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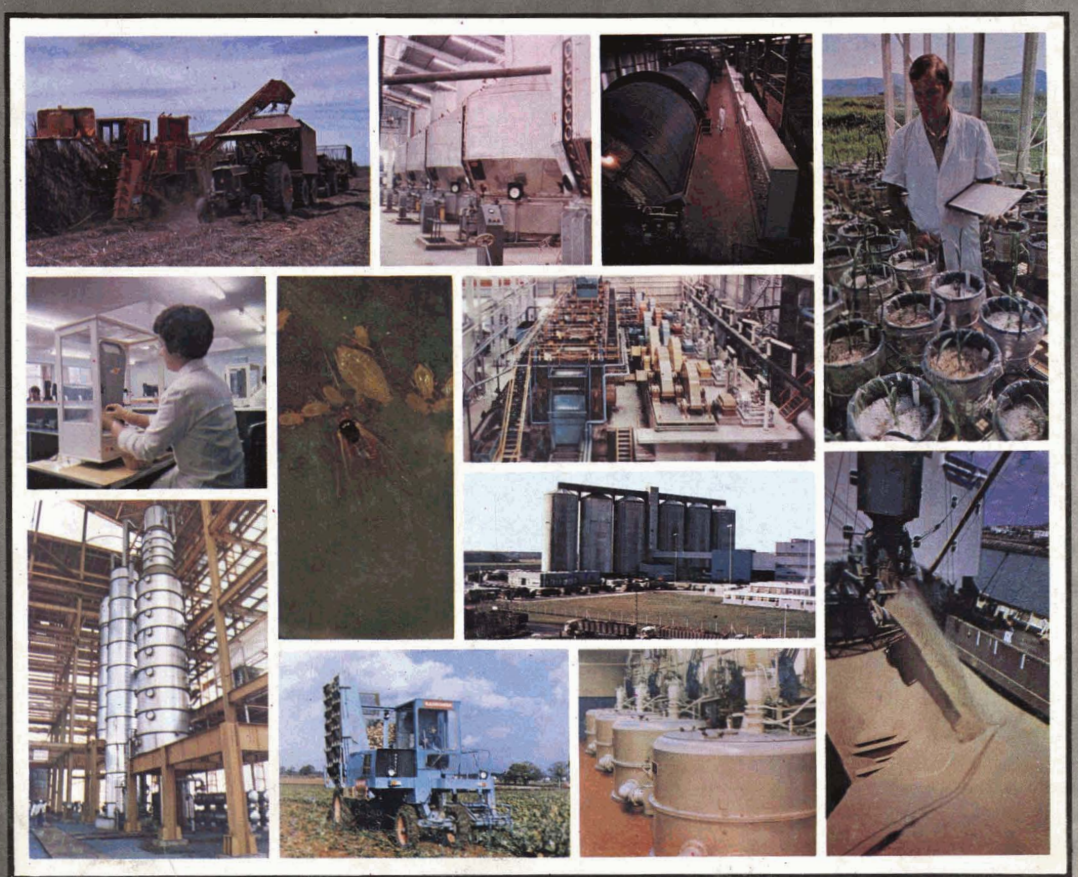

OCTOBER 1978

RENOLD

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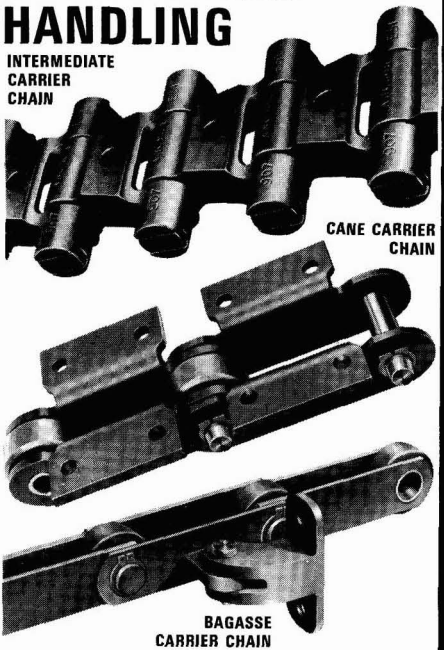
CHAINS FOR MECHANICAL HANDLING



