been somewhere between 3 and 4 and at a quite low degree of decolorization. However, it is important to be in a position to ascertain that the styrene resin decolorizes better than the acrylic resin for the greater part of what may, in most cases, probably be viewed as a normal working life for such resins.

In such a comparison, it is more instructive to consider the colour leakage instead of the decolorization. The amount of colour which each respective resin leaves in the juice in total throughout the entire experiment period is proportional to the area between each respective line in Fig. 8, and the 100% line. For Filter 3, this area is approx. 30% less than the corresponding area for Filter 1, which indicates that Filter 3, i.e. the styrene resin, has left approximately 30% less colour in the juice. This is of considerable economic importance in the subsequent crystallization process.

The white sugar yield can be increased by, for example, back boiling in one or more stages, which means less syrup sent to the recovery house.

The experience gained in our refinery has shown that a reduction of the liquor colour by 30% gives a volume reduction of approx. 30% in 3rd syrup sent to the recovery house; this entails considerable consequences for energy consumption and sugar losses.

Decolorization during the cycles

During the experiment period, both cane raw sugar and imported and domestic beet raw sugar were processed. The amount of colour supplied to the filters during each cycle in the processing of the different raw sugar qualities is apparent from Figure 9. It will be seen that the amount of colour has been approximately of the same order of magnitude throughout the entire period, i.e. approx. 20 × 10^3 tonnes DS × colour/m³ resin/cycle.

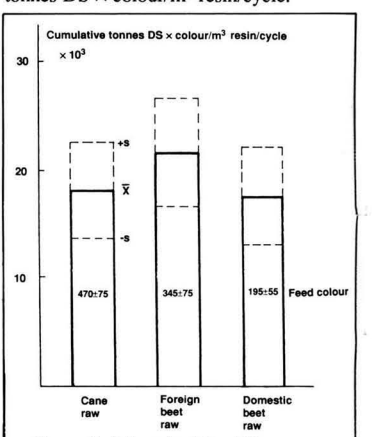


Figure 9. Colour load for different raw sugars

This amount of colour is comparatively slight. The reason for this is that we must place high demands on decolorization in order to be able, using a

single-stage decolorization process, to realize such a low juice colour that the mixture of the the three first refined sugar strikes can display sufficiently low colour to be acceptable for cube sugar.

It is also of interest to consider the progress of the decolorization during the cycles. In Fig. 10, the analysis results from the test cycles have been compiled, on the one hand for the periods with melting of cane raw sugar, and, on the other hand, for beet raw sugar. During each cycle, an average of slightly less than 20×10^3 was supplied, but in certain cycles the figure rose to approx. 25×10^3.

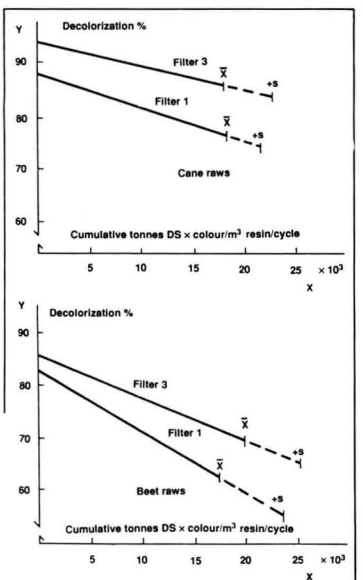


Figure 10. Decolorization during the cycles

For both types of raw sugar, the degree of decolorization throughout the entire cycles was higher for the styrene resin, and the decolorizing effect of the styrene resin throughout the entire cycle would appear to deteriorate slightly more slowly than for the acrylic resin.

The reason why the lines for the cane raw sugar periods are higher and incline less is that the melting of the cane raw sugar is at an early stage during the two experiment years, while the melting of the beet raw sugar generally takes place later.

Change of pH, ash content and invert content

As a result of the passage of the juice through the ion exchange mass, a certain change of pH, ash content and invert sugar may take place. We have found, by and large, that the following changes occur:

Table II. Quality alterations

Raw sugar	Cane	Beet
pH	-0.2	+0.1
Ash %DS	+0.02	+0.01
Invert %DS	+0.00	+0.01

These values are taken from the normal operational sampling and analyses from the whole station. At the beginning of a cycle, changes in pH and ash % DS are greater than the above mean values. The pH may deviate by up to +0.7 pH units, and the ash % DS by approx. +0.5. The invert sugar content is hardly affected at all. It has not been possible to demonstrate any differences between the acrylic and styrene resins compared here in these respects.

Summary

At the refinery in Arlöv, a comparative experiment was carried out for a period of 69 operational weeks where the decolorizing effect of a macroporous strongly basic acrylic resin and a macroporous strongly basic styrene resin were compared. During this experiment, two filters each of 7 m^3, were filled with acrylic resin and one with styrene resin. During the experiment, both cane and beet raw sugar were processed. Throughout the entire experiment the three filters were run at as closely approximating conditions as possible, i.e. juice quality, juice volume per cycle, regeneration process, etc. were the same for all of the filters.

The total amount of colour which was pumped into the filters during the experiment period was approx. 2.5×10^6 tonnes DS × colour/m^3 resin. The amount of colour per cycle was approx. 0.02×10^6.

The experiment results show that, in our process, the styrene resin subjected to the experiment showed a better decolorizing effect than the acrylic resin. As a mean figure for the experiment period, the styrene resin displayed 30% lower colour leakage than the acrylic resin. This gives in our refinery an approx. 30% volume reduction in 3rd class syrup sent to recovery, which entails considerable consequences for energy consumption and sugar losses.

The reduction in decolorizing effect is more rapid for the styrene resin, but not until at a total colour amount of 3-4 × 10^6 tonnes DS × colour/m^3 resin do the decolorizing effects become equal in magnitude.

Facts and figures

Indian sugar imports reduction plans[1]

India plans to reduce white sugar imports to 600,000 tonnes in the season April 1986/March 1987 according to the Press Trust of India. This compares with 2,000,000 tonnes imported during the 1985/86 season.

New enzyme technology for HFS manufacture[2]

Toyo Breweries Co. Ltd. has developed a new technology for immobilizing enzymes or microbes for a bio-reactor. The enzymes or microbes are incorporated in polyvinyl alcohol and the cost is reported to be only half that of immobilizing the enzyme on an existing polymer. Initially, Toyo put on the market in January 1986 an immobilized microorganism which generates glucose isomerase for HFS production, and it is said Toyo is also aiming at the development of a new enzyme that can produce 55% HFS directly from liquid glucose.

