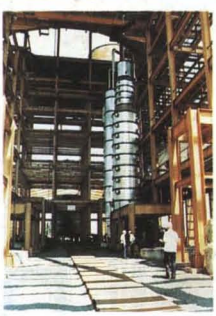
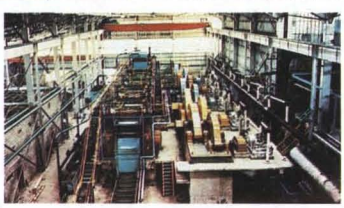
INTERNATIONAL SUGAR JOURNAL



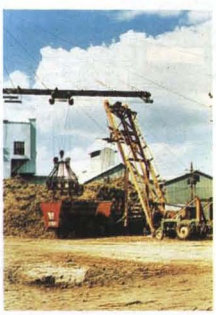












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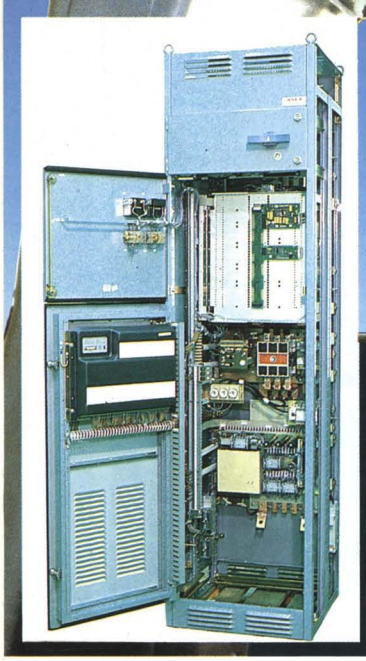

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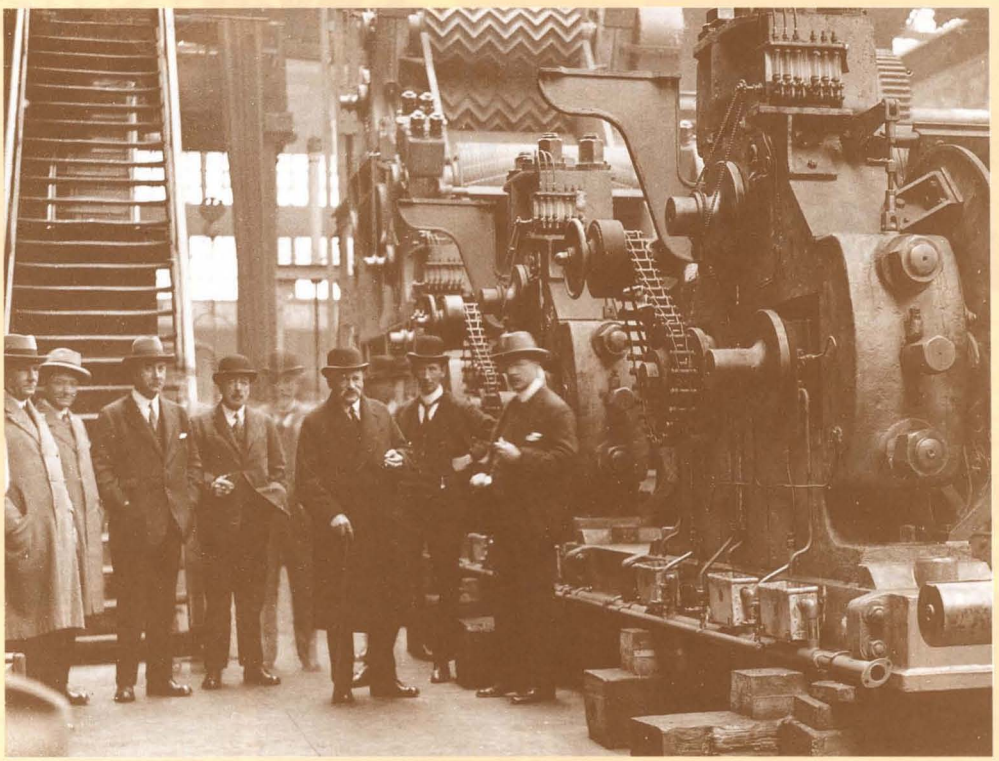

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News and views

International Sugar Agreement

Producers and consumers agreed at the September UN sugar conference[1] on the terms of a new I.S.A. to run for three years from January 1, 1988, and then to be renewable annually for a maximum of two further years. The principle of 1000 votes per group (importers and exporters) was maintained but importers are now liable for only 42.5% of the costs of the International Sugar Organization (instead of 50%) and the exporters for 57.5%. The ISO Council will review annually members' budget contribution, taking into account the latest trade statistics. Contributions cannot be changed by more than 5% per year.

Japan sugar-containing imports increase[2]

The sugar refiners in Japan have asked the Ministry of Agriculture to reduce the official domestic price of sugar, which is kept artifically high, so as to enable them to compete with imported products containing sugar. Domestic sugar consumption has fallen steadily since the mid-1970's when it reached a peak of 3.2 million tonnes, which contrasts with the 2.5 million tonnes estimated for 1987. The reasons for the decline are a drop in demand for sweeteners in general and an increased use of high fructose syrup, consumption of which has remained steady lately at 620,000 tonnes annually.

The candy industry in Japan, which currently absorbs from 35 to 40% of total sugar consumption, is raising its imports of products containing sugar. Imports of sweetened chocolate alone rose from 24,000 tonnes to 31,000 tonnes in 1986 and were 11,000 tonnes during the first four months of 1987 – a rise of 60% over the same period in 1986. The reason for the increase is that raw sugar imports pay a duty of 150%, compared with 30% for chocolate with a 95% sugar content; this duty will have to be lowered to 10% in 1988 as a result of pressure from the USA which wants to increase its chocolate exports. The price of refined sugar in Japan is nearly twice that in Canada and 50% higher than in the United Kingdom.

World sugar prices

The slide in raw sugar prices in late August came to an end and reports of Soviet and Egyptian sugar purchases, and inquiries by other Middle East countries and by China brought the London Daily Price from $147.40 on September 1 to $152.40, aided by reports of lower production in Cuba and Indonesia. Reports from Brazil which indicated a million tonnes greater availability of sugar resulted in a fall to $146.20 on September 7. Lack of availability of Thailand sugar, owing to drought, and further reports of Cuban difficulties in meeting contracts strengthened the market as did Czarnikow's estimate of reduced EEC export sugar availability, and reports of bad weather causing difficulties in both East and West Europe. Licht's first estimate of world sugar production, announced near the end of September, was a further strengthening factor and the LDP finished the month at $163 per tonne. White sugar prices were much less affected by the considerations which caused variation in those for raw sugar and the LDP(W) was much more stable, starting the month at $182.20 and ending at $186, with the whole of the month's prices within the range $181 - $187.60.

Europe beet sugar production, 1987/88

It is usual for tests on European beets to be carried out from some time in August in most countries and those published so far in 1987 have shows that the cold, wet weather in Northern Europe and heatwaves in the southern part of the continent have reduced probable yields of sugar per hectare. C. Czarnikow Ltd. recently referred to the fact that the sugar beet is a plant with highly recuperative powers which has in the past given satisfactory results in spite of an unpromising early appearance[3]. "It is far too early to make substantive forecasts, but our first projections . . . point to a further fall in output in Europe this season".

F. O. Licht GmbH[4] also note that "it is still too early to forecast European sugar production with a high degree of accuracy"; nevertheless, the two forecasts are quite similar (to within 170,000 tonnes, raw value) and both set output at the lowest level since 1980/81. Because of the closeness of the estimates, and the fact that the Licht figures were published a week later than those of Czarnikow, we reproduce the former below, together with comparable figures for 1986/87.

	1987/88	1986/87
	tonnes, raw value	
EEC		
Belgium	895,000	1,017,000
Denmark	390,000	543,000
France	3,910,000	3,734,000
Germany, West	2,800,000	3,468,000
Greece	212,000	312,000
Holland	1,030,000	1,325,000
Ireland	217,000	202,000
Italyl,715,000	1,868,000	
Portugal	5,000	5,000
Spain	1,050,000	1,092,000
UK	1,300,000	1,438,000
Total EEC	*13,524,000*	*15,004,000*
Other West Europe		
Austria	402,000	307,000
Finland	79,000	132,000
Sweden	291,000	386,000
Switzerland	121,000	129,000
Turkey	1,790,000	1,465,000
Yugoslavia	1,010,000	855,000
Total West Europe	*17,217,000*	*18,278,000*
East Europe		
Albania	40,000	38,000
Bulgaria	110,000	179,000
Czechoslovakia	770,000	860,000
Germany, East	645,000	730,000
Hungary	450,000	473,000
Poland	1,730,000	1,892,000
Rumania	560,000	610,000
USSR	8,350,000	8,650,000
Total East Europe	*12,655,000*	*13,432,000*
Total Europe	29,872,000	31,710,000

1 *I.S.J.* 1987, **89**, 181.
2 *Reuter Report*, July 1, 1987.
3 *Czarnikow Sugar Review*, 1987, (1764).
4 *Int. Sugar Rpt.*, 1987, **119**, 403.

West Indies sugar production, 1987[5]

With the 1987 sugar crop ended in Barbados, St. Kitts and Trinidad, and only the late crops in Guyana and Jamaica still not completed, it is possible to make a fairly accurate estimate of 1987 sugar production for Caricom, the Caribbean Community. The total is set at 633,300 tonnes and includes 83,300 tonnes in Barbados, 245,000 tonnes in Guyana, 195,000 tonnes in Jamaica, 25,000 tonnes in St. Kitts and 85,000 tonnes in Trinidad.

The Barbados crop was some 6700 tonnes below the target of 90,000 tonnes, owing to extremely dry weather affecting the cane harvested towards the end of the crop. The St. Kitts crop was also below target, owing to delays in harvesting caused by heavy rain. The Trinidad crop was some 15,000 tonnes below target, owing to illicit cane fires. The main crop in Guyana is still due to be harvested and there is no reason to suppose that total production will be above the current estimate. In Jamaica, harvesting starts again in December, but the current estimate is unlikely to be exceeded for the year.

As forecast, the 1987 production figure is likely to be considerably below that for 1986 (673,700 tonnes). The Caricom sugar industries are therefore most unlikely to have any sugar available for the world market, as local consumption and export quotas in the preferential markets of Europe and the United States will account for the whole of 1987 production. This is mainly due to a policy of restricting production in view of continued depressed world market prices at well below the cost of production.

Indian 1987/88 outlook[6]

Notionally, production of sugar in India continues for the full twelve months of the year but for the final few months of the October/September crop year very little is produced. To the end of June 8,385,000 tonnes had been produced; during recent years less than 2% of the crop has come in the last quarter so it may be realistic to assume output in the campaign which drew to a close recently was not far away from 8,550,000 tonnes of white sugar.

Interest is naturally now focussed firmly on the possible output in 1987/88, particularly in view of the adverse effect which the severe drought has had, especially in the major producing states of Maharashtra and Uttar Pradesh. The delayed monsoon rains lasted only a very short time; some improvement in the outlook must have been derived but it is difficult to assess how great this has been. For the time being, therefore, it is assumed that next season's crop will not differ greatly from that of 1986/87, although some reports are suggesting a reduction of 10% or more.

The authorities have succeeded in fine-tuning India's sugar policy over the past few seasons and, until this year's drought, had steadily narrowed the gap between the country's sugar requirements and domestic production. One area where the sugar factories had been campaigning for greater equality with the open-pan producers is the molasses market, where there has been a disparity in the levels at which the two sectors have been able to sell their product. A new molasses and alcohol policy has been announced but it is not yet clear whether this has changed the overall balance. Molasses prices have been doubled as has the excise duty. It is not clear whether these adjustments will have any effect on the cane buying strategy of sugar factories compared with the open-pan sector. Certainly, any likelihood that overall cane supplies for next season may decline could lead to more aggressive cane buying by gur and khandsari producers and encourage diversion from the sugar factories.

Consumption requirements in the 1986/87 season are estimated to amount to some 8.8 to 9.0 million tonnes. Over the past five seasons consumption has increased at annual rate of some 8%; assuming this continues into 1987/88, domestic needs will be of the order of 9,600,000 tonnes. This is still very low on a per caput basis and could easily be sustained, even after taking into account the substantial extent to which India meets her demand for sweeteners with open-pan sugars. However, there is the prospect of declining per caput incomes as export earnings from many crops may be reduced in the coming season and some food imports may increase. Assuming no change in stock figures is made, and on the basis of the foregoing production and consumption projections, India would appear to have an import need of a little over one million tonnes in the 1987/88 crop year.

Philippine sugar factories for sale[7]

Eighteen sugar factories in the Philippines have been offered for sale because of huge losses and mounting debts with government financial institutions, according to the US Agricultural Counsellor in Manila. They will be offered for sale by the government's Asset Privatization Trust (APT). Three factories are in debt to the Development Bank of the Philippines and the rest to the Philippine National Bank.

Philippine Sugar Regulatory Administration officials have reported that there are some foreign concerns interested in buying the factories. China is reported to have offered to buy one factory to be reassembled in China. The first four factories now open to public bidding are Cagayan Sugar Corporation, Bukidnon Sugar Milling Company, Davao Sugar Central Company and Calinog-Cambunao Sugar Mill; they have total debts of about 3140 million pesos (US $154.3 million).

Low world sugar prices, declining domestic sugar production and past mismanagement have doomed many of the factories, and most are running at only about 35 - 40% of capacity, owing to a lack of cane supply and over-capacity installed in the 1970's. With the current area planted to sugar cane only about one-half of that of the mid-1970's and production down a similar amount, this structural adjustment seems inevitable.

5 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 414.
6 *Czarnikow Sugar Review*, 1987, (1765), 133.
7 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 416 - 417.

Product news

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The new steam turbines

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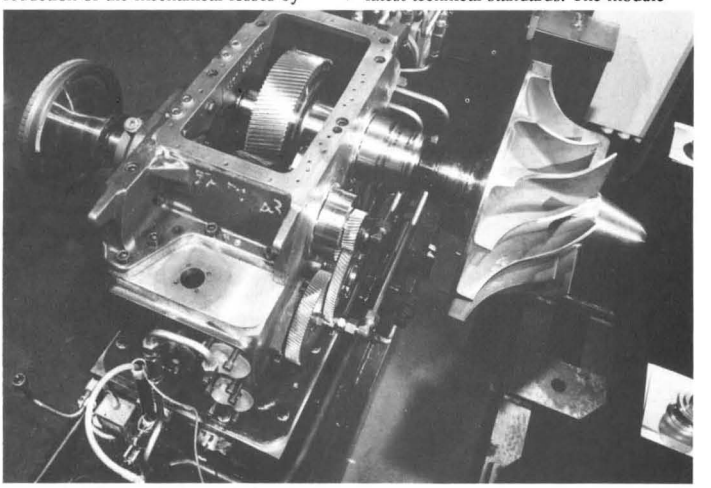
The CFA turbines, fitted with Curtis wheels with single-row blading, have proved to be particularly successful under operating conditions with high wetness factors whereby the energy potential available in low-pressure steam can be utilized economically.

The new series of CFR steam turbines can be optimized mechanically and thermodynamically in such a way that, with a single-stage internal turbine, efficiencies of up to 77% are achieved with high drops in steam pressures. This means a specific steam throughput approximately 25% lower than the classical Curtis turbine. A modern electronic governing and control system with selectable control characteristics permits speed and back pressure control, ensuring simple operation and a high operating safety for the total plant.

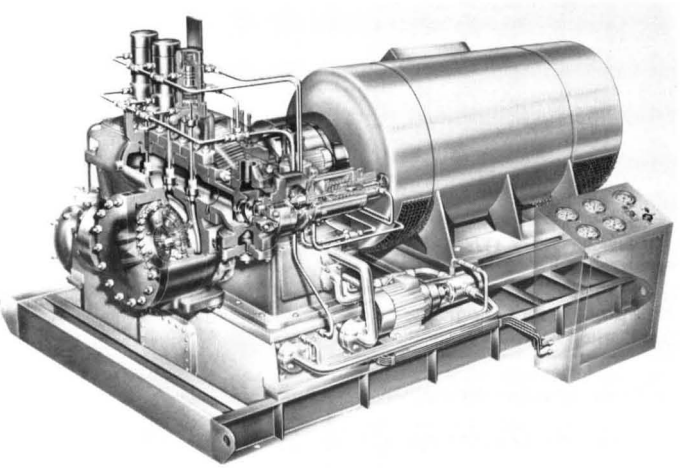
The new centrifugal compressors

The SFMG series includes 8 sizes with impeller diameters from 280 to 1400 mm. With this series, volumetric throughputs of up to 80 m³/sec can be handled at a maximum pressure rise of 2 bar. Two impeller varieties are available for each size to optimize the turbo-unit with regard to aerodynamics at the specified operating conditions. The open impeller with bent-back bladding, the matching of the impeller profile and rotor speed, the one-sided support of the rotor, i.e., overhung design and the reduction of the mechanical losses by utilizing integral gearing result in maximum efficiencies of 85% beign achieved. Control is acieved by means of an inlet guide vanes and/or speed variation, are required by the performance graph for the plant.

An essential part of the KKK module system for geared steam turbines and compresssors is the turbo-gearing series in close stages which meets the latest technical standards. The module



A KKK type CFR geared steam turbine combined with a KKK type SFMG 400 kW centrifugal compressor, partly dismantled



Single-stage geared CFR steam turbine with radial inflow driving a three-phase alternator

system allows for the design of turbines and compressors with integral gearing as well as for combining both with common gearbox. A centrifugal compressor may be arranged on the one side and the turbine drive on the other, whereby the compressor and turbine rotors are supported on one side. This provides a perfect combination of two matching units without utilizing a high-speed coupling.

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New process for biological purification of waste water

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Further details:

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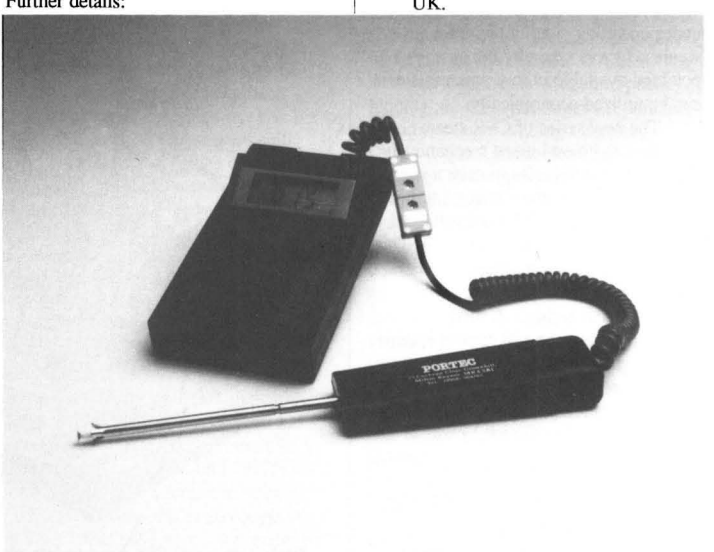

Lewatit monodisperse for the sugar industry

For many years Bayer has been one of the major suppliers of ion exchange resins. In a research programme aimed specifically at the requirements of the sugar industry, Bayer has now developed a completely new generation of ion exchange resins: ®Lewatit monodisperse.

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On the following page you can read about the major advantages of Lewatit monodisperse – advantages which will also help to improve your competitiveness.