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Specialised Renold chains have been supplied to the cane sugar industry since 1920. Over 90 years of precision chain manufacture ensure a product combining high strength with compactness, minimum weight and low cost for long life and trouble-free operation.
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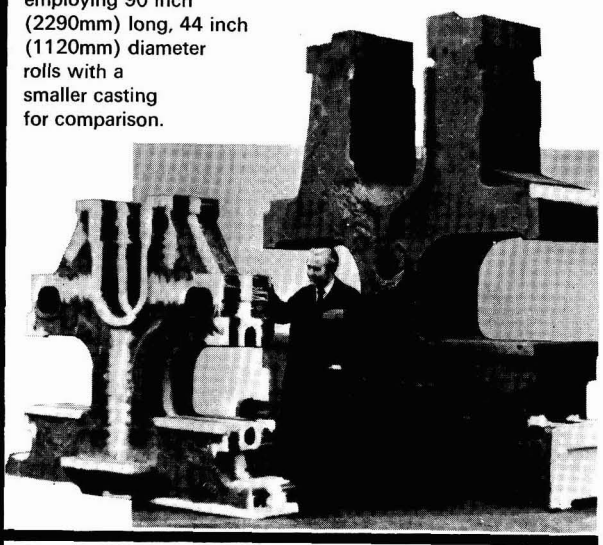
Hydraulic, electrical and mechanically operated variable speed systems.
Couplings, clutches and brakes.
Power transmission ancillaries.

CASTINGS & FORGINGS

Holcroft Castings and Forgings, a Renold subsidiary company, supplies steel, iron and bronze castings and steel forgings.

The photograph shows at 13½ tonne headstock casting for a 12 roll tandem employing 90 inch (2290mm) long, 44 inch (1120mm) diameter rolls with a smaller casting for comparison.



POWER TRANSMISSION GEARING

One of three 800hp triple reduction, double helical gear units supplied to the Philippines. Spur gears up to 127mm circular pitch, 760mm face width and 4700mm diameter can be supplied for heavy tandem drives.

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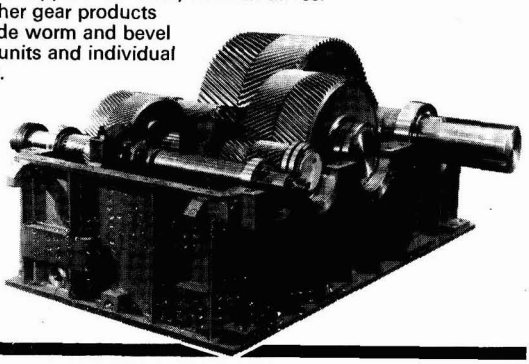

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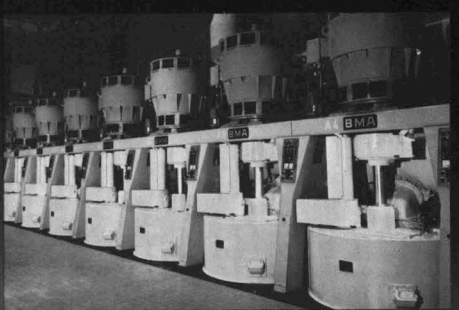
for all products



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* Extremely smooth running
* High number of charges
* Non-oscillating basket suspension during discharging
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BMA centrifugals are first-class products resulting from a specific development.