US sugar refining company revival[3]

On April 11, Revere Sugar Corporation emerged from almost one year of reorganization under Chapter 11 voluntary bankruptcy proceedings. Revere claimed protection from its creditors on April 25, 1985. Undisputed claims were expected to be paid at 25.5 cents on the dollar in May and disputed claims at the same rate in June. Only Brooklyn refinery in New York will resume operations; the refinery and machinery have been maintained in top condition during the dormancy period. An official at Revere hoped that production at the refinery will be on stream by late 1986.

1 *Public Ledger's Commodity Week*, April 19, 1986.
2 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 208.
3 *Dyergram*, 1986, (10-86), 1.

Laboratory clarification of raw cane and sorghum juices

Use of ion-exchange resin and carbon

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Introduction

Use of lead compounds for the clarification of raw sugar cane and sweet sorghum juices prior to quality analysis results in the generation of hazardous lead wastes which must be carefully disposed of. Lew[1] has described the use of ion-exchange resins and carbon for decolorization of beet juices. However, use of these compounds has not been adopted by the cane sugar industry. The following study was designed to evaluate the use of ion-exchange resin and activated carbon as a substitute for lead sub-acetate clarification of cane and sweet sorghum juices.

Materials and methods

Amberlite* IRA-410 anion exchange resin was obtained through Sigma Chemical (St. Louis, MO), and used at 25% moisture content. Except where the volume of juice and amount of resin + carbon were variables, 6 g of juice was clarified with either 1 g of lead sub-acetate or 1 g resin + 0.25 g Darco activated carbon, grade S-51 (Atlas Chemical, Wilmington, DE). Juice samples were shaken for 15 sec with lead or resin + carbon, allowed to settle for 15 min, and filtered through Whatman 2v filter paper with the addition of Celite filter aid. Filtered samples were quantitatively transferred into 100 ml volumetric flasks and brought to volume with distilled water. A Rudolph Autopol IIS automatic saccharimeter with a 200 mm flow-through cell was used to determine the pol content of the sample. The Brix (g soluble solids/100g juice) in the juice was determined in some samples using a Bausch and Lomb precision refractometer. Apparent purity of sucrose was then calculated as a percentage of soluble solids (g sucrose/100g soluble solids).

Results and discussion

A large amount of resin +carbon depressed the pol of clarified juice (Table I) and hindered the filtration. The filtering rate after adding 1 g of resin + 0.25 g carbon to about 6 g of juice was found to be similar to that with lead sub-acetate treatment and the measured pol value was similar. In subsequent experiments, 6 g of juice was clarified with approximately 1 g of an 80% resin + 20% carbon mixture and compared with juices clarified with lead.

Table I. The effect of lead or IRA-410 ion-exchange resin + carbon on the pol of sugar cane juice

Method	Juice weight, g	Pol	Time to filter, min
Lead			
1 g	27.1	17.63	15
1 g	5.8	17.77	10
Resin + carbon			
4 g + 1.0 g	26.0	16.50	30
4 g + 1.0 g	5.6	16.92	20
3 g + 0.75 g	5.6	17.29	20
2 g + 0.50 g	5.8	17.50	15
1 g + 0.25 g	5.8	17.62	10

Addition of equal quantities of glucose and fructose to sweet sorghum juice (Table II) and cane juice (Table III) depressed the pol reading and apparent purity of lead-clarified samples as expected, and depressed the pol and apparent purity of juices clarified with resin + carbon. Although pol and apparent purity of resin-clarified juices were consistently lower than those of juices clarified with lead, there was a very high correlation between the two methods (r = 0.99 for sweet sorghum; r = 0.99 for sugar cane), and the difference was not great.

Table II. The effect of lead or resin + carbon clarification on pol and apparent purity ofadulterated sweet sorghum juice

Invert sugar added, %	Pol		Apparent purity, %	
	Lead	Resin	Lead	Resin
0	13.64	13.42	68.89	67.78
0.92	13.38	13.14	65.24	64.07
1.82	12.98	12.74	61.11	59.98
2.74	12.70	12.38	57.91	56.45
3.66	12.36	12.00	54.67	53.07

Suspecting that lead and resin + carbon clarification depressed apparent purity below actual purity in samples with high invert sugar, sugar solutions of

1 *I.S.J.*, 1983, **85**, 323 - 327.
* Mention of a proprietary product does not constitute endorsement or a recommendation for its use by USDA

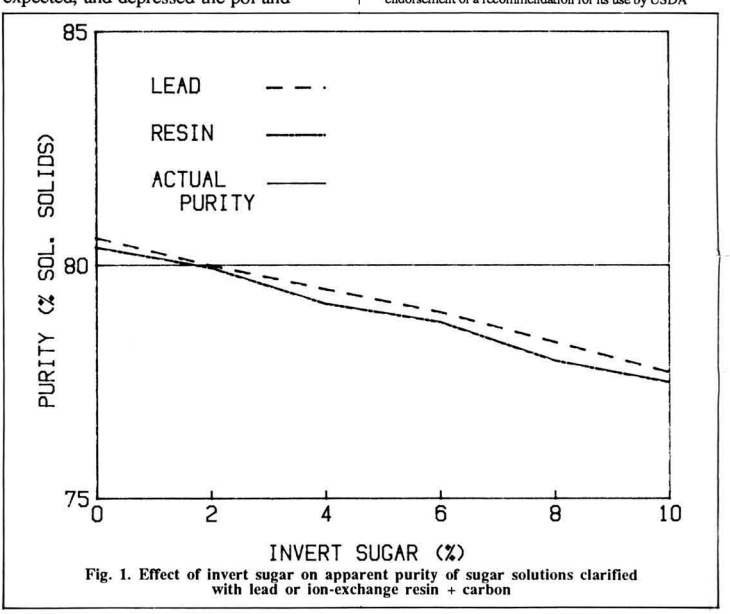

Fig. 1. Effect of invert sugar on apparent purity of sugar solutions clarified with lead or ion-exchange resin + carbon

Table III. The effect of lead or resin + carbon clarification on pol and apparent purity of adulterated cane juice

Invert sugar added, %	Pol		Apparent purity, %	
	Lead	Resin	Lead	Resin
0	17.18	17.18	89.34	89.34
0.92	16.92	16.82	84.77	84.27
1.84	16.58	16.40	80.14	79.27
2.74	16.16	16.02	75.66	75.00
3.66	15.84	15.60	71.74	70.65

constant sucrose concentration (80% soluble solids) were adulterated with varying concentrations of invert sugar (0 to 10%). KCl (10 to 20%) was added to keep the sucrose concentration constant. Results showed that, at very low invert concentration, apparent purity was overestimated (Figure 1), while at higher concentrations, purity was increasingly underestimated. Again, however, there was a very high correlation between the lead and resin methods of clarification (r = 0.99). That this discrepancy between actual and apparent purity was due to the presence of invert sugar was shown when the purity of sugar solutions of constant invert concentration (4%) was decreased by the addition of KCl (sucrose concentration 60 to 80%; KCl concentration 16 to 36%). In this experiment, carbon and resin clarification gave good estimates of actual purity (Figure 2) although again resin slightly underestimated the value. The correlation between lead and resin clarification was excellent (r = 0.99).