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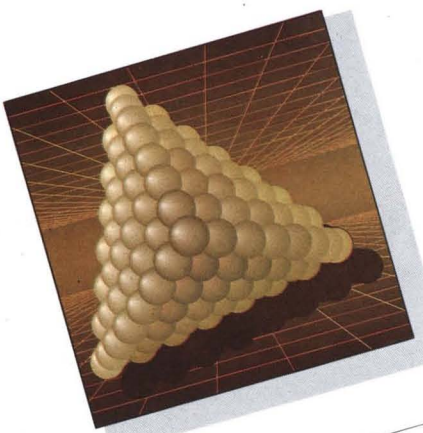
Lewatit monodisperse

The new generation of ion exchangers for the sugar industry



		Lewatit MDS 6368 A	Lewatit MDS 1368	
Form supplied		Cl	Na	Ca
Shape		Beads	Beads	
Colour		Light beige, opaque	Light brown, translucent	
Matrix		Polystyrene	Polystyrene	
Functional group		Quaternary amine	Sulphonic acid	
Bead size distribution (min. 90%)	mm	0.65 (± 0.05)	0.35 (± 0.05)	
		620 – 700	750 – 850	
Shipping weight	g/l	1.05	1.22	1.28
Density	approx. g/ml	60 – 65	50	47
Moisture content	% wt.	0.8	1.9	2.0
Total capacity (in exchange units)	min. mol/l	– 20 – + 100	– 10 – + 120	
Stability	Temperature range °C	0 – 14	0 – 14	
	pH range	– 20 – + 40	– 10 – + 40	
	Temperature range °C	3	5	
Storage stability in original packing	min. years	25 l Polybag	25 l Polybag	
Standard packing				

The extremely uniform bead size of Lewatit monodisperse offers a number of advantages in the treatment of solutions, e.g.

- even flow distribution
- low pressure drop, making correspondingly higher bed depths possible
- no clogging of nozzles with fines
- optimum bead size for the particular application
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OC 4063 A

Bayer

Steam turbines for the cane sugar industry

By Ray Bowell and Derrick Bloom
(Peter Brotherhood Ltd., Peterborough, England)

Introduction

There can be few applications for a steam turbine which are as arduous as driving the shredder or the mills in a cane sugar factory. By comparison, driving alternators to produce electrical power for the mills is considerably less of a task. When selecting a turbine for a sugar cane mill, therefore, the factory manager must consider many points.

Single-stage turbines are generally less expensive than multi-stage machines but they are less efficient at converting the energy in the steam into mechanical power. In the majority of cases the ideal turbine for driving shredders, "Unigrators", cane knives and mills is the single stage turbine. Where very large mills are used (for example in Australia) the shredder may be driven by a multi-stage turbine or by two single-stage turbines, one on each end of the shredder.

It is desirable for the shredder drive and the mill drives to be of the same manufacture, and preferably of the same size. This will reduce costs by reducing the number of spares that need be held.

Obviously, as bagasse becomes too valuable to burn in boilers and is used for other purposes (such as the manufacture of paper and board) it will be necessary to use multi-stage turbines to drive the mills, to reduce steam consumption. However, this is comparatively rare at present.

Single-stage turbines

The single-stage turbine should be of a robust design. The integral geared unit with an overhung rotor (see Figures 1 and 2) is ideally suited for sugar factory applications and has many advantages over the separately geared unit. It has fewer wearing parts, only four bearings instead of six, and only one gland instead of two; maintenance and spares costs are therefore considerably lower. The use of integral gears also reduces the costs of shipping and provision of suitable foundations as the overall length of this type of machine is considerably less than that of a separately geared design.

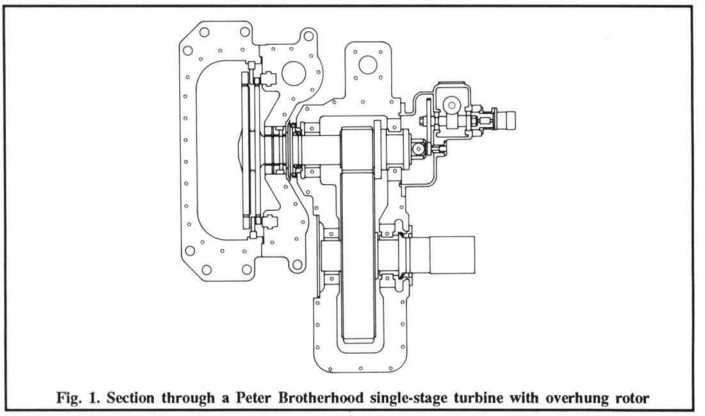

Fig. 1. Section through a Peter Brotherhood single-stage turbine with overhung rotor

A further advantage of the integrally-geared machine is that it does not require a high-speed coupling between the turbine rotor and the pinion, thus reducing the number of spares required, eliminating what can be a source of problems if not regularly maintained, and making alignment easier. With an integrally geared unit the oil reservoir is incorporated in the turbine bedplate, again reducing the overall size of the unit.

The maximum capability of the turbine must be carefully considered. With correct maintenance, a steam turbine will have a long life; 25 to 30 years is not uncommon and the factory manager should always look to the future and consider buying a turbine with a higher output capability than his present requirement. The advantage of this is that if the capacity of the mill is increased in, say, 10 or 20 years time it will be necessary only to renozzle the turbine to achieve the desired output. This can be achieved at a moderate cost compared to the considerable expense of purchasing a new turbine. The gearbox should be given careful consideration. For long life and high reliability, the gears should be hardened and ground and preferably of single helical design. With single helical gears, the relief groove

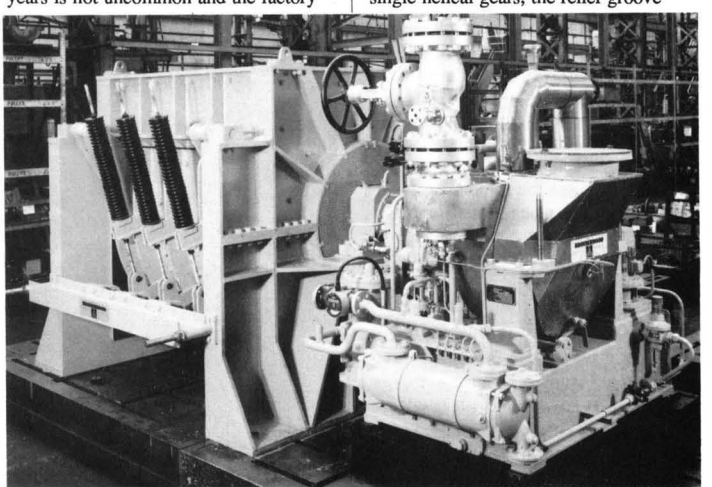

Fig. 2. A Peter Brotherhood single-stage Frame 22.9 turbine coupled to a cane shredder

required on double helical gears is not necessary and this makes the overall bearing span for single helical gears much less than for double helical. The result is much lower elastic deformation under load and higher critical speeds.

With the stabilizing effects of uni-directional thrust loads, single helical gears are unaffected by the problems of mis-match of double helical gears which can cause pinion shuttle and higher vibration and noise levels. The AGMA service factor (the normal relationship between the gear design power rating and the continuous power requirement) should be a minimum of 1.7 for mill drives and 2.0 for shredder drives. A service factor of 1.1 is adequate for alternator drives where the duty is less arduous.

It is important that the turbine is fitted with a forced lubrication system. Long experience is the sugar industry has demonstrated that oil ring lubricated bearings are not as reliable.

The turbine should be fitted with two oil pumps, the main one being shaft driven and the auxiliary pump being motor driven for start-up and shut-down purposes. The oil cooler should be of shell and tube design.

Almost all turbine wear and faults can be attributed to dirty lubricating oil and it is important that both the main and auxillary oil pump suction lines are fitted with strainers and that an oil filter of 10 - 15 microns is fitted downstream of the pumps.

Bearings should be of the precision machined steel shell type with white metal linings. Ball and roller bearings can be used but in the authors' experience have given much shorter running times before replacement is required.

Although the alternator drive duty is less arduous than that of shredder or mill drive, the same considerations apply in turbine selection. It is usual for the alternator drive to be a multi-stage turbine (see Figure 3) with three, four or five stages. However, at small factories with alternator output requirements of 2000 kW or less, a single-stage turbine of the same frame size as those for the shredder and mills may be used, allowing savings to be made on spares and parts holdings.

Turbine selection

There is a growing trend in some areas to specify that sugar factory turbines should be to API (American Petroleum Institute) standards in a bid to achieve higher reliability. The authors believe that such a trend is misguided as the API standard is not necessarly a level of excellence in turbine design and manufacture but was written to meet the specific requirements of the American petrochemical industry. The standard has little relevance to the sugar industry where the more arduous duty requires a totally different design approach.

Any factory manager who has recently purchased or considered purchasing a steam turbine will know that the price for what may appear at first sight to be similar equipment will vary considerably – possibly by as much as 50% between the lowest and highest prices. Although the cheapest machine may satisfy some of the requirements above it is usually only the machines in the middle of the price range and above that will satisfy all the criteria. The best value for money is not necessarily the lowest price.

A sugar factory is no place for a turbine of unproven design. A mill train usually consists of one shredder and four or five mills, all powered by turbines; the failure of just one of these turbines will bring the whole milling process to a halt, causing considerable financial loss.

When looking at competing turbines the factory manager must question the experience of the turbine manufacturer. He needs to ask how long the company has been making turbines, when they were first installed in sugar factories, is the turbine simply one of a standard range or was it specially developed for sugar factories, how many are in operation and how long they have been working.

Peter Brotherhood, for example, has this year delivered more than 20 turbines of proven design to sugar factory customers in Asia and Africa. The majority of the turbines covered by these orders are of the single-stage type described above and are built to a design which the company has progressively developed since it first installed steam turbines in sugar mills over 30 years ago.

Six machines were ordered for a new sugar factory at Sanghar in Pakistan. Two of the turbines, each rated at 2MW (2680 bhp), are of the multi-stage type to be used for generating

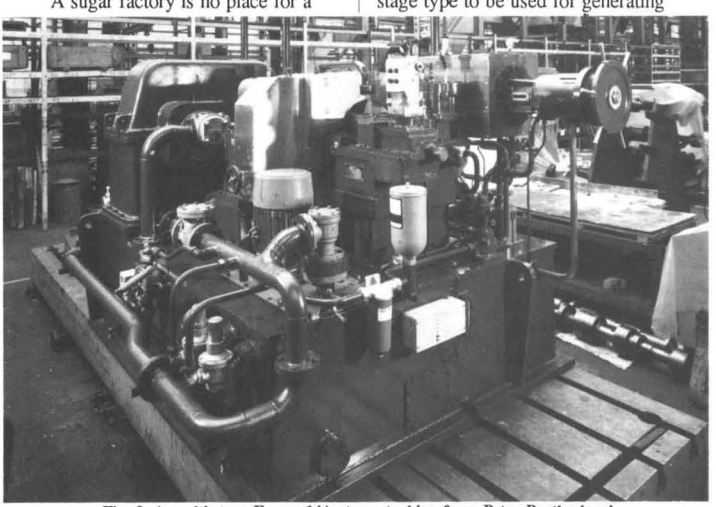

Fig. 3. A multi-stage Frame 14A steam turbine from Peter Brotherhood used to drive an alternator for electricity production in a sugar factory

electricity. The other four machines, all rated at 450 kW (600 bhp), are of the single-stage type described above and will provide mechanical power for the mills themselves.

At another factory in Pakistan, a total of seven Peter Brotherhood turbines have been installed. All of them, including the alternator drives, are of the same single-stage frame, giving considerable savings on spares and maintenance costs.

In Tanzania, consulting engineers responsible for the redevelopment of the existing sugar mill at Mtibwa have specified the purchase of the Peter Brotherhood turbines and speed reduction gearboxes for powering uprated mills. The new turbines, rated at 400 kW (530 bhp), will replace existing machines which have come to the end of their working lives.

It is Peter Brotherhood's second contract at Mtibwa. In 1985 the company supplied a similar turbine for the same purpose. The customer's experience with this machine was one of the major reason for awarding Peter Brotherhood the order for the remaining three.

Turbine design

In common with most other forms of rotating machinery, steam turbines obey the laws of dynamic similarity. This means that, if two turbines are geometrically similar, with a linear dimension ratio of R (where R>1) and the smaller turbine rotates R times as fast as the larger, they will both be suitable for the same steam inlet and exhaust conditions.

Since the ratio of flow areas at a given point in the expansion will be R^2 then the power of the smaller turbine will be $1/R^2$ times that of the larger machine. However, the larger machine will weigh R^3 times as much as the smaller one. The smaller turbine will therefore produce R times as much power for a given weight, offering a substantially better power to weight ratio.

A further and most important consideration is the transient thermal stresses that arise during starting, stopping and load changes. In general these will be lower in the smaller turbine for the same rate of change of condition with time, enabling the smaller turbine to be started and loaded more quickly.

However, for engineering and economic reasons, small high-speed turbines cannot always incorporate the same detail refinements as larger machines. Conversely, larger turbines cannot always employ the same construction methods as smaller machines – for example, forging production problems may prevent the use of a solid integral disc rotor and a "built-up" form of construction using "shrunk-on" discs may have to be used.

The important conclusion to be drawn from this line of reasoning is that turbines designed and selected to run at the highest rotational speed possible with current technology will offer benefits of size, weight, cost and operational flexibility. It must also be borne in mind that size and weight have some bearing on costs of transport and erection.

A comparison between American and European turbine designs for similar duties will show quite clearly the preference for higher rotational speeds shown by European manufacturers, due mainly to the economic pressures of strong competition that exist in Europe.

The majority of steam turbines used in the sugar industry for both electricity generation and mechanical drive purposes are equipped with main output gearboxes. This means that the optimum turbine rotational speed can be selected free from any speed constrains imposed by the driven machinery.

Maintenance and overhaul

Many sugar factories operate on a continuous basis throughout the crushing season whilst in some countries the factories shut down every weekend. The planned frequency of overhaul must take this pattern of operation into account because it is during the restarting and rapid loading that the greatest wear normally occurs, as differential thermal expansion can cause light contact between the shaft, steam glands and seals.

If the main requirement of the maintenance program is reliability then it should be safe to undertake major overhauls at intervals of up to four or five years, provided accurate daily readings are taken which will show any slow deterioration of machine performance.

Of course, certain components must have more frequent maintenance – oil filters must be changed, oil coolers must be checked and maintained, and oil and control systems must be serviced in accordance with the manufacturer's instructions. In any event it is important to ensure that the turbine emergency trip system is in perfect working order as a regular and frequent routine procedure.

On completion of the overhaul, checks should be made to ensure that the lubrication system is operating correctly, that no leaks exist, and that emergency trips and valves function correctly.

Prior to start-up, the thermal lagging should be carefully replaced to ensure that no thermal distortion will occur.

Wear is usually confined to the shaft gland and blade seals and, since it affects only efficiency and not reliability, a small amount of wear can be tolerated if reliability is the maintenance objective. Turbine design, in common with all engineering, is a compromise between cost, reliability and efficiency. When new turbines are being considered and maintenance schedules are being planned, a realistic view must be taken of the value of thermal efficiency.

The benefits to be gained through ease of operation, extreme reliability and long periods between overhauls can more than repay the small loss of efficiency caused by specifying a similar machine.

Operational hazards - steam impurity

It is recommended that contamination of steam should not exceed 0.2 ppm of chlorides and 0.02 ppm of silica. If the feed water contains more than the recommended level of silica, deposits of the material will occur on the nozzles and blades, gradually restricting the steam passages and hence the ability of the turbine to deliver its design power.

If the steam supply contains even small amounts of common salt and the turbine is operated intermittently,

extensive corrosion will occur if the machine is allowed to remain wet during the idle periods. In these circumstances, the parts will be immersed in a hot salt solution and deep corrosion of internal parts is inevitable.

It should be appreciated that, as a dry turbine does not rust even if it is covered in a layer of salt, it is probably easier and cheaper to keep the turbine dry during shut-down periods by blowing hot air into the exhaust casing than to improve the feed water purity. Although problems with impurities in feed water are quite common, they can be eliminated by careful consideration of the correct water treatment plant at the design stage, based on a detailed analysis of the make-up water.

Operational hazards -- water induction

In addition to water produced within the turbine following expansion beyond the saturation point, water can, and often does, enter the turbine through steam connections, e.g. via the main inlet and process steam connexion. Often turbines will swallow comparatively large quantities of water without observable damage, provided the water is in a finely divided state or droplet form and the period of application is reasonably short. However, large slugs of water are a different matter and extensive mechanical damage invariably occurs when a turbine is subjected to water carryover.

Investigation often points to incorrect boiler operation — every operator knows that boiler priming or foaming can force water over into the steam header. However, a frequent source of trouble is the main steam pipe. All steam pipes can form condensate, particularly those carrying saturated or low superheat steam. Normally the steam flow carries the water along the periphery of the pipe bore and it is removed by a separator.

Problems may occur when steam lines designed for maximum flow operate at reduced flow rate when condensate will collect in the line because the steam velocity is too low to carry it along. At a low point in the line there will be a gradual build-up of condensate which reduces the effective pipe area and increases the local steam velocity. Steam passing over the surface of the water creates waves. The wave further reduces pipe area and with increasing local steam velocity the wave form eventually fills the pipe and becomes a high velocity slug of water.

Generation of a water slug is a rapid process and there is usually no warning. When the slug, travelling at pipe line velocity, say 40 m/sec, replaces the steam passing through the first stage nozzles, its velocity is not increased by expansion and it cannot enter the blade passages. These may be travelling at 300 m/sec or more and the water is carried around in the axial gap between the nozzle ring and the blading.

In order to pass through the blading, the slug must first be divided and accelerated up to blade speed. It is the force imposed by splitting the slug and the subsequent acceleration of its parts that imposes large inertia forces on the blading, causing distortion or breakage and a large axial thrust that can (and frequently does) cause mechanical failure.

Probably the component most vulnerable to mechanical damage in these transient conditions is the rotor thrust bearing. Most turbine designs have thrust bearings which have an overload capacity of between 2 and 5 times the thrust load obtained at maximum power output. The power consumed by the thrust bearing and its effect upon overall efficiency, combined with consideration of initial cost, usually precludes the fitting of thrust bearings with larger overload capacity in small and medium power machines.

Turbine supervisory equipment normally includes thrust bearing wear-down indicators with visual and acoustic alarms and shut-down sequences, especially in unmanned machinery areas. However, because of the rapid rate of failure, typically a few seconds, these may only provide security against complete destruction of the machine. It follows, therefore, that the most effective security is provided by attention to the causes of water carryover and its prevention.

Steam mains designed to eliminate pockets and dead legs where condensate may collect and which are equipped with adequate drainage facilities are essential if water entrainment during start-up is to be avoided.

Cyclone water separators have now been developed to a high level of efficiency and makers claim better than 99% removal of water droplets from the steam flow. Designs are now available which are strong enough to withstand the full impact of large slugs of water without the internal disintegration which caused great damage in the past.

In practice it is impossible to prevent some water entering the turbine should a large boiler prime take place, since this would require a separator drain trap reservoir of disproportionate size and cost to ensure short term storage without entrainment. However, the water that does pass through the separator appears at the turbine inlet in a more divided state than before and is less likely to create the catastrophic damage referred to earlier.

It is of the utmost importance that an internal examination of the machine should be carried out as quickly as possible should it be suspected that a large boiler prime has occurred. The examination should not be confined to a mere visual inspection of the parts but should include metrological checks to establish whether the rotor shaft is bent or otherwise distorted. A crack detection survey of the rotor and blading should also be made using magnetic particle or dye penetrants to ensure the safety of the machine for future operation.

When examining a failed thrust bearing to determine the cause of failure, a careful inspection of pad pivot bar and the abutment face on the thrust carrier will often show a brinelling of the surfaces. This in itself is often a sure sign of extreme overloading of the bearing and if the depth of the brinelling is measured in a laboratory it will give an indication of the magnitude of the overload.

Future trends

When considering future development of sugar mill turbine technology it

ISJ Abstracts

Cane sugar manufacture

Revolutionary TRPF system

S. S. Bhad. *Bharatiya Sugar*, 1986, **11,** (14), 9 - 11.

The principal features of a SSTRPF (short-space two-roller pressure feeder) system for cane mills are described; the scheme is suitable for installation between adjacent mills in a tandem without the need to move any of them and eliminates the need for separate mill drives.Trial operation of the system installed between the 5th and 6th mills at one factory in India has shown a reduction in bagasse pol and moisture content from the last mill and an increase in extraction.