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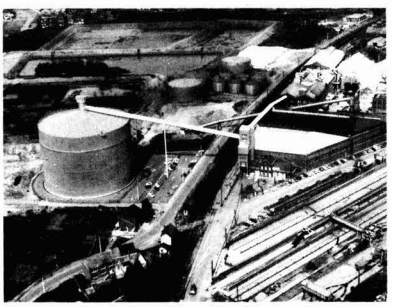

Pollution, sticking of crystals toegether,
moisture control...
All these problems affecting preservation of
bulk sugar have been carefully studied
by A.B.R. ENGINEERING.
The warertight steel casing, the fully automatic
filling and emptying, the isolation, all lead to a very
filling and emptying, the isolation, all lead to a very
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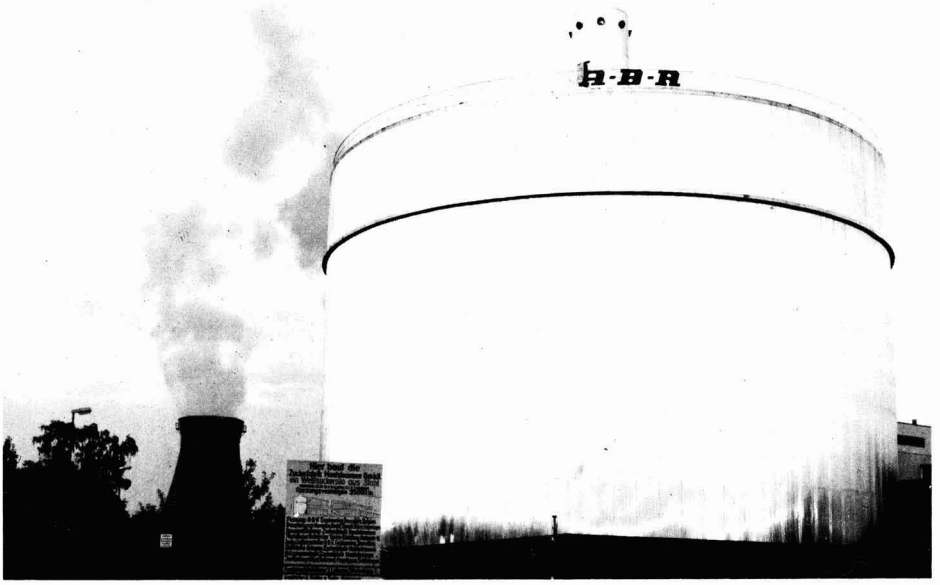
undisputed advantage over all other solutions.
The light weight of its structure enables you to
make big savings on the foundations.
Moreover, it takes less than one year to set up.



6 silos in Belgium, 7 in Spain, 5 in Yugoslavia, 2 in Great Britain, 1 in France,
1 in Poland and 1 in Germany.

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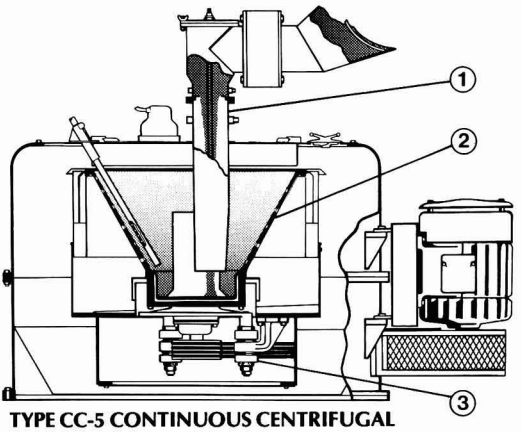

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CAPACITY PLUS! It's designed and built into Western States Continuous Centrifugals.

Proven by extensive experience, the Type CC-5 feeding/pretreatment system **(1)** is the prime key to CAPACITY PLUS. The enclosed and directed feed stream insures a steady introduction of massecuite to the basket's loading bowl. The built-in arrangement for massecuite pretreatment provides the final lubricating and heating to obtain highest-quality products from even the most viscous massecuite encountered.

The Type CC-5 solid, cast stainless steel conical basket **(2)** is another key to CAPACITY PLUS. Efficient separation is the fundamental purpose of the continuous centrifugal and drainage holes from bottom to top of the CC-5 basket assure earliest possible elimination of molasses. Power input is thus more effectively used for higher production of product.

Smooth operation is provided by the tripod support system **(3)** incorporating adjustable rubber buffers for dampening vibration. This support system minimizes mechanical problems and enhances CAPACITY PLUS performance.

Get the entire money-making CAPACITY PLUS story today. Contact us or your local Western States representative and find out what the Western States Type CC-5 Continuous Centrifugal can do for you!