Conclusions

For the clarification of high purity juices, the resin + carbon method described is an excellent replacement for the hazardous lead used for sugar cane and sweet sorghum juice analysis. The resin and carbon may be mixed prior to use in an 80% resin to 20% carbon ratio (w/w). One gram of the mixture is sufficient to clarify 6 g of juice, which produces sufficient clarified juice, after dilution, to determine pol using an automatic saccharimeter. The resin is relatively inexpensive and easy to dispose of. Since increases in invert sugar levels depressed the estimate of sugar purity from the true value, whether clarified by lead or resin, alternate methods of analysis, such as HPLC, might be considered for low purity juices, where increased accuracy is desired.

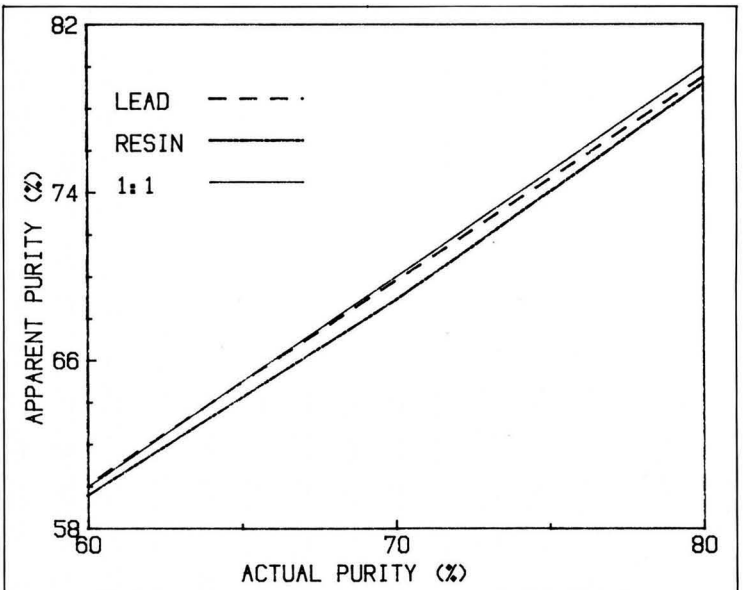

Fig. 2. Apparent purity of 60 - 80% sugar solutions clarified with lead or ion-exchange resin + carbon

Facts and figures

Bulk storage facilities in Hawaii[1]

Two additional facilities, able to store 100,000 short tons between them, are to be built in Hawaii at a cost of $2.5 million. Plans call for a 60,000-ton store adjacent to the Puunene mill of Hawaiian Commercial & Sugar Co. on Maui, and a 40,000-ton store at the Haina mill of Hamakua Sugar Co. on the island of Hawaii.

New sugar factory for Burma[2]

Tsukishima Kikai Co. Ltd is to supply a 3200 million yen sugar factory to Burma's Foodstuff Industries Public Corporation which is to be erected at Yedashe, 300 km north of Rangoon. The plant, to be completed by the end of 1988, will have a capacity of 1500 t.c.d. Burma has four sugar factories of which two are very small with capacities of 50 and 600 t.c.d., respectively. Production in 1984/85 was 69,000 tonnes, raw value, and that in 1985/86 is estimated at 70,000 tonnes.

Indian bagasse paper factory[3]

Tamil Nadu Newsprint & Paper Ltd. at Pugalur was set up with a 10,000 million rupees World Bank loan and went into operation in July 1985. Promoted by the state government, it is designed to produce 240 - 300 tonnes of newsprint per day, the raw material being 75% bagasse or more and up to 25% of wood, mainly eucalyptus. To encourage use of bagasse for newsprint manufacture, the Indian government has exempted from excise duty paper made with 75% bagasse or more. The Sugarcane Breeding Institute is studying the development of high sucrose cane which also has a high fibre content, up by nearly a third from the usual 10 - 15%.

Barbados sugar industry contraction[4]

With the pessimistic outlook for its preferential priced markets, the Barbados sugar industry is planning to reduce sugar production to 85,000 tonnes plus a 5% margin, according to the US Dept. of Agriculture. Sugar cane acreage is to be reduced by about 15% and at least one factory is to be closed. Total production for the 1985/86 season is now estimated at 110,000 tonnes, and calendar year 1986 exports at 85,000 tonnes, which compares with 77,600 tonnes in 1985.

1 *Sugar y Azúcar*, 1986, **81**, (4), 8.
2 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 224.
3 *N.S.I. News*, 1985, **21**, (2), 2 - 4.
4 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 222.

Increasing crystal content in massecuite by mechanical vibrations

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Introduction

Although there are many criteria and differences concerning the role of viscosity, and even more concerning the mechanism of molecular diffusion in the volume of the solution as a dominant or non-dominant factor in the kinetics of crystallization of sucrose[1], there is no doubt that, when low-purity mother liquors are used, viscosities are extremely elevated and are a real obstruction to growth. The situation becomes critical in massive crystallizations, when the crystal content of the medium increases as a result of its natural expansion, thus producing a powerful structuring of the system that then not only impedes the incorporation of sucrose on the crystals but practically stops the flow of the massecuite, making it completely inoperable[2,3].

Up to now, these difficulties have been attacked from various angles, with some positive results, but the problem is still far from being solved. Thus, the final massecuite is often lubricated with liquors of greater purity[4], which partially improves the circulation of the medium but conspires against exhaustion of the syrups.