Reduction in steam consumption in the boiling house

D. S. Lande and S. Y. Jadhav. *Bharatiya Sugar*, 1986, **11,** (14), 15 - 16.

Causes of increased steam consumption in processing are briefly examined and measures that will help reduce it are described.

Recent innovations in milling technology for reduction of losses

T. T. Oommen and R. Choda. *Bharatiya Sugar*, 1986, **11,** (14), 19, 21, 23 - 24.

See *I.S.J.*, 1987, **89,** 78A.

Gravity cooling of condenser water (a case study)

-. Jamaluddin. *Bharatiya Sugar*, 1986, **11,** (14), 25 - 26, 29 - 30.

Vacuum problems caused by the high temperature of injection water in the condensers at the author's factory where spray pond cooling was hampered by a shortage of available power were overcome by a gravity spray system using bamboo cooling beds; in addition, the existing condensers were replaced with rain-and-shower types. Advantages of the new scheme are indicated with the aid of tabulated data.

Experimental data for the boiling of first massecuites

F. Herrera F. and L. Martínez V. *Centro Azúcar*, 1984, **11,** (2), 3 - 10 *(Spanish).*

The boiling process is considered in seven stages [introduction of footing, concentration, syrup feed, end-point, discharge, pan preparation (including cleaning) and establishment of vacuum]. Over a series of 13 strikes at a Cuban sugar factory, the time required for each stage was measured and the variation demonstrated and discussed. Overall lost time amounted to 15.87% of the total and varied between 4 and 35%, and was due to a variety of disturbances such as in quality of the seeding and steam pressure. The data are expected to be useful in the construction of automation schemes.

Cogeneration and the sugar industry

R. de los Rios and A. Calvo G. *Centro Azúcar*, 1984, **11,** (2), 21 - 34 *(Spanish).*

Thermodynamic aspects of the concurrent production of steam and electricity in a cane sugar factory are discussed.

Determination of the optimum time of contact between calcium saccharate and cane juice in the hot liming process

N. Martínez A., T. Prieto H. and B. Melnikov. *Centro Azúcar*, 1984, **11,** (2), 43 - 49 *(Spanish).*

Measurements of the settling time for muds obtained by hot liming of juice with calcium saccharate were drawn to illustrate the variation with different contact times. The curves obtained with juice from different varieties were similar in form and showed that, while 1 minute was the optimum contact time, acceptable results were obtained between 1 and 3 minutes.

Determination of the variables which influence the filtrability of raw sugars and their liquors

J. A. Bordón C., J. Léon J., E. Díaz G. and B. Garcilazo C. *Centro Azúcar*, 1984, **11,** (2), 51 - 60 *(Spanish).*

Filtrability was measured of 25 samples of raw sugar after affination and of the clarified liquors obtained from the samples. Also analysed were the contents of starch, dextran, insoluble matter, ash and pol as well as colour and pH. Regression analysis showed that the most significant effects on filtrability were, in order, those of starch, dextran, insoluble matter and ash.

Mathematical modelling of the process of discontinuous sedimentation of particles in liquids

N. Martínez A. and B. Melnikov. *Centro Azúcar*, 1984, **11,** (2), 61 - 70 *(Spanish).*

A mathematical model was developed for the sedimentation of particles and a differential equation obtained which related the change with time of the concentration of particles at a particular height in the column. Theoretical sedimentation curves were found to be closely matched by experimental curves obtained with $CaCO_3$ particles in water, and simulated and real cane juice.

Quantification of sucrose losses of microbial origin in an industrial tandem

M. T. Hernández N., H. Cuéllar, N. Herrera C. and A. Peña. *Centro Azúcar*, 1984, **11,** (2), 71 - 78 *(Spanish).*

The "spontaneous fermentation" test[1] was applied to crusher juice and to mixed juice before and after the parabolic juice screen at a sugar factory in Cuba of 3500 t.c.d. capacity, while dextran contents were also measured. Statistical analysis of the data gave losses averaging 0.526 tonnes per day. The screen was found to be an important area for bacterial contamination and a significant increase in dextran occurred.

Study on residual liquids, treatment and possible utilization

1 Hernández *et al.: Paper presented to 4th Scientific Forum, Cuban Scientific Academy*, 1981.

I. Morrell F., M. T. Hernández N. and L. Jacinto H. *Centro Azúcar*, 1984, **11,** (2), 79 - 90 *(Spanish).*

The high content of carbohydrates in sugar industry waste waters makes them difficult to treat to eliminate their contribution to environmental pollution. Aerobic treatment requires large amounts of oxygen and produces considerable quantities of muds. Study should be made in Cuba of the adoption of anaerobic systems such as the Anamet process whereby the BOD of the waste water is almost completely removed while producing biomass and/or methane which can be a source of energy.

Dynamics and control of the process of raw sugar crystallization

M. Rodríguez B. *Centro Azúcar*, 1984, **11,** (2), 99 - 109 *(Spanish).*

Using the deterministic model for the boiling of first commercial strikes, and from considerations of balance and kinetic relationships as well as phase equilibrium, a linealized model was obtained, and also a structural diagram and transfer relationships for each of the paths between the entry and exit variables. From these results was obtained a model of state and its controllability and observability tested. Applying the method of relaxation it was possible to synthesize the optimal control of the entry variables in the boiling process with the objective of ensuring high crystallization velocity from as wide a supersaturation range as feasible, without danger of false grain. It is concluded that the implementation of the control system could reduce boiling time by 17 - 20% from the usual.

Criterion adaptable to optimization of a strike from the raw sugar boiling process

O. Navarrina L. *Centro Azúcar*, 1984, **11,** (2), 111 - 114 *(Spanish).*

The design of a sophisticated control system for raw sugar boiling is questioned and it is argued that a very rigid optimization criterion for operation of a pan may not be the optimum for a boiling house as a whole.

Prior design study for a clarifier reactor

C. Díaz R., O. Gozá L., J. Guerra D. and R. Santana M. *Centro Azúcar*, 1984, **11,** (3), 3 - 12 *(Spanish).*

Studies were made with a laboratory-scale reactor-clarifier in which liming and sedimentation of cane juice occur sequentially. The importance of flow patterns in the equipment is emphasized since they affect significantly the efficiencies of both the lime reaction and sedimentation.

Influence of Pan-Aid and Visc-Aid surface-active agents on massecuite exhaustion

S. Marrero A., I. Gallardo A., M. Mazorra M. and L. Carrazana R. *Centro Azúcar*, 1984, **11,** (3), 13 - 16 *(Spanish).*

Simulated massecuites of 10%, 20%, 30%, 40% and 50% crystal content were stirred at 50°C in a laboratory apparatus in the presence of 150, 225 and 300 ppm of the two agents and the effects on Brix, pol, purity, sucrose content, surface tension, viscosity and grain size were determined, some of the data being tabulated. The surfactants reduced the molasses purity, the greatest falls occurring with 10 and 20% of crystals and the highest level of surfactant. Surface tension was reduced in all cases, the greatest effect being with 300 ppm. The viscosity was reduced in all cases but not in a uniform manner. Crystal growth was greatest at crystal concentrations of 10 and 30% and with 300 ppm of surfactant, Pan-Aid having the greater effect.

Control of moisture at the mill feed with maceration in a sugar factory

J. R. Abreu G. and L. Hernández S. *Centro Azúcar*, 1984, **11,** (3), 17 - 24 *(Spanish).*

Sampling and analysis of bagasse entering and leaving a mill demonstrated the great variation in both. Too dry bagasse hinders extraction while too wet bagasse causes slipping, etc.; consequently it is better to control the moisture at the optimum level. To do this it will be necessary to develop a sensor for bagasse moisture, the signal from which, combined with a measure of the bagasse blanket thickness, allows calculation of the amount of water necessary to be sprayed on the blanket to give the desired moisture.

Economic significance of lost time in sugar enterprises

P. García P., G. González A. and J. M. Fernández Ll. *Centro Azúcar*, 1984, **11,** (3), 25 - 32 *(Spanish).*

The cost of labour not usefully occupied during lost time in Cuban sugar factories is discussed.

Evaluation of jaboncillo surfactant on crystallization to exhaustion on the laboratory scale

M. Ugarte M., R. González C., J. A. León J., A. González G. and J. H. Delgado M. *Centro Azúcar*, 1984, **11,** (3), 33 - 38 *(Spanish).*

Trials in a laboratory crystallizer using the title surfactant, added in quantities of 150, 225, and 300 ppm, showed that it reduced viscosity slightly and surface tension to a somewhat greater extent, and gave a better crystal distribution than in its absence.

Pump for sugar solutions, syrup

S. Jáuregui R., I. Pedroso M. and O. Cruz F. *Centro Azúcar*, 1984, **11,** (3), 39 - 46 *(Spanish).*

Experiments on pumping of sugar syrups were compared with using oil products of similar viscosity, 80 - 121 SSU. The results showed, however, that measurements with the oil could not be used to project those which would have been found with syrup, even with the application of correction factors.

More economical operation of power generators of a sugar factory with electrified tandem and interconnected with the national electro-energy system

O. Navarrina L. and J. Santos C. *Centro Azúcar*, 1984, **11**, (3), 47 - 50 *(Spanish)*.

A computer study of a mathematical model of a sugar factory using electrically driven mills and having a steam generator and electric power plant but connected to the national grid has developed means for operating the factory optimally whereby savings can be made in Cuba's limited energy resources.

Mathematical modelling based on the costs of the process of sugar cane juice purification

L. Gómez G., P. Fabregat and A. P. Nikolaev. *Centro Azúcar*, 1984, **11**, (3), 51 - 59 *(Spanish)*.

Mathematical expressions to define the cost of the overall clarification process and of its component parts are developed. From a quantified example it is concluded that the most costly parts of the process are the heating (because of the cost of steam) and filtration (because of sucrose losses). The studies are intended to permit optimization of clarification to produce clear juice of adequate quality at minimum cost.

Automatic control system for the seed dissolver

J. Artiles S., M. H. Chang, I. Reyes G. and A. M. Cornell G. *Centro Azúcar*, 1984, **11**, (3), 61 - 68 *(Spanish)*.

Magma made from *C*-sugar mingled with syrup, used for the footing in sugar boiling, should have a Brix of 90 - 92°; a human operator to ensure this has to work in very high ambient temperature and automatic control is desirable. A system has been developed at a Cuban sugar factory whereby the Brix is measured and controlled in terms of conductivity, and details are provided of the equipment and its low cost.

Evaluation of a surface active agent in the sugar crystallization process by exhaustion on the industrial scale

J. L. Galano P., R. González C., J. A. Léon J. and N. B. Wright. *Centro Azúcar*, 1984, **11**, (3), 91 - 96 *(Spanish)*.

Industrial trials were made of "jabon-cillo" surface-active agent as an additive in *C*-sugar boiling, using 150, 225 and 300 ppm. There was a slight tendency to reduce viscosity and colour and surface tension and also to raise the crystal yield, while use of the agent improved grain size distribution and gave bigger crystals. Benefits would be obtained by the use of the material in final strikes while it would also save the cost in foreign currency of imported materials.

Study on the hydraulic characteristics of a laboratory-scale cane juice clarifier prototype

C. Díaz R., M. A. Barly, M. Corona and J. Guerra D. *Centro Azúcar*, 1984, **11**, (3), 113 - 118 *(Spanish)*.

The F(t) method of Wolf & Resnick[1] has been applied to hydraulic study of a laboratory-scale clarifier, and flow characteristics shown to apply to a prototype unit.

Experimental study of the parameters which influence sedimentation of sugar cane juices

L. Gómez G., P. Fabregat P., J. Leiva M. and D. Izada. *Centro Azúcar*, 1984, **11**, (3), 127 - 132 *(Spanish)*.

Laboratory experiments on juice clarification with cold and hot liming have given results which, by means of computer analysis, have provided equations relating sedimentation velocity and sediment height at 5 and 30 minutes to the various parameters: insolubles content, flocculant addition, temperature, time of heating, calcium and phosphate contents, and Brix. Calculated values were within 10 - 15% of those obtained experimentally.

Usina São Martinho S.A. Açúcar e Alcool

Anon. *STAB*, 1984, **3**, (2), 4 - 6, 8 *(Portuguese)*.

A detailed account is given of this Brazilian sugar company including information on personnel, capacities, agricultural practices and equipment, factory plant, distillery and laboratories, as well as data from the 1984/85 season.

Mechanical precautions for improving the operation and extraction of mills

L. E. C. Maranhão. *STAB*, 1984, **3**, (2), 29 - 30, 32 - 35 *(Portuguese)*.

Factors which affect mill performance are briefly discussed with recommendations to obtain improvements; these cover cane preparation, hydraulic mill pressure and its fluctuations, mill feeding, mill settings, use of welding on rollers, imbibition, drainage and mechanical efficiency of mill operation. More detailed information is provided on pitting of mill drive gear pinions and solutions to this.

Damage caused by steam to turbines and superheaters

Anon. *STAB*, 1984, **3**, (2), 36 *(Portuguese)*.

The damage referred to is, in fact, due to entrained boiler feed water in the steam and advice is given on its detection, causes and reduction.

Central Açucareira Santo Antonio S.A. – Usina Santo Antonio

Anon. *STAB*, 1985, **3**, (3), 4 - 7 *(Portuguese)*.

Details are provided of the cane field and factory equipment and operations at this sugar company in Alagoas, which also includes a refinery section and distillery. In the 1984/85 season it produced a total of 76,720 tonnes of sugar from 808,269 tonnes of cane and 29,183 m^3 of hydrous alcohol from a further 236,932 tonnes.

1 *Ind. Eng. Chem. Fundamentals*, 1963, **2**, 217.

Beet sugar manufacture

Investigations on combustion and combustion control in a sulphur furnace

C. Møller and H. Jansdorf. *Proc. 19th Congr. ISSSCT*, 1986, 806 - 815.

Details are given of a sulphur burner developed at DDS which incorporates a primary chamber and a secondary combustion chamber placed above it and in which the ratio between the air for the primary combustion and that for the secondary combustion is regulated as a function of the temperature of the combustion gas discharged from the primary combustion chamber; the secondary air is preheated in the combustion zone before being fed into the secondary chamber. The heat in the primary chamber favours oxidation of the sublimed sulphur which is further promoted by the preheated air in the secondary chamber. Results from the 1981 campaign showed that the burner was able to produce a SO_2 gas free from sublimed sulphur. Two units of 3.45 m^2 combustion area have been installed at Gørlev factory for thin juice sulphitation and one of 1.75 m^2 for diffusion water treatment; all three units have operated without any problems, and post-campaign inspection of the downstream gas lines has shown no deposits of sublimed sulphur.

The influence of polysaccharides on the filtration properties of 1st and 2nd carbonatation juices

R. G. Zhizhina *et al. Sakhar. Prom.*, 1987, (2), 20 - 22 *(Russian)*.

Literature on the effect of polysaccharides, particularly dextran, on carbonatation juice filtration is briefly reviewed and experiments are reported which confirmed the combined adverse effect of levan and dextran on filtration and settling of juice from beets that had been stored for a long period and beets in an advanced stage of infection by slime-forming bacteria. Filtration was especially affected by a dextran content exceeding 300 ppm, and use of conventional juice purification is advocated with liming before 2nd carbonatation.

Optimization of sugar crystallization by cooling

V. I. Tuzhilkin, A. I. Sorokin, M. V. Lysyuk and A. R. Sapronov. *Sakhar. Prom.*, 1987, (2), 23 - 24 *(Russian)*.

A mathematical model of massecuite cooling is presented which allows for the effect of change in the non-sugars composition on sucrose solubility and viscosity and permits rapid calculation of an optimum temperature gradient in the crystallization process. Its fit was checked by use of a computer to process data obtained in laboratory and factory experiments on 13 types of molasses. Differences in calculated purity and Brix of standard molasses were attributed to the non-sugars effect, and it is recommended to separate massecuite into two categories, having standard purities of 60 - 65 and 50 - 56, for purposes of deciding the optimum boiling and cooling conditions.

Production of concentrated remelt liquors from thick juices and low-grade sugar

V. V. Spichak *et al. Sakhar. Prom.*, 1987, (2), 25 - 26 *(Russian)*.

The kinetics of low-grade sugar melting in thick juices of varying Brix were studied in a laboratory unit, followed by successful tests on a factory scale in which no difficulties occurred in the melting. A melt of 70 - 72°Bx is obtainable using thick juice of 65°Bx that has been filtered and sulphitated, and may be used for boiling without any further filtration.

Results of investigations on imported brands of scale inhibitors

L. G. Belostotskii *et al. Sakhar. Prom.*, 1987, (2), 26 - 28 *(Russian)*.

The physico-chemical properties of a West German, a Czechoslovakian and five French scale inhibitors are tabulated and their performances in laboratory evaporation of 2nd carbonatation juice reported. In all cases, 85 - 95% inhibition was achieved without any adverse effect on the juice properties.

The use of powdered active carbons in the beet sugar industry

A. U. Dmitrenko, S. A. Brenman and Ya. O. Kravets. *Sakhar. Prom.*, 1987, (2), 28 - 30 *(Russian)*.

Tests were conducted on 26 brands of imported and Soviet powdered active carbons used to treat syrup. Results for 13 of them are discussed; for efficient decolorization, 0.6% carbon on Brix was found to be adequate and the optimum time of treatment was 20 min.

Experience in operation of a unit for 2nd carbonatation juice processing at Chortkovskii sugar factory

V. V. Zots *et al. Sakhar. Prom.*, 1987, (2), 37 - 39 *(Russian)*.

A version of the 2nd carbonatation system described previously[1] was tested on juice from a nominal 6000 tonnes of beet/day. By comparison with a conventional scheme, the new one with post-carbonatation ripening to reduce $CaCO_3$ supersaturation reduced molasses sugar and 2nd carbonatation juice lime salts. Some defects in the sparging system are noted and a number of recommendations made.

Sucrose content, clear juice purity and storage rot of sugar beet

W. M. Bugbee and D. F. Cole. *J. Amer. Soc. Sugar Beet Tech.*, 1986, **23**, 154 - 161.

Investigations showed that the sucrose content and purity of juice and white sugar yield per tonne of beet fell with increase in storage rot during 150 days at 5°C. The fact that storage rot development was more negatively associated with clear juice purity than with beet sucrose content at harvest suggested that higher concentrations of non-sucrose dissolved solids in beets of low juice

1 Shutka *et al.*: *I.S.J.*, 1986, **88**, 129A.

purity stimulated an increase in the aggressiveness of storage pathogens or interfered with the beet's defence mechanisms. A regression of storage rot and sucrose content at harvest showed that storage rot fell by 1.8% for every 1% increase in sucrose content, and by 1.4% for every 1% increase in clear juice purity. Poor storage properties in the experiment could have been caused by excess nitrogen in the soil and/or by moisture stress.

Nordharzer Zucker AG - Baddeckenstedt factory

Anon. *Die Zuckerrübe*, 1987, **36**, 76 *(German)*.

A brief outline is given of beet reception at the title factory.

The efficiency of raw juice purification using milk-of-lime prepared with the addition of ammonium chloride and hydrochloric acid

V. A. Loseva, I. S. Naumchenko and V. M. Perelygin. *Rpt. Voronezh Technol. Inst.*, 1986, 7 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (3), Abs. 3 R439.

The quality factors were determined of milk-of-lime prepared by varying methods and of juices purified by the conventional scheme and with introduction of ammonium chloride and hydrochloric acid into the water used for slaking of the lime. It was found experimentally that addition of 0.01924 - 0.00133% ammonium chloride and 0.03710 - 0.002155% HCl on weight of lime raised the activity of the lime by 12 - 21%, the purity of the 2nd carbonatation juice by 1.3 - 2.3% and the purification efficiency by 10 - 15%.