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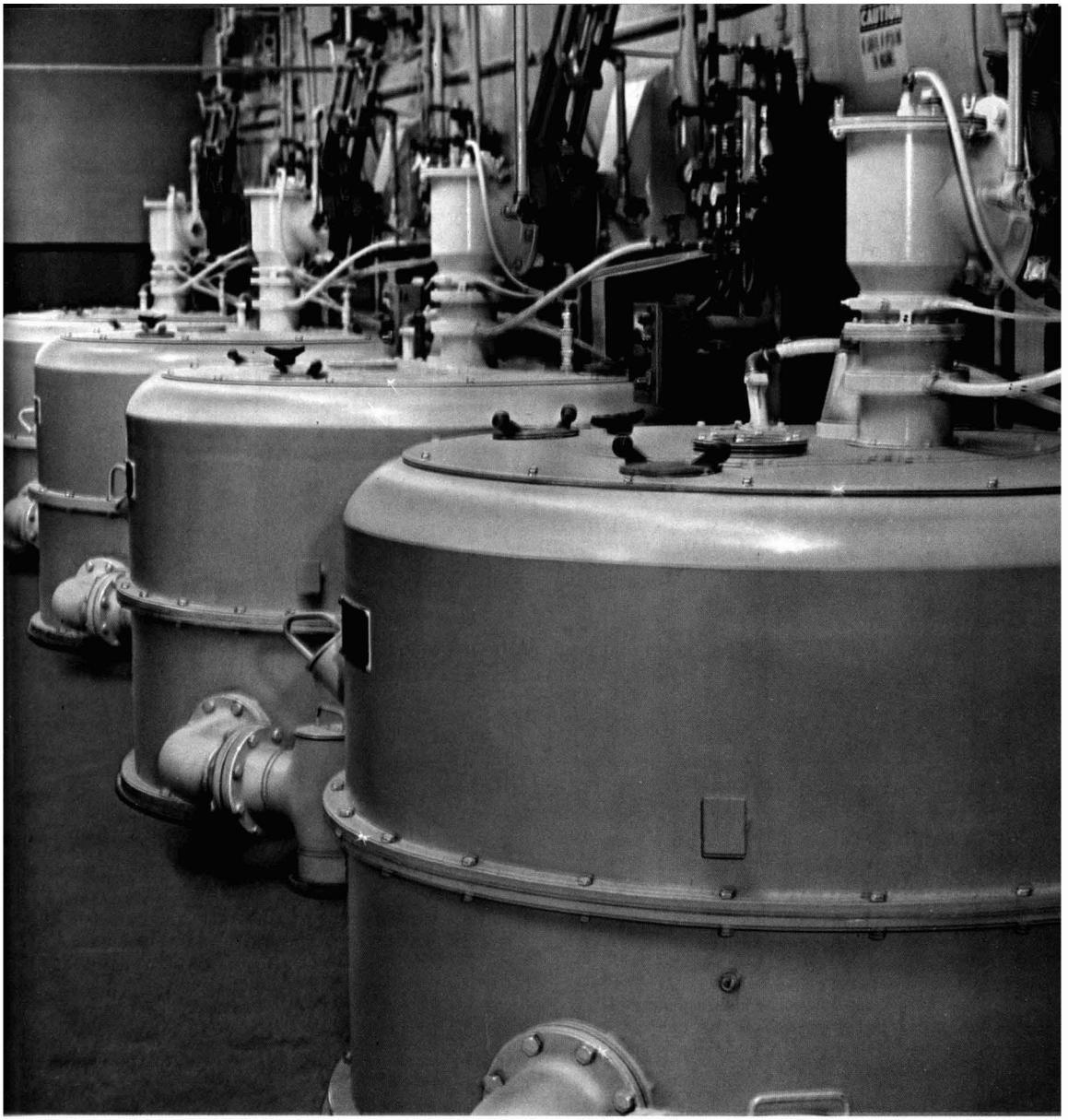