Another variant that has been very extensively developed in recent years is the use of viscodepressive chemical agents[5], which have often proved effective in diminishing viscosity by some 15%. Nevertheless, when the crystal content exceeds 40%, viscosity rises so rapidly that the barrier imposed by the structuring of the medium soon appears again (See, for example, Figure 1 showing a curve similar to those reported in this work.) In fact, this barrier is impossible to avoid, since it is of practical interest to increase the crystal content to the maximum, which means that the mother liquor is constantly decreased.

Another factor is also worthy of note: that related to the homogeneity of application of the viscodepressive agent. It is difficult to guarantee that the entire volume of massecuite in question will contain a minimum concentration of the agent, either because the application is discontinuous or because there are already

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mixing difficulties in products of such high viscosity[5].

In view of these difficulties, it seemed desirable to try some other means that would permit moving the curve in Figure 1 more to the right, that is, so that the top of the curve would correspond to a higher percentage of crystals, whereby a greater quantity of sucrose could be extracted from the mother liquor while still maintaining acceptable fluidity and achieving a more homogeneous application to the massecuite.

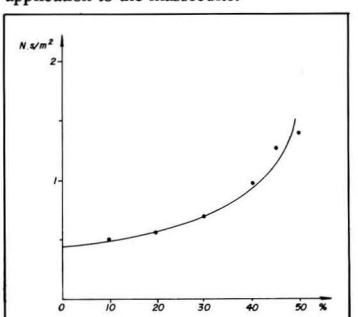

Fig. 1 Typical curve of viscosity *vs.* crystal content

The most appropriate way to do this seems to be by treating our system with mechanical vibrations. For many years now, it has been common practice in the field of concrete construction to use mechanical vibrations to make cement mixtures more compact. It is evident at a glance that this oscillating movement tends to make these materials more fluid, allowing them to fill the spaces in their forms.

Meanwhile, a study of the rheological properties of carbonate sludge[6] also showed that, as a result of the application of low-frequency mechanical vibrations, fluidization of the medium is obtained. Thus, given the similarity in terms of the dispersion of the solid medium in the liquid in these systems, compared with those that interest us, it was felt that some positive effect might be found.

In order to clarify this matter, certain laboratory experiments were made to determine the rheological behaviour of the systems under consideration, in an acoustic environment.

Experimental

The basic measuring equipment used was a rotational viscometer with a measuring cylinder H of diameter 21 mm within a measuring receptacle having a diameter three times that of the cylinder. The measuring receptacle (see Figure 2) was expressly designed for these experiments and its dimensions guarantee a fluid behaviour equivalent to an infinite medium, i.e. the walls do not influence the measurement[7]. The bottom of the measuring receptacle is a membrane that vibrates at a fixed amplitude of 1.2 mm and a frequency of between 0 and 50 mHz.

The oscillations of this membrane are caused by an eccentric axis joined to a rod firmly attached to the membrane. The number of revolutions per second of the axis is equal to the frequency of the membrane, which was determined with the help of a stroboscope having a ± 1 Hz error of measurement.

The walls of the receptacle have channels for the circulation of water pumped from a thermostat at a temperature precisely controlled to within ±0.1°C. The error in determining the shear stress of the massecuite is 3%. The test

1 VanHook: *Proc. 16th Congr. ISSCT*, 1977, 2613 - 2621.
2 Gromkovskii: *Doctoral Thesis (Venezh)*, 1977.
3 Schukin: *Bull. Acad. Sci. USSR*, 1978, (5).
4 Alemán *et al.*: *CubaAzúcar*, 1977, (4), 30 - 34.
5 Lodos & Díaz: *ibid.*, 1978, (1), 3 - 16.
6 Kemblowski: *Gaz, Cukr.*, 1977, **85**, 25.
7 Gromkovskii: *Izv. Vuzov. Pishch, Tekhnol.*, 1977, (4), 157 - 162.

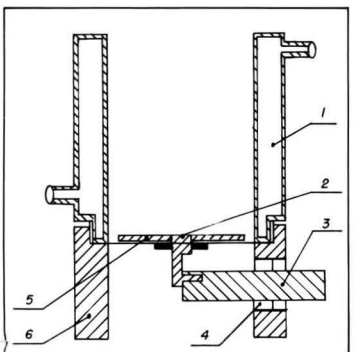

Fig. 2. Measuring receptacle used in the experiments: 1 channels for thermostat control; 2 rod; 3 eccentric axis; 4 bearing; 5 membrane; 6 base

materials were prepared synthetically from a syrup of 86° Brix and 45 purity, mixed with refined sugar of uniform size (0.42 - 0.59 mm) in weighted proportions determined *a priori*.

Results and discussion

The rotational viscometer used as a means of measuring allowed us to establish the curves of flow in an acoustic environment with a constant amplitude (A = 1.2 mm) and frequencies between 0 and 40 Hz.

Figure 3 shows the curves of flow at 55°C for values of crystal content between 0 and 45% and for frequencies from 0 to 20 Hz. The shear stress and rates are expressed as (newton/m^2) and (sec^{-1}), respectively. This system evidences a powerful non-Newtonian behaviour which is inferred from the non-linearity of the relationship between g_r and Dr.

It can also be observed that the curves of flow to 20 Hz move considerably below those corresponding to crystal content at zero frequency. This effect becomes more significant for values above the percentage of crystals.

Figure 4 presents the family of curves of flow at 50°C corresponding to 45% of crystals, one of the factors of most practical interest, for frequencies of 0, 10, 20 and 40 Hz. It is clear that the displacement of the curves of flow is greater for low frequencies than for values above 20 Hz.

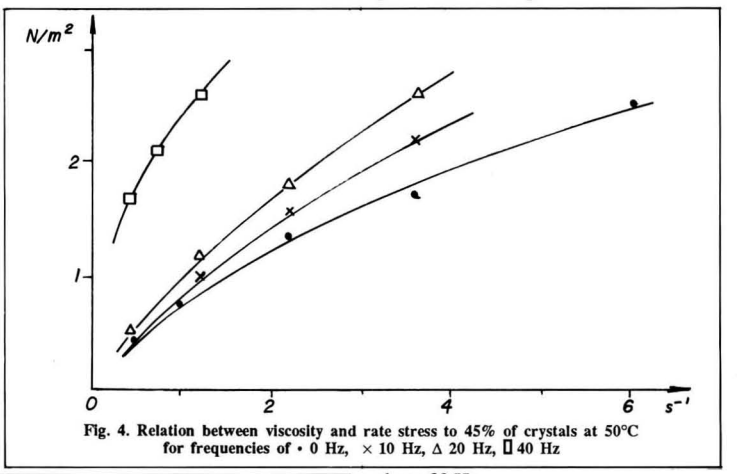

Fig. 4. Relation between viscosity and rate stress to 45% of crystals at 50°C for frequencies of • 0 Hz, × 10 Hz, Δ 20 Hz, □ 40 Hz