A new approach to large-scale sugar beet (juice) deionization: new Demineralization/ Demi process

G. Rousseau. *Ion Exch. Technol.*, 1984, 381 - 390.

The development of the new Demineralization/Demi process is reported. The basic principle lies in batch processing of 70°Bx thick juice in a mixed bed of a weak cation exchange resin and a weak anion exchanger in a 1:2 ratio. The amount of cation exchange resin (Amberlite ER-161) is 6 m^3 at a bed thickness of 0.5 m, while that of the anion exchanger (Amberlite IRA-35) is 12 m^3 at a bed thickness of 1.0 m. One complete cycle lasts 4 hours. In tests at a sugar factory, the thick juice purity was increased from 91 to 94.5, and 75 - 80% decolorization was effected. Molasses purity fell from 58 - 60 to 50. Only very slight dilution of the juice occurred in the process; with treatment of an initial 51 m^3 of thick juice per cycle, the final volume will be 60 m^3, including sweetening-off, which signifies the presence of only 9 m^3 extra water per 18 m^3 resin. The process described has been patented by Rohm & Haas and Générale Sucrière.

Effect of temperature on the solubility of $Ca(OH)_2$ in the presence of added ammonium chloride and hydrochloric acid

V. A. Loseva, I. S. Naumchenko and V. M. Perelygin. *Rpt. Voronezh Technol. Inst.*, 1986, 7 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (3), Abs. 3 R440.

Results of an experimental study of Ca hydroxide solubility in water and aqueous sugar solution as a function of temperature and of ammonium chloride and HCl addition showed that it rose in the presence of the chlorides but fell with temperature rise from 25° to 90°C. However, the solubility was higher in the presence of the electrolytes than in their absence over the given temperature range. In view of this, their addition would permit removal of a greater quantity of non-sugars during raw juice purification.

A miniature pH meter with mechanically cleanable antimony electrode

M. Ludwicki and S. Wawro. *Biotechnol. i Chem. Zywn., Ses. Nauk.*, 1985, 65 - 68; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (3), Abs. 3 R447.

A diagram and description are given of a mechanically cleanable antimony electrode. Measurements of sugar juice pH using this and a glass electrode were compared. It was found that the antimony electrode had an accuracy of pH ± 0.1 and may be used for 2nd carbonatation control.

Evapo-crystallization towers in operation

E. D. Bosse. *Sugar y Azúcar*, 1987, **82**, (2), 38 - 39.

The performances of the BMA evapo-crystallization towers at Wabern and Lehrte sugar factories are reported. (See also Bosse: *I.S.J.*, 1986, **88**, 15A.)

Interactions in the development of data processing and process engineering -possibilities for process management in the future

T. Cronewitz. *Zuckerind.*, 1987, **112**, 103 - 107 *(German)*.

Computerized data processing as an aid to process management is discussed and the concept of the management system of the future described. The occurrence of errors and the cost of erasing them are also examined.

Automation and process data logging systems in sugar factories of Süddeutsche Zucker-AG - definition of their role

P. Peters. *Zuckerind.*, 1987, **112**, 107 - 114 *(German)*.

Details are given of the distributed control and information systems used at Südzucker factories, and future prospects are discussed.

Danish microprocessor controller for the pan floor

G. R. Møller. *Zuckerind.*, 1987, **112**, 123 - 124, 126.

The new microprocessor-based automatic control system developed by DDS for pan boiling is based on continuous mon-

itoring of the syrup and massecuite level for automatic control of syrup feeding and supply of vacuum and steam as well as massecuite tightening, and continuous control of supersaturation (based on conductivity), massecuite temperature and all secondary functions based on valve actuation. All the data can be communicated via a VDU, keyboard and matrix printer, with interlinkage between the system and a host computer.

Quality assurance - what it means to British Sugar

J. Davies. *British Sugar Beet Rev.*, 1987, **55**, (1), 2 - 3.

The importance of quality assurance in regard to e.g. liquid sugar microbiology, sugar packeting and beet quality, is explained by the man responsible for coordinating the quality assurance program at British Sugar.

A simulation model of a mixed factory. Low-grade sugar melting variant

B. Kopriva and J. Gebler. *Listy Cukr.*, 1987, **103**, 37 - 45 *(Czech)*.

By solving a mathematical model developed earlier[1] for a mixed factory manufacturing white sugar from its own beet and from raw sugar supplied from elsewhere and where all the *C*-sugar is melted, the series of models for calculation of sugar balances using microcomputers is completed. In addition to the basic model, two models are presented (1) where the low-grade melt is used to make up an artificial affination massecuite, and (2) where this massecuite is transhipped. The three models are compared.

SA-85, a new scheme for automation of sugar manufacture

B. A. Eremenko *et al. Sakhar. Prom.*, 1987, (3), 24 - 26 *(Russian)*.

The new microprocessor-based factory automation scheme discussed is designed for use with a basic factory process as described and is intended to provide highest possible economic efficiency with a daily slice of 3000 tonnes of beet.

Milk-of-lime dosing in the carbonatation station

V. V. Diordik *et al. Sakhar. Prom.*, 1987, (3), 30 - 31 *(Russian)*.

An experimental dosing unit provided with a cone valve was used in investigations of working parameters, results of which justified the choice of such a system for milk-of-lime; a twin-doser system installed at a sugar factory for preliming and cold main liming confirmed the findings and provided smooth controlled feeding without the need for mechanical cleaning of the valve.

Assessment of sugar factory performance from the molasses sugar content

A. P. Pustokhod, B. N. Valovoi and Yu. A. Pustokhod. *Sakhar. Prom.*, 1987, (3), 31 - 35 *(Russian)*.

Whereas the existing official method of assessing factory performance on the basis of molasses sugar in the USSR uses 5-year averages converted to standard molasses purities, it fails to take into account the true processing quality of beet in the current year and the factory technology. A proposed alternative is described in which molasses sugar is calculated from the sugar content in cossettes, total processing losses, raw juice purity and the difference in purity between thick juice and molasses; the difference between calculated and true molasses sugar contents for the campaign years between 1977/78 and 1984/85 did not exceed ± 3%, although a greater divergence for 1984/85 is blamed on instrument error in the determination of raw juice purity. To ease the task of calculation, tabulated values are given of molasses sugar content per 1% sugar yield (the total of white sugar + molasses) expressed as a function of raw juice purity in the range 80 - 90 and crystallization efficiency (the difference between thick juice and molasses purities) in the range 25 - 35.

The new A2-PPR progressive preliming vessel

V. M. Logvin *et al. Sakhar. Prom.*, 1987, (3), 38 - 41 *(Russian)*.

The vertical prelimer described has no moving parts. Raw juice passes up through a series of three cylindrical sections separated by profiled venturi sections where milk-of-lime enters from a lateral feedline and is mixed with the juice. From the top section the juice passes down through another three sections, different in size and shape from the first three and with conical bottom sections, each with a distributor feeding into a constricted channel with elements for swirling of the juice at the top of the next section. From the last section the juice passes through a single cylindrical compartment and over a weir into an inclined lateral pipe, while mud leaves from the bottom of the cylinder.

Treatment of sugar beet with an electrically activated fluid system

V. V. Spichak *et al. Sakhar. Prom.*, 1987, (3), 44 - 47 *(Russian)*.

The changes brought about in a solution by electrolysis, including alteration of the redox potential, surface tension and chemical composition, are discussed as well as the resultant antiseptic properties in regard to beet storage. Trials in which piled beet were sprayed with treated 0.4% NaCl at the rate of 8 - 10 litres/tonne showed a marked fall in the number of rotted beets and in daily losses by comparison with untreated controls.

Anaerobic waste water treatment plant at Offstein factory

H. Schiweck, H. Kutschke and C. Nähle. *Cukoripar*, 1987, **40**, 7 - 12 *(Hungarian)*.

See *I.S.J.*, 1985, **87**, 232 - 237.

Operation and efficiency of quality control at Petohaza sugar factory

1 Kopriva *et al.*: *I.S.J.*, 1986, **88**, 69A.

L. Németh. *Cukoripar*, 1987, **40**, 22 - 27 *(Hungarian)*.

The aims and tasks of quality control and the results achieved at Petohaza sugar factory are discussed, particularly in regard to beet quality and breeding requirements. A diagram depicts the organization of quality control at the factory, which centres on the works laboratory acting on the orders of management.

Raising the efficiency of floating platforms for short-term storage of sugar beet

V. A. Knyazev and V. I. Shelud'ko. *Nov. v Tekhn. Sakh. Pr-va*, 1986, 17 - 23; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (5), Abs. 5 R447.

The effectiveness of floating platforms for short-term storage of sugar beet is indicated; their efficiency can be raised by providing the piles with forced ventilation systems or with large air feedpipes. The construction of such pipes for a forced ventilation system to be used with floating platforms is proposed and optimum conditions are given for beet storage using the system to regulate the temperature and moisture.

Promising chemical means of retarding sugar beet rotting and sprouting processes during storage

V. A. Knyazev, I. R. Sapozhnikova and M. L. Pelts. *Nov. v Tekhn. Sakh. Pr-va*, 1986, 23 - 27; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (5), Abs. 5 R448.

Results of investigations are given on the fungicidal and growth-inhibiting action of a number of chemical preparations on sugar beet. Promising preparations included those containing ethylene, esters of hydroxybenzoic acid, nitrogen-carbonate mixtures and complex or combination mixtures based on pyrocatechin, ammonium carbonate and ethylene derivatives; organized production of these will help to bring about a reduction in storage losses.

Outline and balance of continuous sugar house concepts

K. E. Austmeyer and R. Marwede. *Zuckerind.*, 1987, **112**, 193 - 201 *(German)*.

The effects on boiling house material and energy balances of various measures intended to simplify boiling schemes and increase crystal yield as well as reduce energy consumption are examined. The measures include using syrup instead of water as washing medium in the centrifugals, massecuite cooling by expansion (by comparison with conventional cooling) after normal boiling, continuous boiling with integrated cooling by expansion (e.g. from 0.24 bar in steps to 0.10 bar) and boiling with vapour compression. Integration of the different measures in various 3-boiling schemes is described and the possibility of converting these systems to 2-product schemes demonstrated.

The Tongaat-Hulett continuous vacuum pan

H. E. Uecker. *Zuckerind.*, 1987, **112**, 202 - 203 *(German)*.

The Tongaat-Hulett continuous vacuum pan designed to boil *A*-, *B*- and *C*-massecuites and first operated at Maidstone cane sugar factory in South Africa is described and mention made of the installation of one (made under licence by a West German company) at the Zeil factory of Zuckerfabrik Franken GmbH for low-grade massecuite at an hourly rate of 33 tonnes. The performance of the pan is to be reported later.

New methods of raw juice purification with calcium sucrocarbonate

J. Grabka. *Zuckerind.*, 1987, **112**, 212 - 216.

Calcium sucrocarbonate (CSC), obtained as a gelatinous product by CO_2 treatment of a limed sugar solution, was used in two juice purification methods: (1) progressive liming with CSC at 0.55% CaO on beet to pH 11.2 - 11.5, clarification, liming of the clear juice with CSC (0.35% CaO on beet) and carbonatation , and (2) as in (1) but with liming of the clear juice using CSC at 0.95% CaO on beet. Conventional treatment with a total lime dosage of 1.50% CaO on beet as in (2) was used as reference standard. In terms of thin juice purity, non-sugar removal, lime salts, α-amino-N, colour, sulphate ash, Na and K, method (2) was the best of the three methods, while (1) gave better results than the control. Pulp dry solids was increased by the use of CSC, resulting in reduced energy consumption in pressing, and sugar yield rose. A number of other benefits are noted.

Purification by coagulation of waste waters from sugar industry plants

D. K. Satybaldieva, S. M. Imanbaeva, K. Sh. Shatemirov and A. V. Elovikov. *Izv. AN Kirgizsk. SSR*, 1986, (1), 46 - 48; through *S.I.A.*, 1987, **49**, Abs. 87-160.

Experiments at Aksu sugar combine on purification of waste water of initial COD 720 mg/litre and pH 7.4 are reported. Dosing with $FeCl_3,6H_2O$ or $Al_2(SO_4),18H_2O$ at 0.2 - 0.76 kg/m³ removed up to 97% of the colour but only 57% of the COD (optimum dose 0.73 kg/m³), and the hydroxide flocs took a long time to form and settle into voluminous sludge. 99.7% decolorization and 78% COD removal were achieved by treatment with carbonatation mud (1 g/litre) previously calcined at 900 - 1000°C, either fresh or multiple-regenerated.

Biochemical effects of administering shock loads of sucrose to a laboratory-scale anaerobic (UASB) effluent treatment plant

Seng Chye Eng, X. A. Fernandes and A. R. Paskins. *Water Res.*, 1986, **20**, 789 - 794; through *S.I.A.*, 1987, **49**, Abs. 87-164.

Tests were carried out to find the effects of shock loads of sucrose (as might

occur through accidental spillage of syrup at a sugar factory) on anaerobic treatment of effluent. A laboratory-scale plant (UASB reactor) treating diluted landfill leachate was used. Addition of 50, 12 or 10 g sucrose/litre to the influent caused accumulations of up to 7 g L-lactate/ litre and a decrease in pH from 7.2 to 4.7, which inhibited methanogenesis. There were also major changes in the composition of the biogas, which under the severest conditions contained up to 30% hydrogen by volume.

The Biothane biological plant for waste water

K. Duffek. *Listy Cukr.*, 1987, **103**, 62 - 66 *(Czech).*

Details, diagrams and illustrations are given of the Biothane effluent treatment plant installed at Ochsenfurt sugar factory in West Germany[1] which nominally reduces the COD from 5 - 10 kg O_2/m^3 to 0.25 kg/m^3 in the anaerobic stage and then to 0.025 kg/m^3 in the subsequent aerobic stage.

Industrial chemical cleaning on the water side in steam generators

C. Borrione. *Ind. Sacc. Ital.*, 1987, **80**, 8 - 11 *(Italian).*

The scale problem in three types of boilers (those fed with softened water, those fed with condensate plus demineralized water and high pressure units), treatment with alkaline or acid solutions, corrosion prevention during chemical cleaning (including the stability of corrosion inhibitors, stress corrosion, the use of hydrofluoric acid, hydrogen embrittlement) and control of the cleaning process are discussed.

Investigation of carbonatation juice filtration and the creation of a new automatic filter

Yu. V. Anikeev, E. I. Vorob'ev, V. P. Zubchenko, V. M. Samoletov and N. E. Zevtsov-Lobanov. *Nov. v Tekhn. Sakh. Pro-va*, 1986, 67 - 73; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (6), Abs. 6 R472.

Data are given on the compressibility and permeability of muds formed during filtration and descriptions are given of the design and operation of new automatic units that are modifications of filter-thickeners for 1st and 2nd carbonatation juices and have capacities corresponding to 3000, 4500, 6000 and 9000 tonnes of beet/day. Results are given of factory trials on the filters. Methods are given for intensifying and optimizing their operation. The designs of the new BskhShU-40-3 and BskhShU-80-3.75 moving belt vacuum filters, having filtration surfaces of 40 and 80 m^2, respectively, are designed, and results are given of factory trials on them.

Improving beet quality

M. Loilier. *Sucr. Franç.*, 1987, **113**, 103 - 109 *(French).*

Investigations showed that treatment of growing beet with Topsuc and Impact R fungicides against foliar diseases had no significant effect on losses from respiration during storage of the harvested beet which, however, did contain more sugar and less K and N than the untreated control. Over a period of 29 days, the temperature in storage piles containing beets carrying considerable quantities of dirt showed little fluctuation with time and was generally much higher than the ambient temperature, which fluctuated widely; determination of losses in weight and sugar showed that about 7 kg of sugar was lost per tonne of dirt, while the beet K, Na and a-amino-N contents rose.

Advantage of buying electricity by sugar factories. Influence of fuel price (an actual case study)

R. Ascher. *Sucr. Franç.*, 1987, **113**, 113 - 118 *(French).*

A number of alternative evaporation schemes involving the use of steam and electricity generated by the sugar factory in question plus some bought from the utility are discussed in terms of energy consumption and costs. The factory, slicing 10,000 tonnes of beet per day, operated in October and November using a 2-massecuite boiling scheme and consumed 171.15 therms of steam heat per tonne of beet plus 21.1 kWh of electricity per tonne which it generated using a low-pressure turbo-alternator. By completely electrifying the pan station and compressing all the pan vapours, installing a falling-film evaporator (with vapour compressor) between the 3rd and 4th effects of the quintuple-effect evaporator, recompressing the 3rd effect vapour for use in the 1st effect, buying 18.88 kWh of electricity per tonne of beet from the utility and generating 6.54 kWh/tonne, and increasing the amount of thick juice stored for post-campaign processing, the factory was able to reduce the steam heat consumption to 50.8 therms/tonne of beet and raise its daily slicing capacity to 12,500 tonnes.

Application of a MERA 400 computer at Lublin sugar factory current situation and prospects

J. Pidek. *Gaz. Cukr.*, 1986, **94**, 135 - 136 *(Polish).*

Details and benefits are given of the MERA 400 minicomputer as used at Lublin for factory data recording and processing, covering 150 technological parameters. Future planned expansions of the system are described.

Failure to make use of the potentials of conductance in sugarmanufacture

E. Gierada. *Gaz. Cukr.*, 1986, **94**, 139 - 141 *(Polish).*

The theory of electrical conductance is explained and the measurement of sugar solution conductivity as a function of e.g. temperature, Brix and purity discussed with references to the literature. The many uses to which conductimetry may be put as a component of automatic control systems are listed.

1 Tschersich & Zoetemeyer. *I.S.J.*, 1984, **86**, 40A.

Starch based sweeteners

Studies on purification and kinetics of glucose isomerase on hydrolysates of starch

K. M. El-Sahy, A. H. Fahmy and H. A. Siliha. *Starch/Stärke* , 1987, **39**, 60 - 63.

Glucose isomerase was produced from *Streptomyces phaeochromogenes* by aerobic fermentation at 28°C for 24 hours. The crude enzyme was obtained by disintegrating the isolated cells. Ammonium sulphate at 50% concentration and 0.65 saturation (based on 77% sulphate equivalent to 1.0 saturation) gave a maximum enzyme recovery of 89.4%, while acetone at 3% v/v on enzyme extract gave 66.4% recovery. The crude extract was purified by concentration, dialysis, precipitation with ammonium sulphate, passage through a column of Amberlite CG-50 and treatment of the eluate with acetone to precipitate the enzyme. A study of the reaction velocity *vs.* D-glucose concentration showed the latter to have an optimum value of 0.8M.

Examination of carbonatation of glucose and fructose solutions

L. I. Tanashchuk and N. A. Arkhipovich. *Sakhar. Prom.*, 1987, (2), 48 - 50 *(Russian).*

In a process for fructose and glucose manufacture by sucrose hydrolysis and separation of the fructose from the resultant invert sugar by liming, the Ca fructosate is degraded by treatment with sulphuric acid or CO_2 to yield fructose in a free state. The carbonatation approach was the one investigated, and results showed that optimum was a temperature of 20°C and a pH of 9.2 - 9.3 at which the $CaCO_3$ content was minimal. With an initial glucose content of 9 - 11% the average filtration coefficient had a value of 1.0 - 2.5, the settling rate S_5 was 1 - 2 cm/min and mud volume after 25 min was 20 - 25%; at a fructose content in the initial solution of 9 - 10% the values of the corresponding parameters were: 1.6 - 2.7, 1.5 - 1.8 cm/min and 37 - 40%, respectively.

Enzymatic conversion of glucose to fructose

G. F. Hutasoi. *Proc. 19th Congr. ISSCT*, 1986, 978 - 983.

In an investigation of the properties of purified glucose isomerase isolated from *Bacillus stearothermophilus*, Co, Mg and Mn were found to stimulate its activity while Cu, Zn, Na, K, Ca and Ba inhibited it, so that glucose syrup to be converted to fructose should be pretreated to remove the latter group of metals. The optimum pH ranges for activity and stability were 7 - 8 and 6.5 - 7.5, respectively, and the optimum temperatures for activity and thermostability were in the ranges 65 - 80°C and 40 - 65°C, respectively. The Km value (the glucose concentration at which the enzyme had half maximum activity) was 0.1752M, i.e. almost the same as that of *Streptomyces* sp., while maximum activity (V_{max}) was 5.43 units per mg protein.