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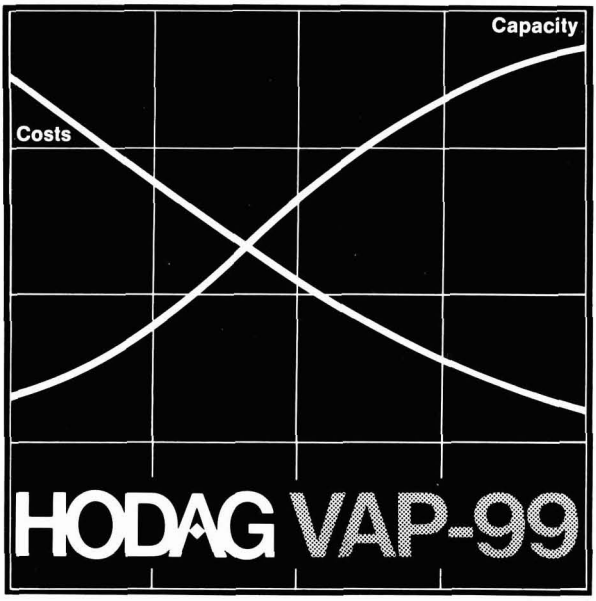

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Hodag VAP-99 is a chemical additive that acts in many ways at once to improve the operating efficiency of multiple effect evaporators.

Scale formation is reduced. VAP-99 inhibits the deposit of scale on evaporator tubes and end plates. This aids heat transfer—increases evaporator efficiency.

Maximum throughput of clarified juice is maintained. Circulation of juice is improved and heat transfer efficiency rises. Greater daily tonnage from existing mill tandems or diffusers can be realized.

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For most conditions, the cost of inhibiting scale and increasing evaporator efficiency is less than 1 cent per ton of cane. Processing conditions, type of scale, and condition of evaporator bodies determine the concentration of Hodag VAP-99 needed to show benefits in your operation.

Get the benefits of regular use of VAP-99. Let your Hodag representative show you how. Fill out and return the inquiry coupon today.

Look into the complete Hodag cleaning program for sugar factory and refinery vessels:
Step 1) Inhibit scale formation with addition of VAP-99 to thin juice
Step 2) Alkaline cleaning with caustic soda and Rapisol Accelerator
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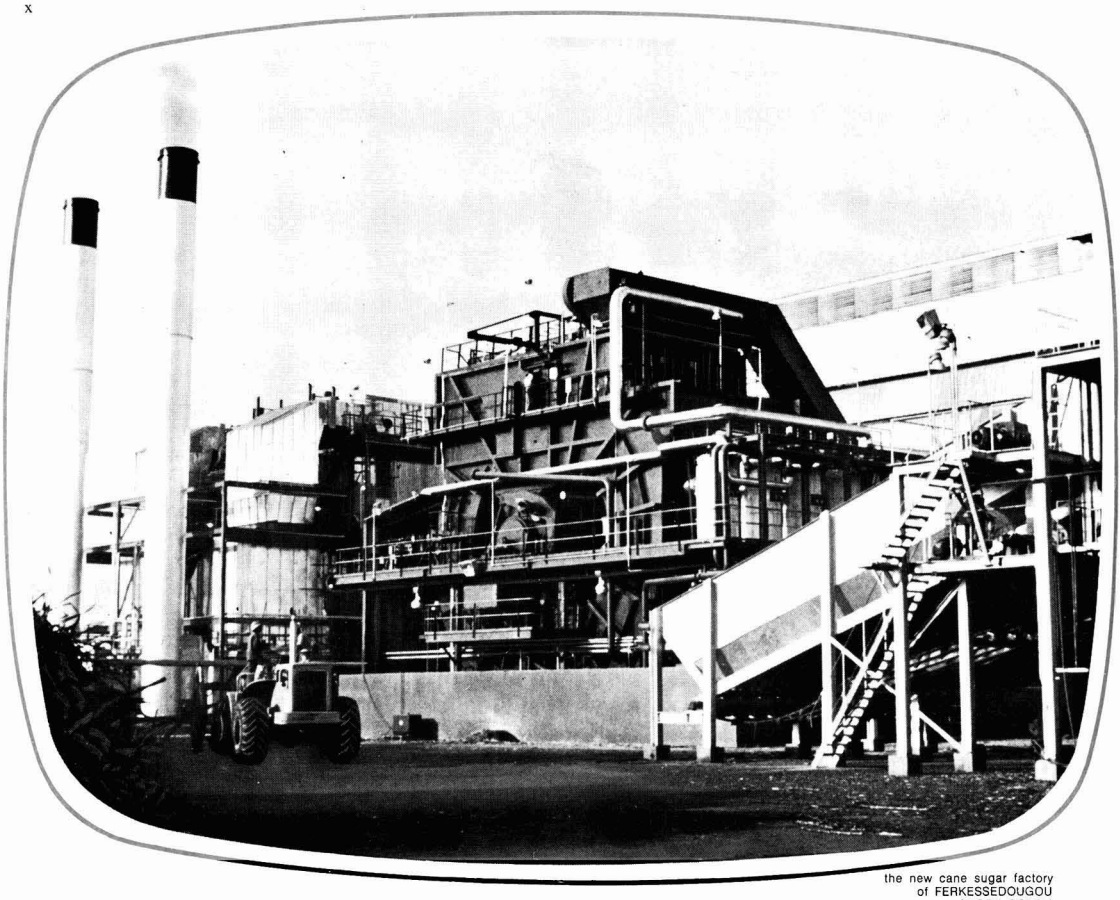