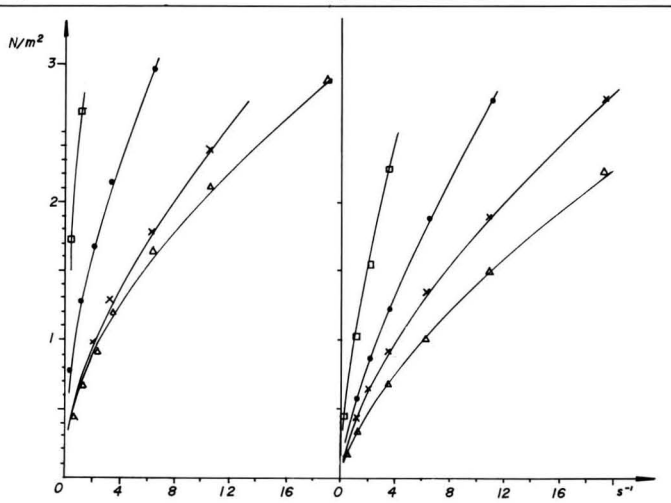

Fig. 3. Curves of flow at 55°C, frequencies of 0 and 20 Hz: Δ 0% crystal content; × 10% crystal content; • 30% crystal content; □45% crystl content

It should be noted that, in the range of short test shear rates, the presence of the acoustic environment tends to align the curves of flow; in other words, there is a certain tendency toward Newtonian behaviour. Although the systems of our study are not pure fluids, but are rather composed of a considerable proportion of solids, they are still capable of flowing and the apparent viscosity, estimated as the coefficient between the shear stress and rate stress, continues to be a parameter of great value which will always give us an idea of the level of opposition to flow.

In the calculations a reference of rate stress equal to 1.2 sec^{-1} was taken for all viscosities.

Figure 5 shows the apparent viscosity in ns/m^2 at 50°C with respect to the crystal content for frequencies between 0 and 40 Hz. As can be seen, when mechanical vibrations of 40 Hz are applied to a mass with 50% of crystals, its

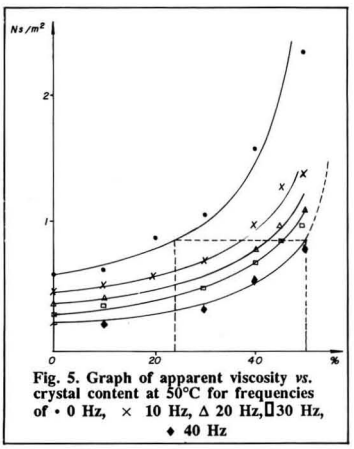

Fig. 5. Graph of apparent viscosity *vs.* crystal content at 50°C for frequencies of • 0 Hz, × 10 Hz, Δ 20 Hz, □ 30 Hz, ♦ 40 Hz

rheological properties are equivalent to another static system with approximately 20% of crystals. This means that the strong structuring that normally appears in this system and that terminates the crystallization has been affected in such a way that it permits us to extend the growth of the crystals beyond a weight content of 50%, which is of great practical and economic interest.

Figure 6 shows the dependency between viscosity and frequency for different crystal contents at 55°C. It is clear that, for high crystal content, the dependency is strong, becoming weaker for lower percentages of crystals. Here it is evident that, for frequencies above 20 Hz, the system enters a state of saturation, which gives us a practical limit of application.

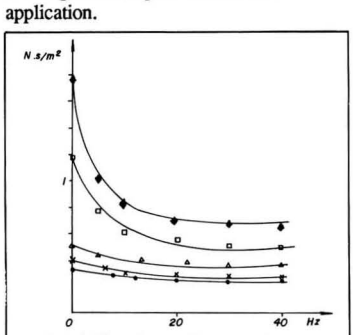

Fig. 6. Viscosity *vs.* frequency for different crystal contents at 55°C: • 0%, × 20%, Δ 30%, □ 40%, ♦ 50%

This can be associated with the fact that now, at this point, the structuring might break at any moment, but also the phenomenon could be associated with the system's response to the coupling with the membrane, source of the vibrations. The latter is suggested by the fact that, when low-purity massecuite is strongly agitated, the solids often separate from the fluid.

Conclusions

In the course of this work, it could be proved that the low-purity massecuite changes rheological properties when made to vibrate mechanically, showing a tendency of the system toward the Newton factor without attaining it, which means that the structuring of the medium could partially break.

Thanks to the application of mechanical vibrations, third massecuite diminishes in apparent viscosity by more than 50%, producing a crystal content above 45%. It was proved that the effect is more notable for high crystal content, which is precisely of the most practical interest. It raises the possibility of extending the growth of sugar crystals to more than 50% by weight of the system while still maintaining a fluidity comparable to a massecuite of 20% crystal content. Above 20 Hz, the system enters a state of saturation, which provides us with a possible practical limit for its application.

Summary

The high viscosity of low-purity massecuite determines the limit of the crystal content that can be obtained. By using mechanical vibrations of 1.2 mm amplitude and frequencies higher than 20 Hz, it is possible to break the powerful structure of these systems to a great extent, thereby diminishing viscosity by more than 50% and permitting an increased crystal content of more than 50%.

Facts and figures

Alcohol from sugar in West Germany[1]

A company has been founded by the farmer-owned sugar industry in Lower Saxony for the planning and construction of a plant to produce some 250,000 hl of alcohol per year for fuel from about 40,000 tonnes of sugar. It is to start operations in 1988 and will be annexed to the Gross-Munzel sugar factory.

Cuban bagasse dryer[2]

A dryer, designed by the Cuban National Sugar Research Institute ICINAZ, has been installed in some 15 sugar factories. It is easy and cheap to manufacture and achieves a reduction of 17% in bagasse moisture, giving a 16% gain in steam generation.

Yugoslavia beet crop expansion[3]

Yugoslavia plans to increase beet production to about 8 million tonnes/year by 1990, against an average for 1981/85 of 6.12 million tonnes, and a 1985/86 crop of 6.5 million tonnes.