Isomerization of D-glucose to D-fructose by means of gelatin-entrapped *Lactobacillus brevis* 74 cells with glucose isomerase fixed inside them

A. V. Ananichev, E. T. Tuleuova, I. V. Ulezlo and A. M. Bezborodov. *Priklad. Biokhim. i Mikrobiolog.* 1986, **22**, (1), 25 - 31; through *S.I.A.*, 1987, **49**, Abs. 87 - 89.

Lyophilized cells were kept 10 minutes at 70°C, treated for 20 min with 1% cetyl pyridinium chloride, mixed with 8% gelatin solution and pulverized in cold butanol to give brown spherical beads 0.5 - 1.0 mm in diameter; these were treated with 5% glutaraldehyde solution and then with 0.1% tannin solution. The product was stored in 0.3% formaldehyde or dry air at 1 - 2°C. It had good hydrodynamic properties and was fairly stable to heat and pH. At optimum pH 7 in phosphate buffer at 75°C without glucose, the glucose isomerase activity decreased by 75% in 96 hr. Treating 2M glucose at 60°C, pH 7 and somewhat less than 1 vol/hr, it gave 43% conversion and lost only 15.6% of its activity in 21 days (extrapolated half-life 43 days).

Experience at Verkhnedneprovsk starch syrup combine in preventing fungal infections of glucose massecuites

N. Ya. Gopchak *et al. Sakhar. Prom.*, 1987, (4), 36 - 37 *(Russian).*

While sodium hyposulphite was successful in reducing the development of fungi in glucose massecuites obtained from starch saccharified by acid treatment and fermentation and brought about improvement in a number of crystallization parameters, the chemical is considered too expensive for normal use; however, an alternative means of solving the problem was found in conducting crystallization at an initial higher temperature of 50°C and gradually cooling to 35°C. The advantages of this scheme are indicated by comparison with the older system.

The viscosity of fructose solutions and syrups

N. I. Odorod'ko, N. A. Arkhipovich, N. P. Ivchuk and V. A. Miroshnik. *Sakhar. Prom.*, 1987, (4), 38 - 41 *(Russian).*

The viscosity of pure and impure fructose solutions and syrups was measured as a function of temperature, concentration and degree of saturation in the purity range 91 - 99 and at crystallization temperatures of 20 - 55°C. An equation is presented for viscosity calculation in terms of concentration and temperature, and results of the investigation are tabulated and given in graph form.

The thermophysical properties of fructose and aqueous fructose solutions

M. A. Gromov. *Sakhar. Prom.*, 1987, (4), 46 - 48 *(Russian).*

Formulae are presented for calculation of density, heat content, heat conduction and heat diffusivity of fructose solutions as a function of temperature and concentration, with some worked examples.

Laboratory studies

Sucrose habit changes due to polysaccharides of a different nature

M. Mochtar. *Proc. 19th Congr. ISSCT*, 1986, 637 - 650.

The effects on sucrose crystal habit of various polysaccharides having different physical and chemical properties were determined. When sugar solution reached a supersaturation of approx. 1.2 it was seeded with fondant sugar in ethanol, and the effects of supplied dextran fractions in the molecular weight range $9.4 \times 10^3 - 2 \times 10^6$ and of purified fractions isolated from factory products in Indonesia and having a M.W. in the range $3.5 \times 10^4 - 4.9 \times 10^6$ were investigated at dry solids concentrations up to 1.5% w/w and 50 - 90°C. Results showed that the sucrose crystal axis ratio c:b increased in the presence of dextran, indicating elongation, and was mainly affected by the content of α-(1 - 6) linkages, although the crystal shape was also significantly affected by temperature and dextran concentration and M.W., with significant interactions between parameters, so that the individual effects of each were reduced and differences in M.W. caused differences in shape at constant temperature and concentration. Because of similarity in the molecular structure between dextran and sucrose, particularly in the glucose-fructose portion of the molecule, it is assumed that dextran influences the sucrose crystal habit through temporary adsorption on the crystal lattice.

Utilization of the MOP Videoplan for sugar crystal sizing and hence evaluating the performance of continuous *A*-centrifugals

R. J. F. Rivalland and C. H. M. Ponsot. *Proc. 19th Congr. ISSCT*, 1986, 651 - 662.

The MOP Videoplan is an image analyser that utilizes a microcomputer, a magnetic board and cross-hair cursor with a video camera coupled to a microscope through which sugar crystals may be observed and precisely measured. A formula has been derived for the equivalent diameter of a crystal so that values of length and width are automatically converted to it by the computer; linear correlation was established between reported crystal sizes obtained by sieving and actual crystal equivalent diameter in the range 0.5 - 0.75 mm for various shape factors (length/width). Correlations have also been obtained between the equivalent diameter and (i) crystal thickness and (ii) crystal mass. Hence, mean aperture values of normal sugar samples may be obtained within 1 hr. A method has been derived on the basis of the correlations for evaluation of the performance of an FC1000-SE-GCV continuous and an FCB Compact C411 batch *A*-centrifugal, both machines being fed with the same massecuite. Crystal breakage was significantly higher at 12.3% in the continuous machine compared with 2.3% in the batch centrifugal, while remelting was about the same in both machines (both remelting and sugar quality improving with increased wash water rates, as to be expected).

Colouring matter inclusions in sucrose crystals

G. Mantovani, G. Vaccari, G. Sgualdino, D. Aquilano and M. Rubbo. *Proc. 19th Congr. ISSCT*, 1986, 663 - 669.

Investigations on colouring matter inclusion in sucrose crystals grown in cane syrup have confirmed the results obtained earlier for beet sugar crystals[1,2] relating to zonal colouring, the mechanism of inclusion and crystal habit modification. The effect of the presence of varying amounts of habit-modifying impurities and hence of decrease in the growth rate of certain faces on colouring matter inclusion was particularly marked in the case of cane syrup, whereby distinct differences could be found between apparently identical syrups. The possibility of reducing colouring matter inclusion by modifying the boiling process is mentioned.

Colorant in raw sugars

M. A. Clarke, R. S. Blanco and M. A. Godshall. *Proc. 19th Congr. ISSCT*, 1986, 670 - 682.

After a brief review of cane raw sugar colorant composition, covering both those originating in the plant and those occurring during processing and including colour precursors, descriptions are given of methods used to determine phenolics, amino-N, alcohol-precipitable material, iron, total polysaccharides, invert sugar, ash and colour content at different pH levels. Results are tabulated for 10 unwashed and washed raw sugar samples from various countries, and the refining properties of the sugars are indicated. The colour removal efficiencies of five refineries each using a different clarification and decolorization process are then examined, showing that phenolic colorants are the most readily removable type and that phosphatation refineries remove more colour than do carbonatation refineries.

Use of C-18 reverse-phase HPLC in the Australian raw sugar industry

P. C. Ivin, J. C. Baird and P. Collins. *Proc. 19th Congr. ISSCT*, 1986, 765 - 773.

Details are given of the reverse-phase HPLC method based on the use of cartridges packed with uniformly sized silica particles having long-chain C_{18} aliphatic groups bonded to their surface and used in Australian sugar factories for sucrose analysis[3]. Statistical analysis showed that no significant deterioration occurred in samples within 20 hours of preparation, whereas considerable deterioration was evident in most samples after 43 hours. Typical retention times are given for various components separated on a C-18 cartridge. The reproducibility of the method was assessed by sucrose determination in five samples of molasses and one sample of low-grade massecuite; results showed an average difference between two laboratories of only 0.08% sucrose (ranging from –0.6% to +0.5%).

1 Mantovani *et al.*: *I.S.J.*, 1985, **87**, 119A.
2 Idem: *ibid.*, 1986, **88**, 84A.
3 Ivin *et al.*: *ibid.*, 1983, **85**, 348.

The raffinose effect on sucrose morphology and kinetics

G. Vaccari, G. Mantovani, G. Sgualdino, D. Aquilano and M. Rubbo. *Sugar Tech. Rev.*, 1986, **13**, 133 - 178.

Results of recent detailed studies on sucrose crystallography are discussed, including the theoretical faces of the crystal and face-by-face kinetics of both single and twin crystals. Investigations have been conducted on the possible attachment of the raffinose molecule to the various faces of the sucrose crystal, taking a study of the growth morphology of the crystal with application of the Hartman & Perdok theory as reference and using Berman's data on the structure of the raffinose molecule[1]. Possible modes of attachment of the raffinose molecule to the sucrose molecule are discussed for faces p', p, a, c, r and d on the basis of experimental data involving two types of kink and two sets. The elongation parameter, i.e. the ratio of crystal length in direction (001) to crystal width in polar direction (010), of twin sucrose crystals in the presence of raffinose is examined. During crystal growth there is a change from a 1st-type twin (p' faces pointing outwards) to a 2nd-type twin (with the single crystals behind each other and growing along the a faces) and finally to a 3rd-type twin (with the p faces pointing outwards). Moreover, in the presence of raffinose, a crystal that at first has the morphology of a 1st-type twin can change to one which is morphologically analogous to a single crystal. Conclusions drawn[2-5] concerning the spiral growth on the 100 face of the sucrose crystal are discussed on the basis of the theories of Kern & Monier[6] and of Cadoret[7], whereby it is shown that the interpretation of Dunning is consistent for the (001) edge but is not valid for an explanation of the elliptical form of the spiral itself.

Sugar crystals - notes on inclusions

A. VanHook. *Sugar J.*, 1986, **49**, (7), 4 - 5.

A number of observations on sugar crystal inclusions are presented. Surfactants generally reduce inclusions, which will be avoided only if crystal growth is slow, steady and uninterrupted (the best conditions being obtained with slow cooling); even if undersaturation does not occur as a result of even a minor change in temperature, veils and similar phenomena may appear because of the irregular growth. Whereas stirring would seem to be necessary to ensure uniform growth, an illustration depicts almost totally clear crystals grown very slowly under static conditions. Under normal batch crystallization conditions, flaws start to appear when crystals reach a size of approx. 50 μm, possibly because of difficulties in maintaining uniform conditions as the crystals grow; similarly, veils are almost always found in the boundary layer of seed crystals but are usually absent in new growth. Enclave inclusions are most common between the prism faces 110 and $1\bar{1}0$ at the non-truncated end of the crystals; these are the two fastest growing faces of the sugar crystal which, under normal circumstances, extends twice as fast in the direction of the $1\bar{1}0$ face than in the opposite direction. Mother liquor inclusions may wander with temperature variation. Reference is made to methods for quantitative evaluation of crystal inclusions; microscopy is only of qualitative value.

Dextran analysis: a modified method

D. Sarkar and D. F. Day. *J. Amer. Soc. Sugar Cane Tech.*, 1986, **6**, 102 - 107.

According to a method described earlier[8] for dextran analysis in raw sugar, the polysaccharides were separated from the sugars by centrifuging in Centricon tubes containing an ultrafiltration membrane having a cut-off point of 10,000 M.W., after which the dextran was quantitatively determined using dextranase. Because of the need for a high-speed centrifuge and the prolonged separation time of 4 hr, the method is unsuitable for routine use by sugar factory laboratories, but a modification is described in which the ultrafiltration is replaced with polysaccharide separation by alcohol precipitation. 40 g of raw sugar is dissolved in 50 ml of distilled water and 0.1 g alpha-amylase added; after incubation for 1 hr at 55°C with occasional stirring, the sample is made up to 100 ml and 2 ml of this pipetted into a 15-ml glass centrifuge tube and 8 ml of absolute alcohol added during mixing. After 10 minutes' centrifuging at 2000 rpm, the supernatant is discarded and the precipitate re-suspended in 10 ml of 80% ethanol before further centrifuging at 2000 rpm for 10 min. After the supernatant has been discarded, the tube is inverted on a filter paper to drain all the liquid, and the precipitate dissolved in water for quantitative transference to a 5-ml volumetric flask; the tube is rinsed and the contents also transferred to the flask, the contents of which are then made up to volume with water. The dextran analysis stage is as in the original method. Recovery of dextran added to raw sugar was 94.7 - 98.4%, and the method was accurate for any sugar sample containing more than 40 ppm dextran on solids. Up to 30 samples can be routinely processed per day, and the use of alcohol precipitation makes the method suitable for use with dextrans of very low molecular weight.

The glucose electrode and its use in the sugar mill laboratory

D. F. Day and D. Sarkar. *J. Amer. Soc. Sugar Cane Tech.*, 1986, **6**, 108 - 111.

Cane sugar factory products were analysed for sucrose on the basis of inversion by means of a Yellow Springs Instrument analyser which measured glucose using an immobilized glucose oxidase/peroxidase electrode. Details are given of the procedure used for sample preparation and for analysis, including measurement of sucrose by the difference between two glucose readings taken

1 *Acta Crystallogr.*, 1970, **B26**, 290.
2 Dunning *et al.*: *Coll. Int. CNRS*, 1965, (152), 303.
3 Albon & Dunning: *Acta Crystallogr.*, 1960, **13**, 495.
4 Dunning: *Proc. CITS*, 1967, 3.
5 Idem: *Ind. Sacc. Ital.*, 1967, **60**, 225.
6 *Bull. Soc. Franç. Minéral. Crist.*, 1956, **79**, 129.
7 Thesis Univ. Caen, 1965.
8 Day & Sarkar: *I.S.J.*, 1985, **87**, 123 - 126.

before and after invertase addition and sample incubation. Results showed that the values for juices were comparable to those obtained by polarimetry, while molasses values were close to Lane & Eynon titration values but were consistently lower than them by 1 - 3%. However, while the analyser gave readings in close proximity to pol values in the case of raw sugar samples, its precision was not sufficient for it to be used for analysis as a basis for payment; this is attributed to the fact that the instrument is designed for use where there is an appreciable background level of glucose in a sample, unlike high-pol samples. For process juices, the analyser has the advantages of being unaffected by colour, polysaccharides and other non-sugars, relatively simple to operate and requiring minimum maintenance.

Measuring dextran in raw sugars – historical perspective and state of the art

R. P. DeStefano and M. S. Irey. *J. Amer. Soc. Sugar Cane Tech.*, 1986, **6,** 112 - 120.

A review with 39 references is presented of the historical development of methods for dextran determination in raw sugar, and a critical evaluation is made of the Roberts method and the modified CSR haze technique. It has been found that a number of organisms other than *Leuconostoc mesenteroides* are present in large numbers in crusher juice, and some of these produce substances detected as dextran by one or both methods. It was also found that material determined as dextran by the Roberts method differed from purified dextrans or dextran produced by juices inoculated with *L. mesenteroides* in their response to changes in alcohol concentration and to pretreatment with ion exchange resin or dextranase. On the basis of these findings it is concluded that the specificity of both methods is at best questionable.

Automatic determination of the saturation temperature of molasses

M. Saska and W. Keenliside. *J. Amer. Soc. Sugar Cane Tech.*, 1986, **6,** 126 - 131.

While supersaturation control in boiling can be accomplished with reasonable accuracy, this is not the case in low-grade massecuite cooling and reheating. Results of a survey in Louisiana in 1984 showed that cooling profiles deviated from the optimum while there were significant increases in mother liquor purity during reheating. The saturation temperature is therefore of critical importance for control of these operations. Standard laboratory methods for its determination are slow and tedious, but a new technique based on the principle of differential thermal analysis (DTA) has given promising results. Two cells of identical dimensions, one containing the test molasses and the other containing molasses plus crystal sugar (synthetic massecuite), are heated directly by means of electric plate elements; thermocouples linked in a differential mode measure the temperatures of the two materials, the difference between the two values being governed by the thermal capacity of the two cells (which should be constant provided crystals neither dissolve nor form). When the saturation temperature is reached, the massecuite-containing cell has a higher thermal capacity, so that the cell temperature will rise at a slower rate and the saturation temperature can be readily determined. Close agreement was found between the DTA values and molasses saturation temperature as determined by visual observation of crystal surfaces. The system is currently undergoing further development, including use of a sophisticated one-cell scheme.

Chromatographic separation of molasses by the lagging electrolyte method

R. F. Kambarova, N. B. Kazakova, V. M. Rogozina and G. A. Chikin. *Sakhar. Prom.*, 1987, (2), 31 - 32 *(Russian).*

While sugar recovery from molasses is possible by chromatographic separation on a sulphonate cation exchange resin in a salt form, earlier studies showed that KU-2-4 resin in sodium form was suitable only for pre-delimed molasses or for molasses of low Ca^{++} content. Deliming uses up extra time and necessitates utilization of reagents; however, a resin in Ca^{++} form allows deliming to be excluded. In experiments with dilute molasses of 37 - 40°Bx and 55 - 59 purity treated with KU-1-4 resin at 10 vol/vol molasses, colouring matter represented the first fraction eluted with decarbonized water, followed by sucrose and finally Ca, Mg, K and Na salts; the slower movement of the electrolytes relative to sucrose was in contrast to their faster movement through a column of resin in Na^{+} form. An average 65% of the total sugar content in the original molasses was recovered at a daily treatment of 1.6 tonnes of molasses per m^3 of resin and an elution velocity of 1.2 m/hr.

Determination of the foaming coefficient of some commercial surface active agents used in the sugar industry

M. Duarte V., G. Lago M., L. R. de la Nuez and M. López L. *Centro Azúcar,* 1984, **11,** (2), 35 - 42 *(Spanish).*

The Ross & Miles method[1] was applied to measuring the foaming coefficient of one commercial surfactant and found to give the same value reported by the manufacturer. It was therefore used to examine a number of other materials and their properties found to relate to their chemical structure.

Inorganic non-sugars in the cane sugar manufacturing process

G. Fernández, M. Darias and M. Caridad R. *Centro Azúcar,* 1984, **11,** (2), 115 - 121 *(Spanish).*

Spectrographic analyses were carried out on sulphated ash from mixed juice, limed and clear juice, syrup, massecuites, sugar and molasses. Of a total of 20, 10 elements (Ca, Mg, K, Na, Si, Fe, Al, Mn, Cu and Pb) were present in detectable quantities in all products.

1 *J. Oils & Soap,* 1941, 1899.

By-products

A comparison of an Upflow Floc (tower) digester and UASB system treating cane juice stillage

R. G. Cali and J. P. Barford. *Agr. Wastes*, 1985, **14,** (4), 291 - 299; through *S.I.A.*, 1986, **48,** Abs. 86-1676.

An Upflow Floc (tower) digester and an Upflow Anaerobic Sludge Blanket (UASB) system were compared for the treatment of low-sulphate cane vinasse. Use of a synthetic flocculant (Zetag 88N) in the UF digester improved biomass retention, resulting in faster start-up than in the USAB system, but the eventual performances of the two systems did not differ significantly. In both, effluent recycling substantially improved digester stability. Loadings greater than 22 kg COD/m³/day with removal of >70% total COD and >95% soluble COD were achieved.

Anaerobic treatment of alcohol production wastes

T. H. Y. Tebbutt and W. A. Nogueira. *Effluent and Water Treatment J.*, 1985, (8), 277 - 278, 280 - 281, 283; through *S.I.A.*, 1986, **48,** Abs. 86-1677.

Long-term laboratory studies in England on the anaerobic purification of effluent from molasses fermentation (COD 27,000 - 45,000 mg/litre, COD:BOD about 2:1, pH 4.5) are reported. With increasing organic or biological loading, % removal of COD decreased, but kg COD removed/m³/day increased linearly over the range tested (up to 16 kg COD/m³/day). Gas yield was not much affected by loading except at low loadings (<2 kg COD/m³/day). Removal % decreased as the ratio of volatile acids to alkalinity increased. It is considered that this process would be feasible in Brazil as the first stage purification of vinasse.