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equipped with the modern
extraction process:
THE SATURNE DIFFUSER
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modernization or extention of a sugar mill
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are not conceivable without taking into consideration
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2) a better research of rentability

The new conception of the continuous maceration process

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guarantees through a simple and sturdy equipment:

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- a better extraction compared to a 18-roll mill tandem, giving a mixed juice of high purity

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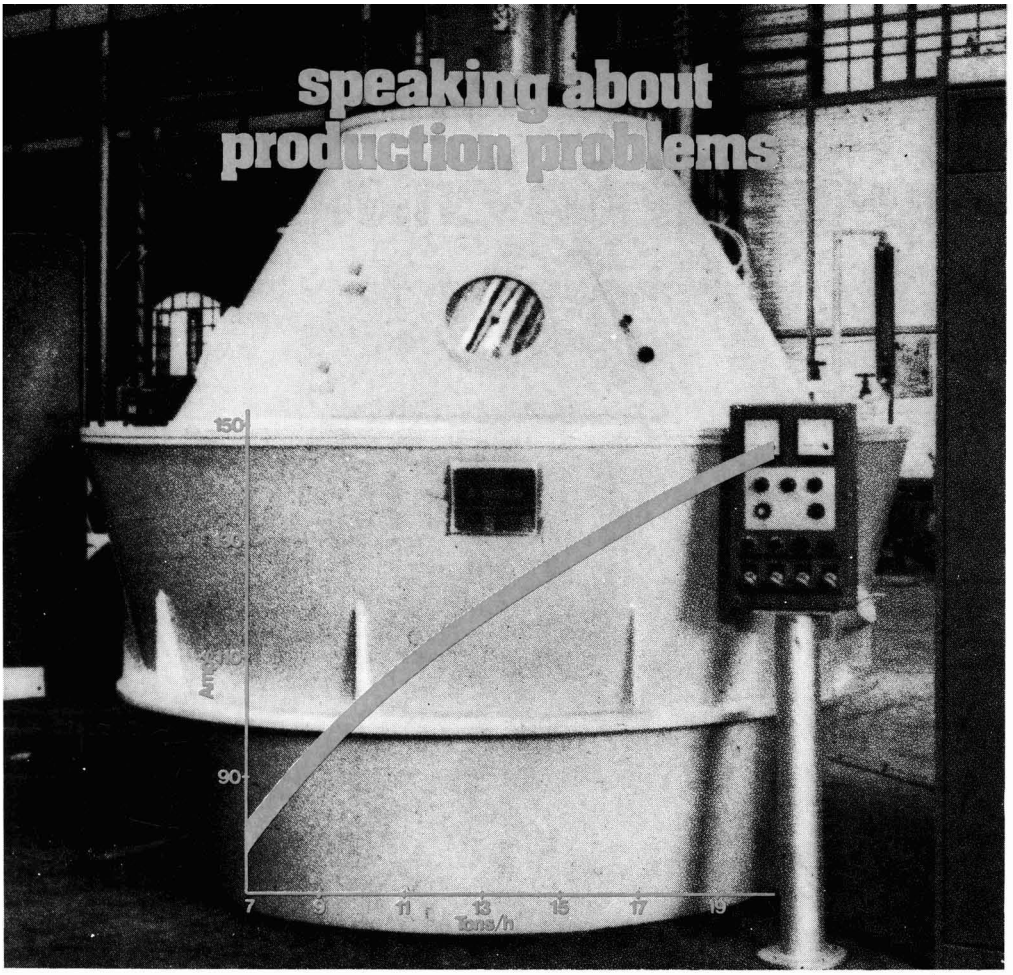