Further Pakistan sugar imports[4]

The Pakistan government authorized the Trading Corporation of Pakistan to import a further 150,000 tonnes of white sugar for arrival during May/August and this quantity was, in fact, bought at a tender in mid-April. It is in addition to 100,000 tonnes for which licences were issued earlier this year and to white sugar imported by the private sector. Only a few months ago, domestic producers were suggesting that, with local output in 1985/86 expected to be almost in line with consumption needs and adequate stocks following the excellent crop in 1984/85, there would be no need to import sugar. Disagreement over cane prices led to disruption of supplies to the factories, however, and this, with other causes, has resulted in a drop in production of nearly 200,000 tonnes, while demand has continued to grow.

Indian white sugar export to the EEC[5]

The State Trading Corporation of India finalized a deal for the export of 10,000 tonnes of Indian white sugar under the Indo-EEC Trade Agreement, at a price which is substantially higher than that realised in 1985 for a similar tonnage and the prevailing world price for white sugar.

New Cuban sugar factory[6]

A new sugar factory at Majibacoa in the eastern province of Las Tunas was opened recently; it has a capacity to crush 700,000 tonnes of cane a year to produce 100,000 tonnes of sugar.

1 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 243.
2 *Cuba Economic News*, 1985, **21**, (148), 4.
3 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 244.
4 *Czarnikow Sugar Review*, 1986, (1748), 53.
5 *Sugar Scene*, 1986, **4**, (5), 12.
6 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 246.

Facts and figures

ICUMSA 19th Congress, 1986

The 19th General Assembly of the International Commission for Uniform Methods of Sugar Analysis took place during May 25 - 30, 1986 in Cannes, France. The reports of the Referees for the various subjects, discussions and recommendations adopted will be published in due course. The President, Professor Erich Reinefeld of the Braunschweig Technical University, had decided to retire on the grounds of age and Murray Player of CSR Limited in Australia was elected President in his place. Because of the need for close collaboration between the President and General Secretary, Dr. A. Emmerich resigned from the latter post and Dr. E. Whayman of the Sugar Research Institute was elected in his place, Dr. Emmerich being named Honorary General Secretary. A new body of Vice-Presidents was elected and an invitation to hold the next General Assembly in the USA in 1990 was accepted.

Crystallization technology

A three-day intensive course on this topic, intended for bench-scale, pilot-plant and commercial-scale engineers, chemists and technologists, is to be held in the Hague, Holland, during December 17 - 19, 1986, under the aegis of the Center for Professional Advancement, Palestrinastraat 1, 1071 LC Amsterdam. Details of the course, which costs $1035, may be obtained from the Center.

Süddeutsche Zucker-AG campaign results, 1985/86

In spite of a reduction of the company's beet area from 115,000 to 113,000 ha, the beet crop rose from 6.223 to 6.362 million tonnes in 1985. The sugar content was also higher at 17.69% against 16.48% in 1984, so that production amounted to 970,000 tonnes, 9.5% more than the 886,000 tonnes of 1984/85. Slicing capacity rose from 73,000 to 75,000 tonnes/day so that the campaign occupied an average of 85 days in 1985/86, exactly the same as in 1984/85.

Dominican Republic sugar factory closures[1]

The State Sugar Council (CEA) which owns 12 of the the Dominican Republic's 16 sugar factories, has announced it will close six of them at the beginning of 1987. The action results from low sugar prices and cuts in the US quota to 302,016 short tons in 1985/86 against 447,040 tons in 1984/85 and 535,392 tons in 1983/84. Sugar production in 1985/86 is expected to be about 700,000 tonnes, tel quel, substantially down from earlier years when it always exceeded the million tonne mark.

New Indian sugar factory[2]

A new cooperative sugar factory, Ukai Pradesh Sahakari Khand Udyog Mandali, at Khushalur in the Surat district of Gujarat went into operations in February and is now functioning at its full capacity of more than 1250 t.c.d.

Discussions on alcohol from beet in Spain[3]

The closed sugar factory of Cía. de Industrias Agrarias S.A. at Santa Eulalia in the north-eastern Spanish province of Teruel may be re-opened with the object of converting it into an alcohol plant. A special conference has been held in Zaragoza to consider the project. Conversion to an ethanol plant would be easy as most of the existing machinery could be used. It is estimated that with an investment of 400 million pesetas, a production of 60,000 litres of alcohol per day is possible.

Colombia sugar exports, 1985[4]

	1985	1984
	tonnes, raw value	
Canada	0	12,000
Japan	24,000	0
Korea, South	12,000	0
Morocco	26,000	0
US	185,684	123,730
Venezuela	47,250	47,250
Total	294,934	182,980

Czechoslovakia sugar production, 1985/86[5]

White sugar production from beet in Czechoslovakia in 1985 amounted to 864,041 tonnes, substantially up from the 776,750 tonnes produced in 1984. Refined sugar from imported raws in 1985 totalled 105,328 tonnes, against 159,582 tonnes in the previous year.

Zimbabwe alcohol production capacity expansion[6]

The country's only alcohol plant, owned by Triangle Ltd. in the Lowveld, has been authorized by the government to embark upon an expansion program to increase its production from 40 million to 70 million litres per year. Alcohol content in the local petrol blend has recently declined from 20% to about 14%; however, the Ministry of Energy, Water Resources and Development is hoping to restore the higher level in an endeavour to conserve foreign exchange.

Dietary fibre from beet[7]

According to the 1985 annual report of Cardo AB., about 80 million kroner are being invested in a plant at Köpingebro (where there is a sugar factory belonging to the subsidary company Svenska Sockerfabriks AB.) for production of Fibrex, a fibre made from beets.

Malaysian interest in alcohol manufacturing[8]

Malaysian alcohol producers are currently seeking Brazilian knowledge and technology to examine the economics and practicality of producing fuel-grade ethanol. Concern over air pollution and dependence on foreign oil are prompting interest. Molasses and other vegetable wastes would be likely feedstocks and raw sugar might be imported from India or neighbouring countries such as Thailand if efforts to use indigenous feedstocks prove fruitless or uneconomical.

Yugoslavia barter agreement for sugar exports[9]

Yugoslavia plans to export 152,000 tonnes, raw value, of white sugar during the 1985/86 marketing year, compared with 126,000 tonnes exported in the previous year. With the current squeeze on hard currency, many contracts are on a barter basis, as was a deal with Kenya in 1984/85[10]. According to press releases, a similar agreement has been reached for supply of 100,000 tonnes to Kenya in 1985/86 in exchange for fuel oil.