Studies on the treatment of distillery effluent by anaerobic filters

E. Schulze and U. Behrens. *Acta Hydrochimica et Hydrobiologica*, 1985, **13,** (6), 697 - 707; through *S.I.A.*, 1986, **48,** Abs. 86-1678.

The kinetics and feasibility of treating beet molasses vinasse by means of batch anaerobic filters were investigated in the laboratory. With influent COD in the range 5 - 25 g/litre, COD removal was 40 - 50% in 5 hr and about 80% in 40 hr. Removal rates were highest during the first 5 hr and for influent COD not above 13 g/litre. Methane productivities were highest during the first 10 hr in the same concentration range. The results confirmed that retention of the bacterial biomass enables an anaerobic process to be operated at low retention times and with concentrated effluent.

TSC waste treatment and nutrient recycling in the sugar cane field

S. W. Li. *Taiwan Sugar*, 1986, **33,** (5), 8 - 16.

The chemical composition of vinasse from yeast fermentation at Hsinying, of bagasse pith, mixed sludge and lime mud from Pingtung pulp factory, of vinasse from Pingtung alcohol distillery and of pig waste slurry are indicated in a survey of Taiwan literature, and flow diagrams are given of the processes at the various plants from which the wastes emanated. Investigations of the effect of land disposal of the wastes and of filter-cake on pollution reduction, cane yield and soil nutrients are discussed; results showed a generally favourable response to field application.

TSC develops the first commercial fermentation industry waste water treatment plant in Taiwan

C. K. H. Lu and J. S. I. Wang. *Taiwan Sugar*, 1986, **33,** (5), 17 - 19.

Details are given of the scheme used since the end of 1985 for treatment of vinasse at Hsinying by-products factory (where cane molasses is the starting material). The Upflow Anaerobic Sludge Blanket (UASB) process in two reactors operating in parallel reduces the BOD_5 from 12 - 13,000 to less than 2000 ppm at a daily throughput of 2600 m³; both reactors yield methane sludge and a supernatant which is aerobically treated in a biofilter to reduce the BOD_5 by at least 50%, after which it is treated in an activated sludge aeration tank and finally in a sedimentation pit from which the effluent has a BOD_5 of <200 ppm. The excess sludge from the anaerobic and aerobic treatments is thickened to about 3% solids and its moisture content reduced to <60% in automatic filter-presses. The volume of acclimated methane sludge in the UASB reactors was still below the requirement of one-third of the working volume, but once the requisite level is reached it is expected that about 20,000 m³ of biogas containing approx. 60% methane v/v will be generated daily.

Submerged fermentation of citric acid

M. Kutermankiewicz. *Gaz. Cukr.*, 1986, **94,** 104 - 107 *(Polish).*

A general account is given of citric acid fermentation of molasses or sugar using *Aspergillus niger* as practised in three Polish sugar factories; the introduction of submerged fermentation on an industrial scale in 1978 increased yields considerably by comparison with the surface process and reduced the health risks to personnel. Details are given of the stages in the typical process as conducted at Raciborz (where sugar is the raw material), of some problems encountered and of the major advantages of the submerged process in which sugar consumption is 1.25 tonnes/tonne of citric acid.

A scoop doser for feeding molasses solution into a yeast propagator

N. F. Nikolaenko and T. A. Moskalenko. *Pishch. i Pererab. Prom.*, 1986, (9), 52 - 53; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (1), Abs. 1 R365.

A diagram and description of operation are given of a doser and scoop for feeding molasses solution into a yeast

propagation vessel. A simple method has been developed for controlling the output of the doser to allow flow of a part quantity of the solution from the scoop; modifications to the doser design are listed. The device provides economy in the use of molasses, reduces its losses and improves working conditions.

Purification, by partial removal of calcium ions, of molasses solutions intended for citric acid manufacture

M. Kutermankiewicz. *Przem. Ferm. i Owoc.-Warzyw.*, 1986, **30,** (2), 25 - 27; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (1), Abs. 1 R400.

The possibility is examined of removing Ca^{++} ions from molasses solutions, intended for citric acid fermentation, using sodium carbonate, potassium carbonate, ammonium oxalate, oxalic acid and ammonium sulphate as reagents. It was found that partial removal of Ca^{++} ions using ammonium oxalate reduced the fermentation time and increased the citric acid yield. However, complete removal of Ca^{++} causes a considerable reduction in the trace element content and thus has a negative effect on the fermentation process.

Effect of certain organic components in molasses on citric acid biosynthesis by the fungus *Aspergillus niger*

I. E. Eglit and M. V. Shevyakova. *Pishch. i Pererab. Prom.*, 1986, (7), 43 - 45; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (1), Abs. 1 R401.

An investigation was conducted on the effect of molasses volatile acids and colouring matter on acid formation and *A. niger* growth. It was found that acetic (I), formic (II) and butyric (III) acids at a concentration of 0.1 g/litre had no inhibiting effect on the fermentation process, whereas I and II at 0.5 g/litre reduced the level of acid formation while III at this concentration reduced fermentation by 30%. The presence in the medium of ≥ 5 g/litre of I, II or III caused complete stoppage of growth of the micro-organism. Simultaneous addition to the nutrient medium of all three acids in a 1:1:1 ratio to give a total concentration ≤ 0.3 g/litre caused 13% inhibition of the process; at a total concentration ≤ 0.7 g/litre the level of citric acid formation fell by 25%. Addition to the nutrient medium of 1 g/litre of colouring matter removed from the molasses inhibited biosynthesis by 9%, and increase in its concentration beyond this further depressed biosynthesis (by up to 49%).

The effect of anti-foam agents used in the sugar industry on the suitability of molasses for citric acid production by surface fermentation

Z. Zakowska, A. Nowakowska-Waszczuk and M. Druri. *Biotechnol. i Chem. Zywn., Ses. Nauk*, 1985, 319 - 322; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (1), Abs. 1 R402.

Results are reported of investigations into the effect on citric acid fermentation of adding Spumol anti-foam agent to molasses. It was found that the preparation did have an inhibiting effect on the process.

Molassed pulp from a legal viewpoint

E. Thier. *Zuckerind.*, 1987,**112,** 30 - 32, 34 *(German)*.

The regulations of the EEC and of member-countries, particularly West Germany, concerning molassed beet pulp as animal fodder are discussed. The main question is whether it should be regarded legally as a single fodder (as in West Germany) or as a mixed fodder (as in the UK and by the EEC Commission). Possible implications are examined.

Commercial feeding of cattle with alkali-treated bagasse and molasses

G. D. Tudor, P. A. Inkerman and E. K. Bromage. *Sugar J.*, 1986, **49,** (7), 12 - 16.

See *I.S.J.*, 1987, **89,** 31A.

Rational use of sugar factory muds

J. P. Vandergeten and A. Vigoureux. *Le Betteravier*, 1987, **21,** (215), 26 *(French)*.

The composition and monetary value of filter-cake are tabulated and its application at 15 tonnes/ha in acid soil and at 5 tonnes/ha in alkaline soil every 3 - 4 years for maintenance of a suitable pH is discussed; the risk of excessive reserves of lime in the soil as a result of repeated massive doses is emphasized. Whereas equipment available until now has not been suitable for application rates below 15 tonnes/ha, a new automatic machine, the Big 2700, has been developed which is capable of applying small quantities (3 - 10 tonnes/ha) over a band width of 15 m.

Peculiarities of the action of denitrifying bacteria on bakers' yeast

N. N. Bocharova, V. G. Chernysh and N. I. Sizova. *Khlebopek. i Konditer. Prom.*, 1986, (9), 32 - 35; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (2), Abs. 2 R368.

In an investigation of the accumulation of nitrites in unsterile molasses wort (caused by the activity of denitrifying bacteria in the original molasses) and of the nature of nitrite formation during simultaneous cultivation of nitrite-forming bacteria and yeasts, it was found that the nitrites formed by the bacteria had a distinctly negative effect on the activity of the yeasts.

Continuous rapid alcoholic fermentation of carbohydrates in a novel immobilized bioprocess

S. Fukushima and K. Yamade. *Proc. 3rd Pacific Chem. Eng. Congr.* (Seoul), 1983, **3,** 425 - 430; through *Ref. Zhurn. AN SSSR (Khim.)*, 1987, (2), Abs. 2 R373.

An energy-saving continuous process for alcoholic fermentation of carbohydrates is proposed which cuts the fermentation

time, increases alcohol yield, reduces nutrient consumption for yeast growth and prevents infection of the media. Fermentation of substrates such as cane molasses and juice is conducted in a fermenter consisting of three rhombic sections placed one above the other. A biocatalyst of aluminium alginate having a particle diameter of 1 - 2 mm is loaded into each section at 0.15 - 0.45% by volume of the section and adsorbs the yeasts at the approx. rate of 220 g dry cells/litre catalyst and retains them during the fermentation process without any appreciable leaching. The bottom part of the lowest section receives CO_2 or NO_2 at a rate of 0.001 - 0.1 vol/vol/min and a substrate feed rate that guarantees optimum fermenter productivity and alcohol yield. The large gas bubbles pass successively through the fermenter via the central zones of the sections, leave from the top of the fermenter together with the fermentation gases and return via the condenser to the bottom of the fermenter; the resultant condensate is added to the fermented mass from the fermenter. The small gas bubbles are retained mostly in the sections and undergo turbulent flow together with the particles of biocatalyst. $Al_2(SO_4)_3$ at 1 - 2 g/litre and dilute H_2SO_4 in an amount to maintain a pH of 2.8 are added to the substrate. *Saccharomyces formosensis* M-III is used for molasses fermentation, and a mixture of this with *S. cerevisiae* Montrachet for juice. As an example, molasses was fermented at 30°C and pH 2.8 in a 150-litre fermenter; at a residence time of 2.8 hr and a sugar concentration in the substrate of 168 g/litre, alcohol of 8% concentration was obtained, while 3 hours' retention and 198 g/litre sugar concentration gave 9.5% alcohol concentration. The yeast content in the eluate from the fermenter was only 8×10^8 - 2.5×10^9/litre/hr. During 90 days' operation of the fermenter no infection of the medium was observed. The process has technico-economic advantages over the Melle-Boinot method involving conventional alcoholic fermentation with yeast recycling. Fermentation schemes are given for alcoholic fermentation of molasses, juice and starch products, and the effects on alcohol productivity, concentration and yield of residence time and relative volume of biocatalyst in the sections are indicated.

Agglomerated products with inorganic (mineral) aglutinants

J. L. Valdés. *Revista ICIDCA*, 1984, **18,** (1), 18 - 23 *(Spanish).*

Experiments have shown the feasibility of manufacturing particle boards from bagasse bound with cement, suitable for use in the construction industry.

General considerations on the production of L-lysine by incremental fermentation

J. L. García and M. Negrete. *Revista ICIDCA*, 1984, **18,** (1), 54 - 60 *(Spanish).*

Experiments on fermentation of raw sugar to produce L-lysine showed that biotin, thought of as an essential ingredient, could be substituted by oleic acid or other unsaturated acids; since these are found in natural products the latter could be used. Use of a semi-continuous fermentation gave a higher concentration of lysine in the fermentate than batch fermentation.

Influence of the acid catalyst in the prehydrolysis with low hydromodulus of bagasse, pith and cane leaf trash

J. Villar, O. Torres, E. Manganelly and A. Calvo. *Revista ICIDCA*, 1984, **18,** (1), 61 - 69 *(Spanish).*

The three raw materials were treated with sulphuric and phosphoric acids at 130 - 140°C, consumption being 0.5 - 4% and 4 - 12%, respectively. The yields of reducing substances were measured and the maximum found with prehydrolysis of bagasse with 2% sulphuric acid at 140°C. The yield of furfural increased with the acid ratio but it was separated on decompression of the reaction vessel and could be recovered later while its separation improved the quality of the product.

Considerations on the installation of centrifugal separators in alcohol distilleries

C. Gregório. *STAB*, 1984, **3,** (2), 39 - 40 *(Portuguese).*

Ancillary equipment to be included in an installation whereby yeast is separated from the fermented must by a centrifuge are discussed; these include a level base, security filters, valves, flowmeters, etc.

Studies on yeasts. I. Studies on taxonomy and propagation of a new strain of *Candida parapsilosis*

F. Hafiz, T. K. Mazumdar and G. K. Joarder. *Bangladesh J. Sci. Ind. Res.*, 1983, **18,** (1-4), 183 - 190; through *Food Sci. Tech. Abs.*, 1986, **18,** Abs. 11 B 5.

A strain of *C. parapsilosis* was isolated from spoiled date-palm juice produced locally. Study of its taxonomic characteristics suggested that it is a variant strain on the basis of its sugar assimilation pattern. As it produces little alcohol but assimilates this compound and has a high rate of growth, yield and protein content (44.8%) in a cane molasses medium, it has a good potential for producing food yeasts.

Comparative study between gasolines and gasohol blends in respect of their contribution to air pollution

C. A. Gotelli. *GEPLACEA Bull.*, 1987, **4,** (5), 10 pp.

A detailed study of tetraethyl lead emission from vehicles using gasoline as fuel has shown that a calculated 21,662 tonnes were released to the atmosphere in Argentina in 1970/83, whereas 36% less lead would have been emitted had gasoline:alcohol blends been used (the gasoline:alcohol ratios are not given). Similarly, it is shown that the blends produce only half of the volume of carbon monoxide generated by gasoline under identical combustion conditions.

is important to recognize that the appeal of any new technique or innovation is, inevitably, an economic one.

It is easy to predict that, over the next decade or so, economic pressures on mill management will increase as countries seek to raise standards of living. Increased operational costs will put an even higher premium on machine integrity and reliability and will dictate expansion of turbine monitoring and diagnosis. Areas such as the analysis of overall machine vibration spectra, continuous monitoring of steam purity, and complete protection from water induction will receive increased attention.

With the advent of higher throughput mills, higher power multi-stage steam turbines will replace single stage machines to reduce steam consumption as bagasse becomes too valuable to burn.

What cannot be readily predicted is the rate at which these technical innovations will be introduced in the vaious cane sugar producing countries. The turbine manufacturer will therefore have to cater for wider differences in operational parameters (e.g. steam pressures, temperatures, and turbine speeds) and a wider range of sophisticated control and operational monitoring systems.

Preventive maintenance will in future benefit from improved monitoring techniques and to improve reliability there will be a continuing trend to provide ancillary equipment with fewer moving parts which therefore requires less maintenance. A typical example of this will be the increasing use of electrical governors using electronic solid-state speed sensing devices free from friction and inertia effects.

Existing turbine output and speed restrictions imposed by blade root stresses will be raised by using new materials with high strength to weight ratios and good erosion resistance, such as titanium alloys, instead of conventional austenitic stainless steels.

New technology will also be employed in blade manufacture. It is currently possible to produce turbine blades with a precision forged aerofoil section but without a blade attachment root; these can then be welded to the rotor disc using electron beam welding techniques.

Blades may also be machined as an integral part of the turbine rotor by using electro-chemical machining techniques. Either or both of these methods will become widely adopted when their economic viability has been demonstrated.

Whatever the future may hold, it is certain that steam turbine development for the sugar industry will continue to be a process of evolution from existing designs rather than revolutionary new developments. Factory managers will still be looking for the reliability which can be demonstrated by proven designs from experienced manufacturers.

ENERGY MANAGEMENT

Surplus bagasse

By Paul Friedman, Diego Leal and Jorge Feria
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Introduction

It is estimated that about 120 -140 millions tonnes of bagasse were produced world-wide during the 1986/87 harvest. It is not known how much of this bagasse was required as a fuel for the generation of steam used in the raw sugar production process and how much remained as a surplus.

Traditionally it has been possible to produce raw cane sugar without the use of large quantities of supplementary fuel. In fact, before the 1970's when the price of oil reached record levels, this small consumption did not greatly affect the economics of sugar production. In the cases where bagasse surpluses existed, problems arose because of the accumulations of this low bulk density, dusty, waste product. Thus, in many cases the boilers were specifically designed with low efficiencies so that all the bagasse produced could be burned.

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D. Leal

J. Feria

Although in theory, surpluses of up to 50% have been postulated[1], in practice, only small surpluses have been reported. These of course vary between countries and even between different sugar factories in the same country.

In the case of Cuba, 430,600 tonnes of fuel oil were consumed during the 1979 sugar harvest (6.17 litres/tonne cane) to produce raw sugar. By means of

1 Friedman *et al.: Paper presented to the 44th Congr. Asoc. Técn. Azuc. Cuba*, 1984.

a program of modernization to increase the energy efficiency of the sugar industry the use of supplementary fuel was completely eliminated during the 1985 harvest.

What then are the prospects of surplus bagasse as a renewable energy source or raw material? A 50% surplus world-wide would supply the equivalent of 12 million tonnes of oil, valued at about 2000 million dollars, every year.

Surplus bagasse, at a cost substantially lower than bagasse replaced by oil in the sugar mill, would bring about a marked improvement[2] in the economies of the following by-products: pulp and paper, some 80 plants with about 2 million tonnes/year capacity; particle board, about 30 plants which produce approximately 300,000 m³/year and furfural, 10 plants with a capacity of 142,000 tonnes/year.

Another use of increasing importance is in the generation of electricity for sale to the public utility. A case in point is Hawaii where bagasse-generated electricity plays a significant role in the state's energy requirements.

In Cuba, bagasse is considered as an important national raw material and renewable energy resource. In this regard, President Fidel Castro[3] has expressed the following: "What has this saving of fuel oil in the production of raw sugar signified? What has it meant in these years with harvests of no less than 8 million tonnes? It has meant a saving of 400,000 tonnes per year of fuel oil that were used with harvests of 6 million tonnes... They then proposed saving another 400,000 tonnes of fuel oil which is used in the preparation of refined sugar, torula yeast and other expenditures of fuel... Starting from a harvest of 9 millon tonnes of sugar, they calculate that they can additionallly produce the equivalent in energy of 2.5 million tons of fuel..."

Materials and methods

The Pablo Noriega sugar factory in Quivicán, Cuba, with a capacity of 1000 tonnes of sugar cane per day, is part of the Cuban Sugar Research Institute (ICINAZ) and in this regard serves as a pilot plant for the Cuban sugar industry.

A program for increasing the energy efficiency of this mill by introducing modern technology was established for the five-year period, 1981/85. As can be seen in the energy balance shown in Fig. 1(a) the mill was quite inefficient and 3436 tonnes (net) of fuel oil were consumed during the 1981 harvest. The mill required about 65% steam on cane owing to the relatively inefficient evaporator station (pre-evaporator plus quadruple effect), high steam consumption in vacuum pans and substantial lossses due to condensation because of poor insulation on piping and equipment and large distances between the bagasse and package boilers and the process equipment. At the same time, the bagasse boiler only produced about 1.7 tonnes of steam per tonne of bagasse and the package boiler about 9 tonnes steam/tonne fuel oil.

The changes carried out for the 1982/85 harvest seasons have been

2 Suárez *et al.*: "The storage of bagasse for the by-product industries", (Editorial Científico-Técnica, Havana), 1982, 80pp.