is the centrifugal you are presently using "big" enough for your needs?

When the total production increases, also the number of centrifugals should be increased.
But, we say, it depends how to face the problem and what type of centrifugal to select.
In fact adopting our "B5" continuous centrifugal in your existing production system, it means that all problems, connected with your new installation, operation and maintenance requirements, will be automatically minimized.
The main technical features of our "B5" continuous centrifugal are infact:

- basket, truncated cone type, having a max. O.D. of 1500 mm. (59") and a max. I.D. of 1360 mm. (54") with a tot. filtering area of 167 sq. dm. (2590 sq. inch.), mounted on a pendular suspension which ensures a perfect dynamic stability.
- massecuite feeding into the basket coaxially with the drive shaft and uniform distribution through a proper device, formed by a cylinder and a cone, which rotates together with the basket.
- d.c. electric motor monitored by a "thyristors" type control equipment, capable of adjusting the centrifugation speed within a range of 1100/1800 rpm, in strict relation with whatsoever productive and/or technological requirement.

Thanks to what above, the "B5" continuous centrifugal guarantees:

- massecuite processing capacities up to 20 Tons/hr, when handling "Low purity" and "intermediate" products.
- improved sugar quality than that of the batch type centrifugals.
- absence of vibrations during operation, thanks to the pendular suspension and other technical devices.
- minimum power consumption.

Our centrifugal is despatched fully tested and assembled and, due to its harmonious self-bearing structure, it starts cutting down costs since time of its installation.