Ecuador sugar imports[11]

Ecuador's sugar production for the 1985/86 crop year was significantly reduced by severe drought and is estimated at 272,000 tonnes. Exports have been made under quota to the US, ammounting to 18,876 short tons, but to meet requirements, a total of just over 70,000 tonnes will be covered by imports under barter agreements. Outlook for the 1986/87 crop is much better, mainly as a result of the return of normal weather and improvement of agricultural practices with an emphasis on increasing yields.

New Yugoslavian sugar factory[12]

The new sugar factory at Pabinska Skela, near Belgrade, should be working at its full processing capacity of 6000 tonnes of beet per day in the 1986/87 season.

Morocco sugar factory expansion[13]

Fives-Cail Babcock of France has received a contract for the second extension of the Sidi Bennour sugar factory to reach a capacity of 7500 tonnes per day of beets from the current 4000 tonnes per day.

Jamaica sugar industry rehabilitation program[14]

The Jamaican government is to undertake a 6-year program to overhaul the island's sugar industry which will include privatization of the management of the industry begun in 1985 when Tate & Lyle took over running of the two state-owned factories. Rehabilitation is expected to cost $52 million but the Agricultural Minister did not disclose the source of the funds. Production is

1 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 246.
2 *Sugar Scene*, 1986, **4**, (5), 13.
3 F. O. Licht, *Int. Molasses & Alcohol Rpt.*, March 1986.
4 *I.S.O. Stat. Bull.*, 1986, **45**, (5), 11.
5 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 267 - 268.
6 *Standard Chartered Review*, May 1986, 14.
7 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 287.
8 *Amerop-Westway Newsletter*, 1986, (150), 12.
9 F. O. Licht, *Int Sugar Rpt.*, 1986, **118**, 288.
10 *I.S.J.*, 1986, **88**, 20.
11 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 290.
12 *Czarnikow Sugar Review*, 1986, (1749), 77.
13 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118**, 290.
14 *Financial Times*, May 20, 1986.

to be tailored to meet the EEC quota of 126,222 tonnes, 25,437 tonnes for the US and about 100,000 tonnes for the domestic market. Land previously used for sugar will be planted to vegetables and also to cane for producing alcohol. A new company with private management is to be established to store and market sugar. Sugar production increased to 296,707 tonnes in 1985, an increase of 14,400 tonnes on 1984, and early efforts at rehabilitation had improved the cane:sugar ratio from 12.36 in 1984 to 10.81 in 1985.

Zaire sugar production, 1985[15]

In 1985, Zaire's sugar production was 60,327 tonnes, white value, while, although a significant increase is expected in 1986, it is unlikely to meet domestic requirements of 150,000 tonnes/year. It is estimated that by 1990 production capacity will be 108,000 tonnes (65,000 tonnes at Kwilu-Ngongo, 28,000 tonnes at Kiliba and 15,000 tonnes at Lotokila). The 1000 tonnes/day sugar factory at Lotokila, in the region of Haut-Zaire, started production in October 1985; it was built with Chinese assistance and belongs to the government. It is fed from a 3000-acre cane plantation and includes a 12,000 litres/day alcohol plant.

Nepal sugar factory project[16]

Among the provisions of agreement between Nepal and China is the erection by the latter of a sugar factory at Lumbini. Nepal has five cane sugar factories which, according to latest estimates, produced 22,000 tonnes, raw value, in 1985/86.

Taiwan sugar production, 1985/86[17]

Sugar production in Taiwan in the 1985/86 season totalled 570,400 tonnes, tel quel, down more than 90,000 tonnes from 1984/85. Target production for 1986/87 has been set at 550,000 tonnes, owing to low world market prices.

Canadian sugar beet contract

Last year no sugar beets were grown in Alberta and the Taber factory did not operate. It had been feared that this situation might continue and that the closure might become permanent. However, a new contract has been negotiated for 1986[18] and was reached through the provision of finance from the provincial and federal governments which will enable the Alberta Sugar Company, a subsidiary of BC Sugars of Vancouver, to operate at a profit. The subsidy program is to continue for the three years.

Canada HFS production and export to the US[19]

Canada Starch Company is the country's sole producer of high fructose syrups, with three plants in Ontario, one at Cardinal producing 42% fructose and one each at Port Colborne and London producing both 42% and 55% product. Canadian HFS cannot compete with refined sugar produced from world market raws so that virtually all output is exported to the US, benefiting from the cost advantage of the weaker Canadian dollar. Census data show that 222,867 tonnes entered the US from Canada in 1985.

World Sugar Journal

This publication, concerned with economic aspects of the sugar industry, will for the future be part of a new publication,*World Commodity Journal*, which will contain sections concerning coffee, cocoa, rubber, tea and edible fats and oils.

Pakistan sugar imports[20]

Pakistan has finalized deals to import 400,000 tonnes of sugar to overcome a shortage due to increased consumption[21]. The state-owned Trading Corporation of Pakistan has completed contracts for 250,000 tonnes in addition to the 150,000 tonnes bought by the private sector. All deliveries are expected before September. With production in 1985/86 at about 1.12 million tonnes against domestic consumption of about 1.5 million tonnes, reserves of about 250,000 tonnes had been used and the price had risen within a month from 8.5 to 9.5 rupees/kg.

Trinidad sugar production, 1985/86[22]

Sugar production in Trinidad from the 1985/86 season totalled 91,712 tonnes, raw value, 10,812 tonnes more than the previous season. The outturn is sufficient for Trinidad to meet its EEC quota.

Mexico sugar export plans[23]

The record crop in 1985/86 will enable Mexico to export at least 350,000 tonnes of sugar in 1986, according to Azúcar S.A. and the National Chamber for the Sugar and Alcohol Industry. In recent years Mexico has exported only to the US but in 1985 it also sent 150,000 tonnes to the world market.

Thailand cane sugar crop, 1985/86[24]

The 1985/86 in Thailand ended on May 18 with a total of 23,999,000 tonnes of cane crushed, against 25,053,000 tonnes in 1984/85. Sugar production reached 2,561,000 tonnes, raw value, or 0.5% more than the previous season. White sugar reached 936,568 tonnes, while raw sugar production was set at 1,543,000 tonnes.