3 Speech delivered at the *First National Energy Forum, Havana*, December 4, 1984.

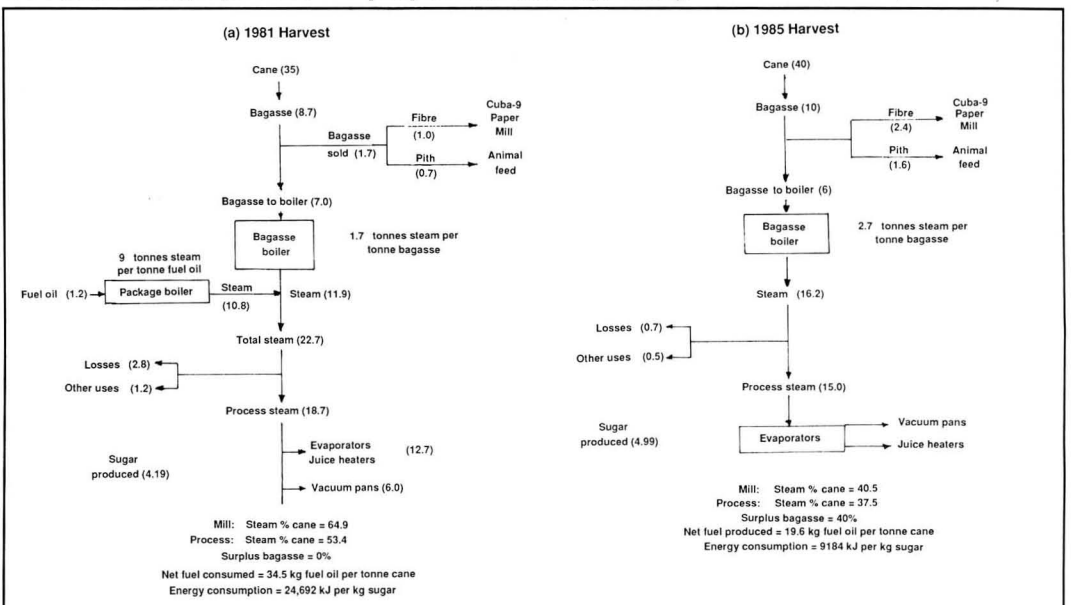

Fig. 1. Energy balances at Pablo Noriega sugar factory (all flows in tonnes/hr)

described in the literature[1,4-11]. With the aid of the SIMEVA evaporator simulation program, the pre-evaporator plus quadruple station of 1023 m² total area was converted to a quintuple effect of 1321 m² total area with vapour bleeding from three effects which worked well during the 1982 season[4,5].

The installation was further modified for the 1983 season by increasing the number of effects with bleeding to four, obtaining even better results[9]. However, owing to difficulties in the condensate systems of the juice heaters, evaporator and vacuum pans and the insufficient capacity of the bagasse boiler, a package boiler using fuel oil had to be used to supply part of the process steam.

For the 1984 season the faults in the condensate systems were corrected, the heating surface area of two effects was increased and a redundant fifth effect was used as a sixth effect[8]. At the same time the bagasse boiler was modified, increasing its capacity from 15 to 20 tonnes of steam of 1.14 MPa (150 psi) per hour by adding water walls and ceiling plus an economizer[10].

A pneumatic bagasse dryer with a capacity of 7 tonnes of moist bagasse per hour was installed for the 1985 harvest[11].

Results and discussion

The results of the fuel balance for the 1981 to 1985 harvest seasons are shown in Table I.

Table I. Fuel balance at Pablo Noriega sugar factory

	1981	1982	1983	1984	1985
Bagasse sold, tonnes	5615	11878	14798	10929	9978
Fuel oil equivalent*, tonnes	1103	2332	2906	2147	1960
Fuel oil consumed, tonnes	4539	2623	3249	245	0
Net fuel consumed (produced), tonnes	3436	291	343	(1902)	(1960)
Net fuel consumed (produced), kg/tonne cane	34.5	2.4	2.5	(14.0)	(16.9)
Surplus bagasse, %	-	-	-	28.7	34.8

* 1 tonne of fuel oil ≡ 5.09 tonnes of bagasse (50% moisture content)

The large surplus obtained during the 1984 and 1985 harvests – 28.7 and 34.8%, respectively – are due to two factors:

(i) The use of a sextuple-effect evaporator station with vapour bleeding from 4 effects to supply all the steam required for the stage-wise heating of the limed and clarified juice and vacuum pans.

(ii) The use of a bagasse dryer which increases the boiler efficiency by utilizing the waste heat in the stack gases to dry the bagasse fuel.

The bagasse dryer was put into continuous operation during the last part of the 1985 harvest. The energy balance shown in Fig. 1 (b) refers to the period of time when the bagasse dryer was in operation.

Conclusions

The Cuban sugar industry now produces raw sugar without the use of supplementary fuel. However, because of the ever-increasing need for surplus bagasse as a raw material and renewable energy source, the sugar industry must be modernized so that this resource will be available.

A modernization program was carried out in the Pablo Noriega experimental sugar factory during 1981/85, decreasing process steam requirements and increasing the efficiency of steam generation.

Owing to this marked increase in energy efficiency, surpluses of 28.7 and 34.8% bagasse were obtained for the 1984 and 1985 harvests, respectively, and about 40% surplus when the bagasse dryer was in operation.

Summary

The need for surplus bagasse as a raw material and renewable energy resource is affirmed. A description of the modifications carried out at the Pablo Noriega Experimental Sugar Mill, Quivicán, Cuba, to increase the energy efficiency and produce surplus bagasse is given. They consist in the installation of: (i) a sextuple effect evaporator station with vapour bleeding from four effects, and (ii) a bagasse dryer using waste heat from the stack gases to dry the bagasse fuel. The results are discussed and energy balances are shown. A surplus of 34.8% of the bagasse produced is reported for the entire 1985 harvest and about 40% when the bagasse dryer was in operation.

4 Friedman *et al.: Paper presented to the 43rd Congr. Asoc. Técn. Azuc. Cuba*, 1981.
5 Idem: *Proc. 18th Congr. ISSCT*, 1983, 1518 - 1531.
6 Valdés *et al.: Paper presented to the 44th Congr. Asoc. Técn. Azuc. Cuba*, 1984.
7 Leal *et al.: CubaAzúcar*, 1984, (Jan./March), 3 - 10.
8 Idem: *Paper presented to the 44th Congr. Asoc. Técn. Azuc. Cuba*, 1984.
9 González & Vázquez: *CubaAzúcar*, 1982, (Oct./Dec.), 3 - 10.
10 Peña: "Boiler modification" *Internal Report*, (ICINAZ, Cuba), 1983.
11 Arrascaeta & Friedman: *Paper presented to the 1st National Energy Forum, Cuba*, 1984.

Facts and figures

Rhizomania found in the UK

In August the press reported the discovery on a farm in Suffolk of the sugar beet virus disease rhizomania — the first time it has been reported in the UK. The Ministry of Agriculture has put the farm under strict quarantine and intends to eradicate the disease. The farmer involved will lose several thousands of pounds because, while the compensation is payable for the lost crop, none is paid for the measures which have to be taken to rid the land of the virus. The National Farmers Union has blamed the Ministry for inadequate measures to exclude the disease, which is widespread on the European continent. Beet seed and plants are subject to import control and imported seed potatoes have to come from areas free of the disease, while second-hand agricultural machinery must be washed before it is admitted to the UK. The NFU say, however, that all soil-carrying imports, such as vegetables, which can carry the virus, should be washed in the country of origin before shipment to the UK. Since the discovery is the first of its kind and measures are being taken to eliminate it, the sugar market discounted any idea of a threat to UK sugar production and announcement of the discovery had no effect on world prices of sugar. Following discussions with this year's host grower, it was decided by British Sugar plc and the UK Sugar Beet Research and Education Committee to cancel the planned autumn demonstration as a consequence of the outbreak of rhizomania. Although the outbreak, in a 20-acre field of sugar beet, was an isolated one, British Sugar were treating it very seriously and were not prepared to expose the host farm or the UK sugar beet industry to the risk of further infection.

Alkaline degradation of monosaccharides

Part IV: Characterization of oligomeric products formed during the alkaline degradation of monosaccharides

By J. M. de Bruijn, A. P. G. Kieboom, H. van Bekkum*, P. W. van der Poel, N. H. M. de Visser and M. A. M. de Schutter

Continued from page 195

^{13}C NMR spectroscopy

Application of ^{13}C NMR for the identification of the $C_{>6}$ acids in alkaline degradation mixtures[21] appeared to be difficult. Some information, however, on the functional groups present in the oligomeric products was obtained from the alkaline degradation of 1-^{13}C-D-glucose using ^{13}C NMR. Quantitative ^{13}C NMR analysis of the total degradation mixture revealed that 32% of the ^{13}C label is incorporated in the $C_{>6}$ acids, which is the same magnitude as the total amount of $C_{>6}$ acids, i.e. 42.5 mol-C_6-%, present in that mixture. The distribution of the ^{13}C label over the various functional groups in the $C_{>6}$ acids is given in Table I. In addition to the expected CH_3, CH_2, CH_2OH and CHOH moieties ^{13}C NMR spectroscopy further emphasizes the presence of carboxylate and olefinic groups in the $C_{>6}$ acids.

Table I. ^{13}C distribution in the $C_{>6}$ acids obtained by alkaline degradation of 1-^{13}C-D-glucose[a]

Functional group	^{13}C label, %
CH_3, CH_2	16
CH_2OH, CHOH	6
C=C	7
COOH	3
Total	32

[a] Reaction conditions: 450 mg 1-^{13}C-D-glucose in 100 ml H_2O (0.025 M), 0.01 M KOH, 78 °C, N_2, 7 hr, 100% conversion

GC-MS analysis

For GC-MS analysis the $C_{>6}$ acids were precipitated with Pb(II) and the precipitate subsequently freed from lead and fractionated by gel filtration (Figure 6P) as described above. The oligomeric products with mol. wt. < 350 were collected, freeze-dried, trimethylsilylated, and analysed by gas chromatography (Figure 12). The gas chromatogram of this low molecular weight Pb(II) precipitate fraction (B), as compared with that of the standard alkaline degradation mixture (A), shows the occurrence of extra acidic products (1-6), which have been characterized by mass spectrometry (Table II). The mass spectra of the trimethylsilylated $C_{>6}$ acids 4, 5, and 6, respectively, are given in Figure 13, together with the most important fragmentations using data of trimethylsilylated aldonic and deoxyaldonic acids[28,29].

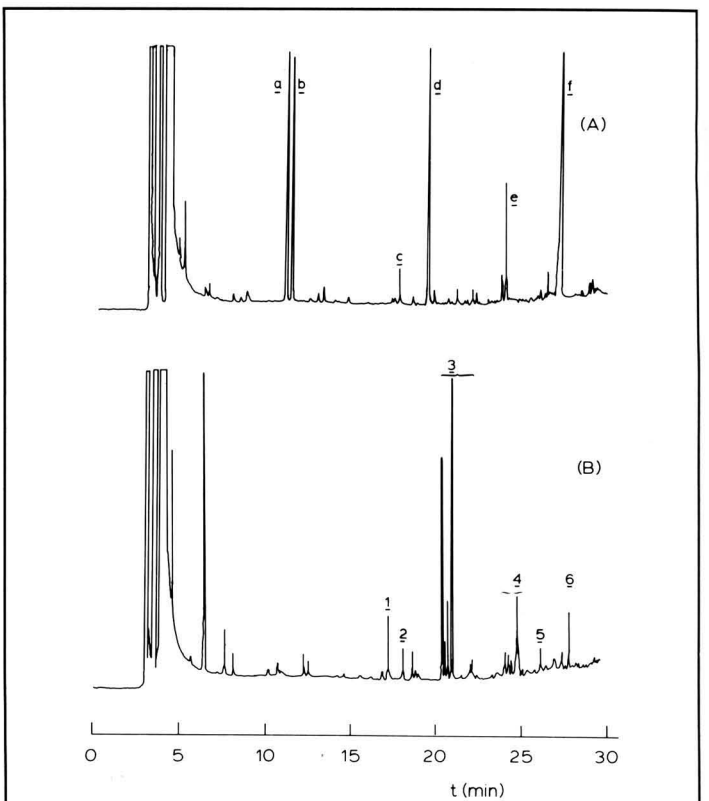

Fig. 12. GC analysis of carboxylic acids (as their TMS-derivatives) as present in the standard alkaline degradation mixture (A) and in the Pb(II) precipitate fraction with mol. wt. < 350 (B); a lactic acid; b glycolic acid; c 2-methylglyceric acid; d 2,4-dihydroxybutric acid; e 3-deoxypentonic acid; f metasaccharinic acid. The structures of 1-6 are given in Table II. GC conditions : see Experimental

A possible explanation for the formation of the carboxylic acids 1-6 (Table II) is presented in Figure 14. Starting from several molecules known to be formed in the alkaline degradation, the pathways indicate the importance of the aldolization of (di)carbonyl compounds during the alkaline degradation of monosaccharides. By β-elimination, benzilic acid rearrangment and dicarbonyl cleavage reactions[3], the chain elongation by aldolization is terminated and the final products are formed.

It may be mentioned that the carboxylic acids 1, 5, and 6 are not stable in alkaline medium because of the presence of an enolizable carbonyl group.

28 Petersson: *Tetrahedron*, 1970, **26**, 3413.
29 Idem: *Org. Mass Spectrom.*, 1972, **6**, 577.

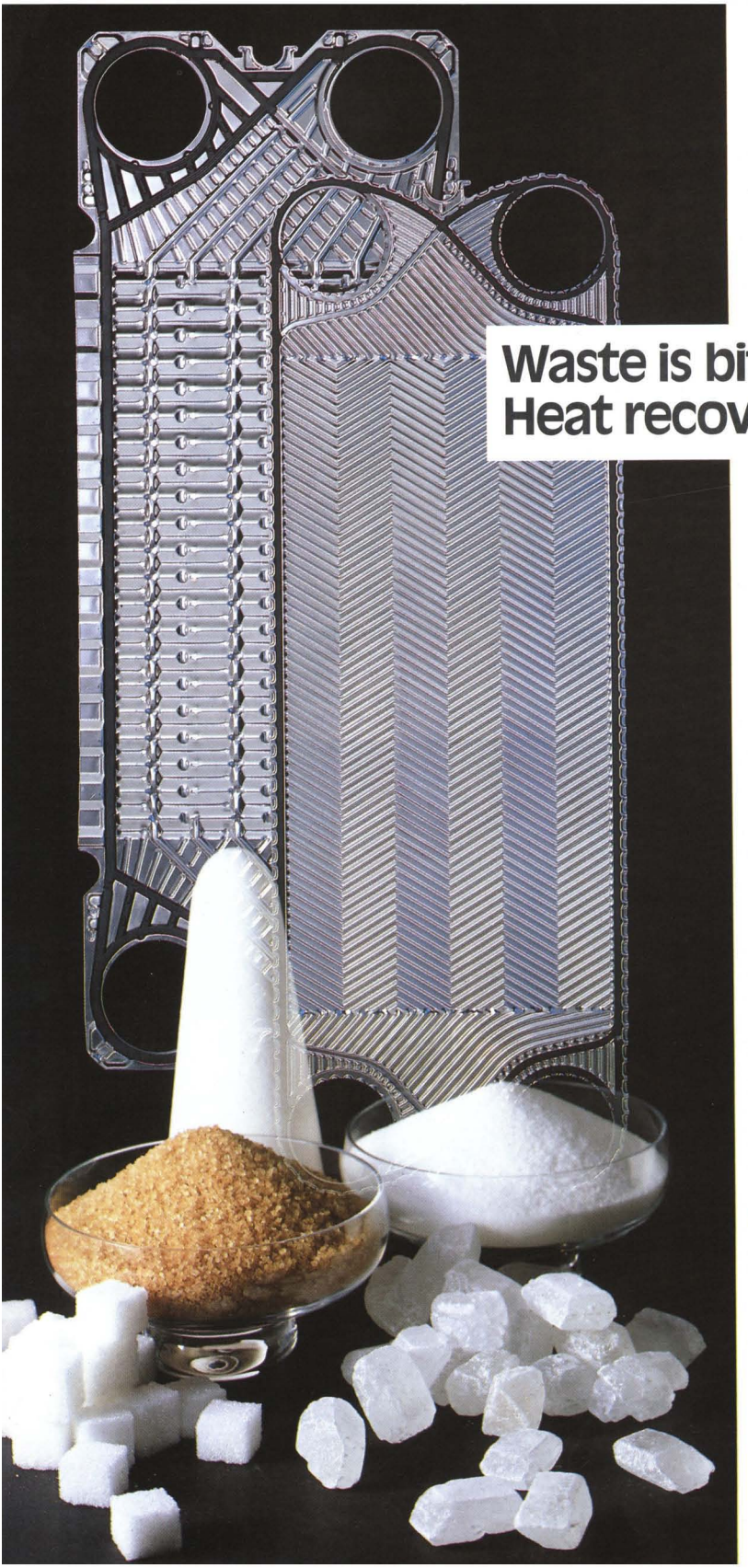

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Table II. Acidic products[a], identified by GC-MS, in the Pb(II) precipitate fraction with mol. wt. < 350 of the standard alkaline degradation of D-fructose[b]

1	CH_3-CO-CH_2-CHOH-COOH
2	CH_3-CHOH-CH_2-CHOH-COOH
3	$(CH_3$-$CHOH)_2$CH-COOH (and isomers)
4	$(CH_3$-$CHOH)_2$CH-CHOH-COOH (and isomers)
5	CH_3-CO-C(CH_2OH)=C(OH)-CH_2-CHOH-COOH
6	CH_3-CO-C(CHOH-CH_3)=C(OH)-CH_2-CHOH-COOH

a The numbering corresponds with the peaks in the gas chromatogram of Fig. 12B
b 0.025 M D-fructose, 0.01 M KOH, 78°C, N_2, 7 hr, 100% conversion

Further reaction of these compounds by aldolization with other carbonyls may explain the gradual increase of the colour of the reaction mixture, as indicated by the absorption at 420 nm, after complete conversion of the monosaccharides (Fig. 8).

The structural features for the $C_{>6}$ acids are expected to be similar to those obtained for the C_7, C_8, and C_9 acids. Definite proof requires further investigation using sophisticated HPLC in combination with fast-atom-bombardment mass spectrometry (HPLC-FAB-MS).

Conclusions

The characteristics of the oligomeric reaction products of alkaline decomposed monosaccharides as determined by various analytical techniques show that these products contain carboxylate, CH_3, CH_2, CH_2OH, CHOH, and (enolized) β-dicarbonyl moieties. The structures of C_7, C_8 and C_9 acids point to their formation by aldolization of small carbonyl compounds, e.g. pyruvaldehyde, glycolaldehyde, acetaldehyde and formaldehyde, in various combinations. The relatively high content of $C_{>6}$ acids with average molecular weights of ~ 350, ~ 500, and ≥ 700 indicates that also the aldolization of C_6 (di)carbonyl compounds such as, for instance, 3-deoxyhexos-2-ulose, 4-deoxyhexo-2, 3-diulose, as well as the monosaccharides themselves, will be involved in the formation of oligomeric degradation products. Thus, under alkaline "degradation" conditions substantial amounts of monosaccharides, partially via initial retro-aldolization, are oligomerized to $C_{>6}$ acidic products. These oligomeric products are responsible for both the UV absorption at 265 nm and the colour formation of the reaction mixture.

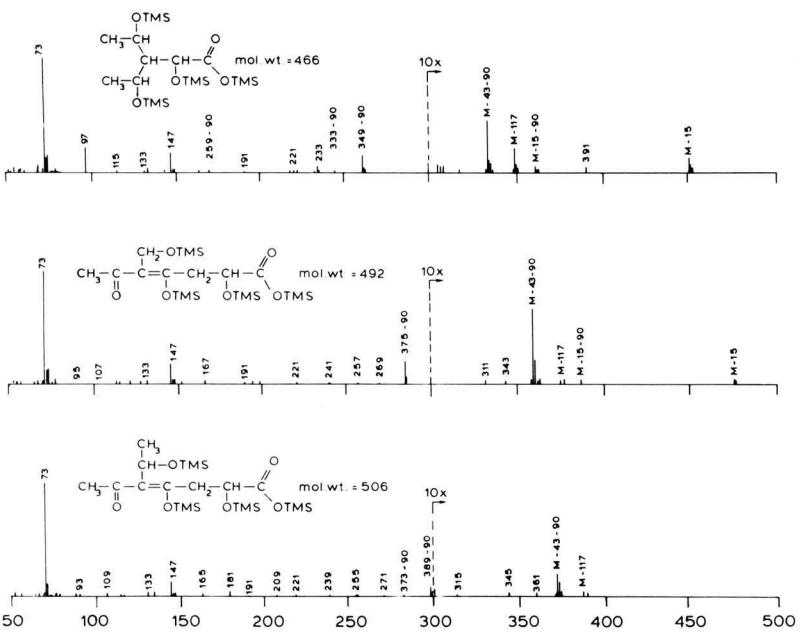

Fig. 13. Mass spectra of the $Cl_{>6}$ acid 4, 5, and 6 (as their TMS-derivatives). Ionization technique: electron impact. Explanation of fragmentation ions[28,29]: M-15: loss of CH_3 from $SiMe_3$; M-15-28: subsequent loss of CO; M-n × 90 : loss of n × Me_3SiOH; M-117: loss of $COOSiMe_3$; m/e = 73 is base peak

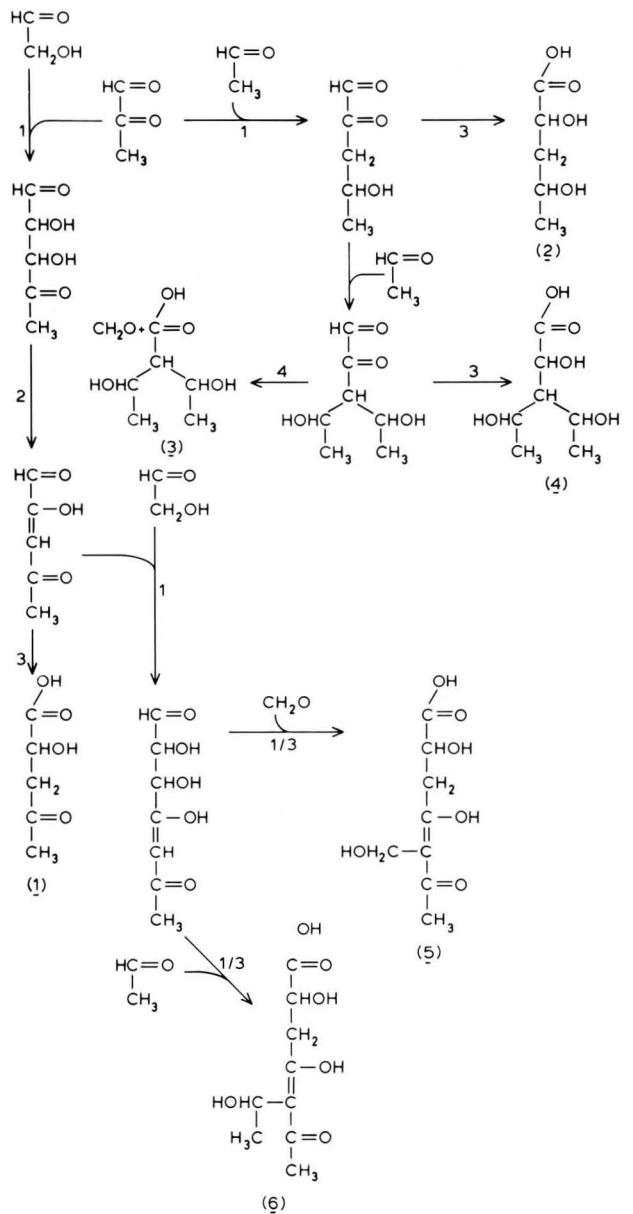

Fig. 14. Possible pathways for the formation of acidic degradation products 1 - 6 via aldolization of (di)carbonyl compounds: 1. aldolization, 2. β-elimination, 3. benzilic acid rearrangement, 4. α-dicarbonyl cleavage

Summary

The nature and structure of oligomeric products formed upon the alkaline degradation of monosaccharides have been studied by UV, IR and ^{13}C NMR spectroscopy and GC-MS analysis. Separation of the reaction mixture into C_1-C_6 acids and oligomeric products was performed by gel filtration and by selective precipitation with Pb(II) salts. It appeared that the oligomeric products comprise a complex mixture of acidic compounds containing similar structural moieties, i.e carboxylate, β-dicarbonyl, CH_3 and CH_2, CH_2OH and CHOH groups. These so-called $C_{>6}$ acids with average molecular weights ~350, ~500, and ≥ 700 are considered to be formed via aldolization of (di)carbonyl compounds which are important intermediates of the alkaline degradation of monosaccharides. Such (di)carbonyls are, for instance, pyruvaldehyde, 3-deoxyhexos-2-ulose as well as the monosaccharides themselves. The structures of a C_7, a C_8 and a C_9 acid have been elucidated by GC-MS analysis. The oligomerization reaction is directly correlated with the UV absorbance at 265 nm during the alkaline degradation of monosaccharides.

Acknowledgements

Mrs. A. H. Knol-Kalkman is acknowledged for recording the mass spectra and Mr. A. A. Wismeijer for carrying out the hydrogenation experiments.

Facts and figures

Guyana sugar factories rehabilitation

Guyana Sugar Corporation is in the market for new machinery to rehabilitate seven of its factories. The project, to be launched through the Inter-American Development Bank Industrial Reactivation Program for the Rehabilitation of Sugar Factories, is aimed at improving the efficiency and productivity of the Guyana sugar factories through the replacement of obsolete and worn-out equipment and to improve the quality of output of the factory workshops. The Guyana Sugar Corporation will shortly be going to international tender, inviting bids from manufacturers and suppliers of sugar manufacturing equipment from many parts of the world. The Inter-American Development Bank will provide a loan of US$9,800,000 to launch the project.

Facts and figures

Alcohol from beets in France[1]

The French government recently announced reduction of taxes on alcohol in order to promote its production as fuel from bagasse. The Italian Ferruzzi group has announced that it will build its first alcohol plant in France, with an annual capacity of 25,000 tonnes, using as raw material 25,000 tonnes of sugar beets and 50,000 tonnes of wheat. The plant will cost between $10 and $20 million and will be located near the Belgian border; Feruzzi already owns a starch factory in the area at Haubourdin and the plant will probably be built there.

Amstar contract to buy Hawaiian raw sugar[2]

A 5-year contract has been signed between Amstar Corporation and C & H Sugar Company under which Amstar will purchase 200,000 short tons of raw sugar from C & H on a calendar year basis, with a provision for unspecified additional tonnage. Also included is a provision for C & H to toll refined sugar for export on the account of Amstar. While the bulk of Hawaiian raw sugar is refined at the C & H refinery at Crockett, California, surplus tonnage has in the past usually been sold to Gulf Coast refineries; the new contract will not only provide Amstar with a secure supply but will also eliminate the need for C & H to seek outside buyers for their surplus.

China sugar production, 1986/87[3]

China's 1986/87 sugar production amounted to 5,728,000 tonnes, raw value, compared with 5,641,000 tonnes produced in 1985/86, according to official sources. Of the total production, 870,000 tonnes were beet sugar and 4,858,000 tonnes cane sugar, compared with 978,000 tonnes and 4,663,000 tonnes, respectively, in 1985/86. Production in 1987/88 is estimated at 5,760,000 tonnes (870,000 tonnes of beet sugar and 4,890,000 tonnes of cane sugar).

Pakistan sugar imports, 1986[4]

	1986	1985
	tonnes, raw value	
Brazil	147,000	0
Cuba	28,000	0
Czechoslovakia	76,000	0
EEC	219,000	4,000
Germany, East	103,000	0
Guatemala	12,000	0
Korea, South	12,000	0
Malaysia	36,000	0
Poland	38,000	0
Thailand	55,000	0
Unknown	0	23,000
	752,000	27,000

Drought in Cuba[5]

Prolonged lack of rain has affected the province of Camagüey, hit by the worst drought of the past 40 years, according to Reuter reports from Havana, and in the first three weeks of August rainfall was only 41% of the usual level[6]. Reservoirs in the sugar cane growing eastern region were at critical level, according to a report on national television, and new water wells have to be drilled. In the 1985/86 Cuban harvest 1,000,000 tonnes of sugar were lost through drought.

Sugar traders cooperation[7]

The French sugar trader Cie. Commerciale Sucres et Denrées (Sucden) and the Malaysian firm Kerry Trading Company are to undertake joint operations following a letter of intent signed in July between the two companies, according to a Sucden official. Having traded some 3 million tonnes of white sugar last year, Sucden is one of the world's leading sugar operators, while Kerry carries out commodity trading activities in Hong Kong, Malaysia and Singapore, and has a turnover of some 1 million tonnes of white sugar annually in south-east Asia. Details of how the companies plan to cooperate have not been finalized. The Kuok Group of Hong Kong have taken 30% of Sucden, which will change its name to Sucden Kerry International.

Drought in India[8]

Most of the sugar cooperatives in western Maharashtra are likely to face a severe crisis owing to an acute scarcity of water. The water level in reservoirs has fallen considerably and this could adversely affect cane development. About half the state's factories will be able to operate only partially in the 1987/88 season and some will not be able to crush at all. Except in two reservoirs the water held is less than 45% of what is normally stored at this time of year and one reservoir has recorded its lowest level in 104 years at 33% of normal storage.

Difficulties for Caribbean alcohol exports to the US[9]

With low prices and reduced export opportunities, Caribbean sugar producers have looked for alternative uses for their crops and production of fuel alcohol for export to the US has appeared promising. Among the latest moves, the state-owned Petroleum Corporation of Jamaica is leasing the Libertad sugar estate and factory in Belize for manufacture of wet alcohol which will be shipped to the US. When fully on stream, the project will bring Jamaican alcohol exports to the US from 30 million to 55 million gallons a year. But the region's alcohol producers have been operating under a cloud of uncertainity while the US government departments argued about the conditions under which Caribbean alcohol could be imported duty-free. Because some producers obtained aqueous alcohol feedstock from Brazil and Spain it has been argued that they were not making a substantial transformation and that the Brazilian and European alcohol was being dumped, duty-free, to the detriment of US producers. The US customs service had ruled that Caribbean alcohol operations made the product eligible for preferential access, but a new Tax Bill would require local added value to be increased to at least 75% by 1989. Tropicana Jamaica, which ships 28 million gallons per year to the US says that, with operating costs between 30 and 35% of the total, Caribbean companies would have to become "indigenous" — but feedstock available from within the Caribbean would generate no more than 4-5 million gallons. The company has leased a sugar factory and just under 2000 acres of cane fields from the Jamaican government in an effort to increase its local supply of feedstock.

West German sugar factory closure[10]

Pfeifer & Langen has announced that it will close its sugar factory in Düren after the coming campaign. The company said that the closure is one measure of the necessary structural reform as factories in the Rhineland area are too small compared with those in Lower Saxony and Southern Germany. The remaining factories can easily process the beet formerly delivered to Düren, which means that the closure will have no impact on production.

China sugar imports and exports, 1986[11]

	1986	1985
	tonnes, raw value	
Imports		
Australia	443,00	452,000
Cuba	307,000	680,000
EEC	0	13,000
Fiji	31,000	58,000
Hong Kong	10,000	5,000
Japan	24	0
Philippines	0	95,000
Thailand	307,000	911,000
	1,098,024	2,214,000
Exports		
Hong Kong	41,813	33,806
India	28,056	194,028
Singapore	15,742	7,631
Sri Lanka	22,000	0
Other countries and unknown	92,389	14,535
	200,000	250,000

British Sugar ownership

In September Tate & Lyle sold three-quarters of its 14.9% stake in S. & W. Berisford to the Chicago-based Pritzker family – friends of the principals of Berisford – and the balance to Berisford directors, bringing their stake in the business to some 20%. This combination is likely to be a stumbling block for a bid by Associated British Foods for acquisition of Berisford following their purchase of the shares previously owned by the Ferruzzi

1 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 344.
2 *Dyergram*, 1987, (15-87), 3.
3 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 365.
4 *I.S.O. Stat. Bull.*, 1987, **46**, (7), 2.15.
5 *Financial Times*, August 20, 1987.
6 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 414.
7 *Public Ledger's Commodity Week*, August 22, 1987; September 5, 1987.
8 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 416.
9 *Financial Times*, August 27, 1987.
10 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 426.
11 *I.S.O. Stat. Bull.*, 1987, **46**, (7), 2.4.

Group[12]. Berisford have rejected the bid as unsolicited and unwelcome; it values Berisford shares at £4.00 per share but they rose on the stock exchange to £4.25, indicating that the market expected the bid to be raised. Some analysts have said it would have to reach £4.50 to be successful.

Belize sugar import requirement[13]

The Tower Hill sugar factory in Belize was expected to cover all local consumption for 1987/88, estimated at 6400 tonnes; however, shortage of cane has restricted production to 2300 tonnes and Belize is now expected to import around 4100 tonnes of white sugar during the crop year.

ISJ readership survey

We would like to thank all the readers who participated in the survey by completing and returning the questionnaires distributed with our April 1987 issue. As previously announced[14], the prize draw winner was Mr. Raymond Rivalland of C.E.R.F., Réunion. The world-wide survey showed that *International Sugar Journal* has around 27,000 readers and that they regard it highly. On average, readers take 5.4 sugar magazines but more than 80% voted *ISJ* the most important. On a 0 - 10 scale, *ISJ* achieved an average score of 8.8, higher than any other magazine, and 94% of copies are kept for permanent reference.

Merit award for the Sugar Milling Research Institute

The Sugar Milling Research Institute in Durban, South Africa, was awarded a Merit Certificate from the National Productivity Institute of South Africa in August 1987 for the SMRI's contribution to increased average industrial extraction between 1977 and 1987 and for recent investigations into the optimization of mud filtration in raw sugar factories. In all factories where the results of this latter research have been applied, sugar losses during filtration decreased significantly.

A/S De Danske Sukkerfabrikker report, 1986/87

Sugar production by DDS factories totalled 425,000 tonnes, some 60,000 tonnes above the EEC quota. The campaign went well, and continued efforts to rationalize and modernize production facilities, together with low fuel costs, permitted achievement of a financial result on the same level as 1985/86. Much investment has been made in developing very productive strains of sugar beet and the share of the market taken by the Maribo subsidary has increased. The strength of the Danish krone relative to other currencies resulted in unsatisfactory earnings by the mechanical engineering companies in the Group and these have required extensive capacity adjustments and measures to improve efficiency. DDS-Engineering secured orders for a large beet sugar factory and a beet seed plant for China and started a major cane sugar factory project in Bangladesh. Projecting for a large beet sugar factory for the USSR is more or less complete while two plants are under construction: a small cane sugar factory for the Central African Republic and a dextrose factory for China. Work is almost complete on a major modernization and conversion of Chinese beet sugar factory.

Nigeria sugar production difficulties[15]

Heavy competition from imported sugar makes it difficult for the local sugar companies of Nigeria to expand production, according to USDA Agricultural Counselor in that country. Devaluation of the Naira has led to the abandonment of planned expansion of plantation area and machinery modernization. Many experts see the only way to raise production is subsidizing local producers; import bans are likely to fail. The two major sugar producing companies report sugar cane yields of 60 to 70 tonnes per hectare from irrigated cane. Sugar yields are reported to be one tonne per 9 to 13 tonnes of cane. The two companies have tried to encourage farmers to produce non-irrigated cane but success has been limited. Tate & Lyle Ltd., the largest sugar importing company in Nigeria, has abandoned the 60,000 hectares sugar cane plantation planned for Haedejia Ja'Amare River Basin in Kano, owing to prohibitive costs of production.

Egypt sugar imports, 1986[16]

	1986	1985
	tonnes, raw value	
Brazil	119,000	212,000
Cuba	139,000	182,000
EEC	209,000	217,000
Germany, East	90,000	42,000
Mauritius	11,000	0
Poland	0	45,000
USSR	0	13,000
	568,000	711,000

Indonesia drought[17]

A prolonged drought in Indonesia has damaged 210,000 hectares of farmland and may force it to import sugar in 1989. The Agriculture Minister has said that 1987/88 crop year sugar production will drop by at least 100,000 tonnes. Planting for the 1989 season had just started when the drought hit and that crop is in severe trouble because many of the seedlings have died.

US sugar import quota regime to continue[18]

The US has decided to continue indefinitely its sugar import quota system, according to the *Federal Register*. It said that Agriculture Secretary Richard Lyng has made his annual determination to continue the system to protect domestic producers. The announcement said large world stocks will prevent a substantial recovery in world prices, making it "impossible to achieve market conditions that give due consideration to domestic producers" without quotas.

Canadian beet support plan[19]

Most of Manitoba's sugar beet farmers will enroll in a tripartite sugar beet stabilization plan jointly sponsored by the federal, Manitoba and Alberta governments. The deadline for farmers to enroll was extended for a month to September 30 because of a delay in circulating the necessary forms in Alberta. The plan will run for a decade beginning with the current crop year. Support levels will be based on 75% of the current cash cost of production, plus 20% of the previous 15-year average price. The Secretary-Treasurer of the Canadian Sugar Beet Producers Association said the decision to participitate in the plan is purely economic; with the world price of sugar at 6 to 8 cents a pound, Canadian producers cannot cover their production costs.

Argentina sugar expansion plan[20]

The US Department of Agriculture reports that the Argentine government has raised the sugar production quota for the 1987/88 crop year to 1,045,000 tonnes, raw value; this represents an increase of 8% over the estimate of May but is still 6% below output in 1986/87. The USDA also reports that, of the total, 1,037,000 tonnes correspond to cane sugar and 8000 tonnes to beet sugar. The increase in the quota was granted so as to ensure adequate sugar supplies on the domestic market since stocks have fallen to low levels.

Jamaica sugar production, 1986/87[21]

Jamaica's raw sugar output for 1986/87 reached 187,966 tonnes, 12,321 tonnes less than in 1985/86, according to the sugar industry authorities. No reasons were given why output has declined though the productivity rating for the harvest was higher. The projection for the next season is 210,000 tonnes of sugar. In April the government said the industry was aiming to stabilize annual production at 245,000 tonnes. This is the amount of sugar needed to satisfy the demands of the domestic market, the guaranteed market in the EEC, the national stockpile and Jamaica's US quota.

US sugar industry problems discussion[22]

At a meeting in Washington on September 11, representatives of sugar cane and beet producers and beet processors met congressional supporters and agreed to establish a committee to study US sugar industry problems. Representatives of the corn wet milling industry will be invited to participate. Some of the issues to be explored by the committee will be: (a) ways to assist Caribbean countries and the Philippines, which are traditional suppliers, without threatening the US price support program; (b) ways to stem imports of sugar blends and sugar-containing products; (c) a possible promotional campaign aimed at increasing US sugar consumption; and (d) possible controls on US domestic sweetener production.

12 See *I.S.J.*, 1987, **89**, 61, 160.
13 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 428.
14 *I.S.J.*, 1987, **89**, 196.
15 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 428.
16 *I.S.O. Stat. Bull.*, 1987, **46**, (7), 2.6.
17 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 431.
18 *Public Ledger's Commodity Week*, September 12, 1987.
19 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 447.
20 *Reuter Sugar Rpt.*, August 12, 1987.
21 F. O. Licht, *Int. Sugar Rpt.*, 1987, **119**, 447.
22 *Czarnikow Sugar Review*, 1987, (1765), 138.

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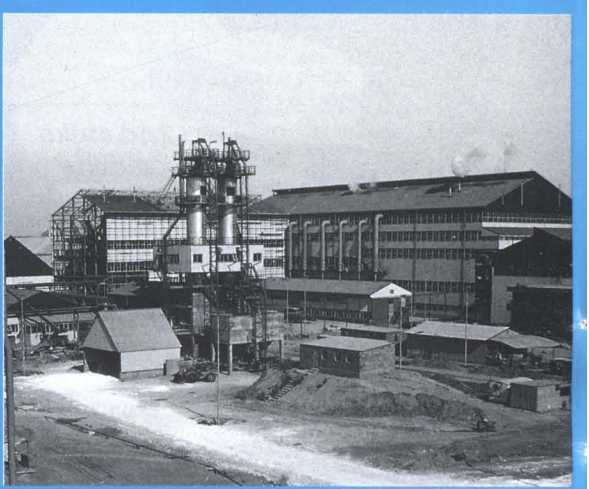

△ Small scale sugar factory at Kyauk Taw-Burma. The factory has a capacity of 350 tonnes of cane per day, and has a Stork distillery producing 5000 liters of alcohol per day from molasses.

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