Uganda mill reconstruction progress[25]

The foundation stone of the reconstructed Lugazi sugar factory in Uganda was laid in mid-May; it should be ready for commissioning in the third quarter of 1987 and will have a capacity of 60,000 tonnes of white sugar/year. More than a third of the 9200 hectares of cane land, which had reverted to bush, has been fully rehabilitated. The main civil works for the factory, which is being built adjacent to the original 1924 factory, will be done by a Swiss construction company and erection, testing and commissioning of plant by a UK firm. Krupp of West Germany will provide the electrical and cooling systems, Buckau-Wolf India will supply the boiler and Fletcher and Stewart of the UK will supply the cane mill. The Sugar Corporation of Uganda will provide $2.3 million of the construction cost, $4 million will come from the Mehta family and $16 million from the African Development Bank, $10 million from the Kuwait Fund for Arab Economic Development, and $8 million each from the International Finance Corporation, The Arab Bank for Economic Development in Africa and the Export-Import Bank of India, $7 million from the Commonwealth Development Corporation, and $5 million from the International Development Association.

Guyana Spring sugar crop, 1986[26]

The Spring 1986 sugar crop in Guyana closed with production of 124,475 tonnes, slightly more than the target and the highest first crop since the industry was nationalized ten years ago. It was achieved in spite of smut disease in the cane fields and a declining labour pool. Total output from both Spring and Autumn crops is estimated at 250,000 tonnes against 257,688 tonnes in 1985.

Ecuador alcohol projects[27]

Owing to low molasses prices, the three principal sugar factories in Ecuador plan to build alcohol distilleries to use the molasses as raw material.

PERSONAL NOTES

His many friends in the sugar industry will be saddened to learn of the death in June of **Ben A. Oxnard,** at the age of 82. He was born into one of the United States' prominent sugar families (relatives built factories and refineries all over the country and the town of Oxnard, California, was named after one who built a beet sugar factory there) and graduated from M.I.T. before starting his sugar career with Savannah Sugar Refinery. He transferred to Great Western Sugar Company, where he was in charge of sales for many years before he retired. He was a fund of stories, many of them featuring one of the Sprague and Oxnard cousins or uncles, concerning activities in the US sugar industry and involving technology, politics, economics and sometimes dubious goings-on. In the 1920's and early 1930's – the Prohibition era – he had worked in the New York sugar market and also travelled in Europe gaining a deep insight into sugar operations and personalities which he would later recall when with friends. Occasionally he would set down on paper some of his recollections; unfortunately it is now too late for a complete set of memoirs which would have provided a fascinating account of sugar history. Ben was part of that history and the industry is poorer for his loss.

15 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 290, 307.
16 *Zuckerindustrie*, 1986, **111,** 521.
17 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 309.
18 *Public Ledger's Commodity Week*, May 31, 1986.
19 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 310.
20 *Reuter Sugar Newsletter*, May 27, 1986.
21 See *I.S.J.*, 1986, **88,** 88.
22 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 320.
23 *GEPLACEA Bull.*, 1986, **3,** (5), Inf.-3.
24 F. O. Licht, *Int. Sugar Rpt.*, 1986, **118,** 325.
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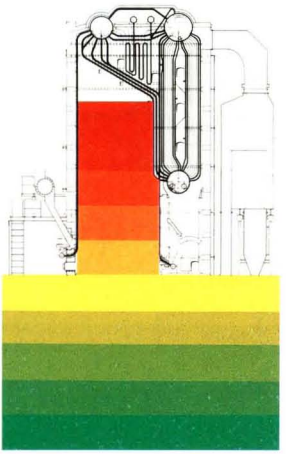
Bagatex 20

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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Membrane Press Filter model PKF

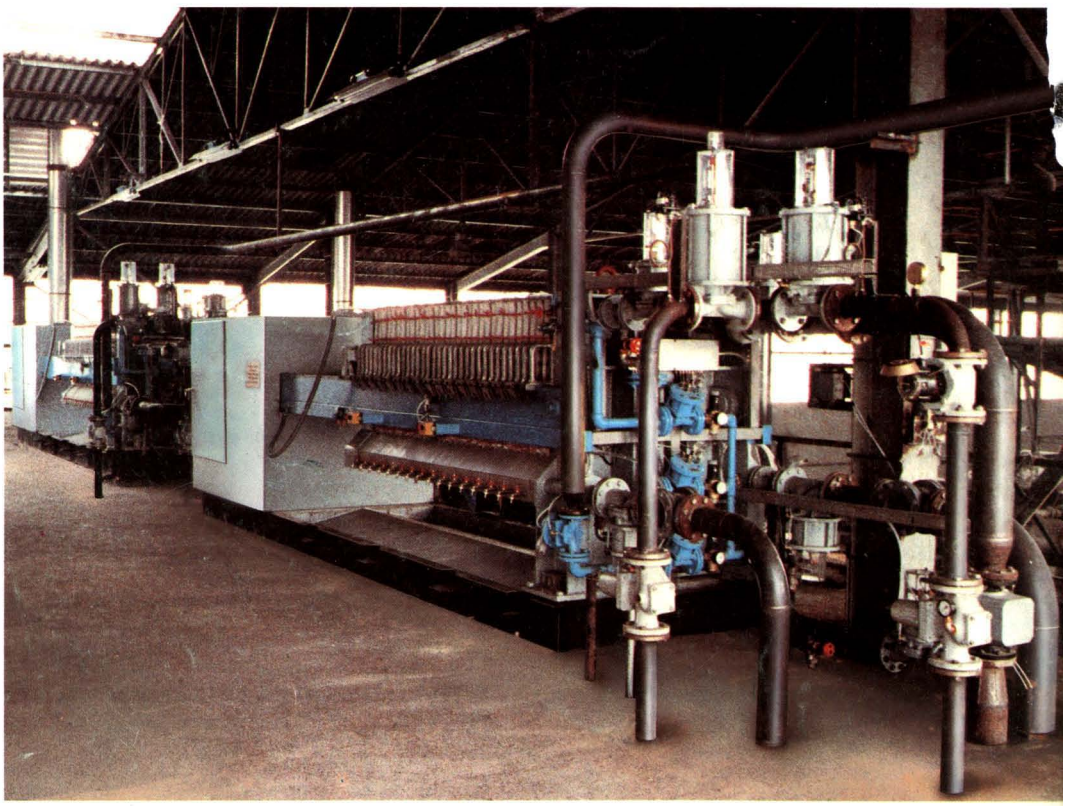
You can obtain more than 70 % dry substance in your filter cake when processing beet and less than 45 % moisture when processing cane.

High operating capacity.

Excellent sweetening-off results.

Fully automatic operating cycles.

For more details ask Putsch about their PKF Filters.



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