bosco: an active presence in the sugar industry

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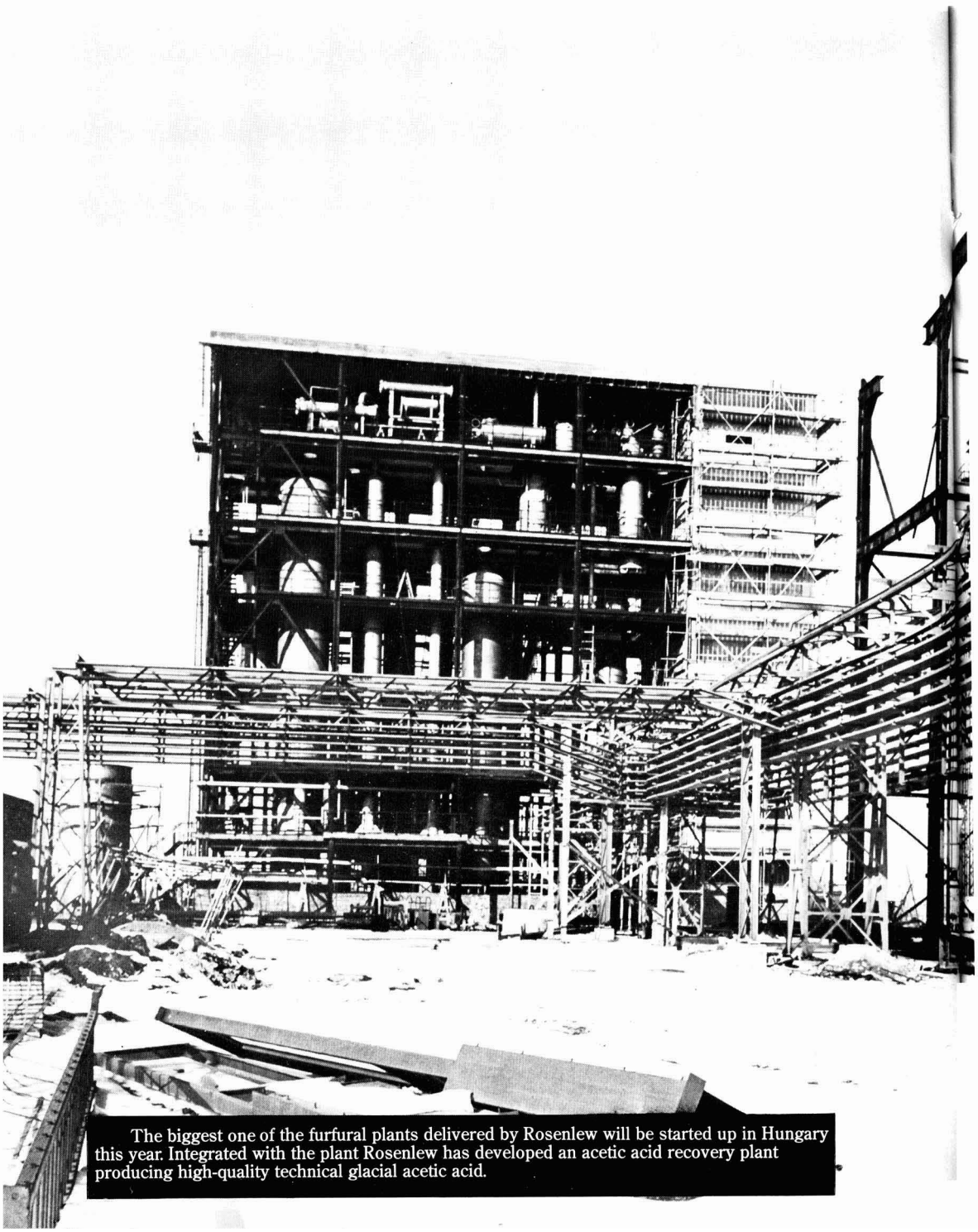
Furfural and furfu
125-year-old Rosenlew's process to



The biggest one of the furfural plants delivered by Rosenlew will be started up in Hungary this year. Integrated with the plant Rosenlew has developed an acetic acid recovery plant producing high-quality technical glacial acetic acid.

fyl alcohol plants.
thnique known all over the world.

Demand for furfural and furfuryl alcohol used by oil, plastic and petrochemical industries as well as foundries is continuously increasing. Oy W. Rosenlew Ab in Finland is the leading manufacturer of furfural plants in the world. With the equipment designed, manufactured and erected by Rosenlew, furfural is already produced in Finland, Spain, Poland, South Africa, the Philippines and the Soviet Union.

Features of Rosenlew Process

- continuous automatic operation
- small space requirement
- good steam economy
- requirement for additional chemicals is negligible
- corrosion problems are easily controlled
- possibility to utilize the hydrolysis residue as fuel
- low labor cost
- produced furfural and acetic acid are of the highest quality

Raw Materials

Natural, pentosan containing raw materials are the only sources of furfural. Typical materials, which can be used for the industrial production of furfural are:

- wood
- corn cobs
- sugar cane bagasse
- almond shells
- oil palm shells
- bamboo
- jute sticks

The factors influencing the choice of raw material are the price, availability, cost of transport and handling, cost of conversion and the value of byproducts.

Rosenlew manufactures also furfuryl alcohol plants. The hydrogenation of furfural to furfuryl alcohol is made in a continuous low pressure gaseous phase process.

The Engineering Works, which has developed the equipment for the manufacture of furfural and furfuryl alcohol, belongs to the big 125-year-old Rosenlew concern. With its high-class engineering skill, versatile special experience and effective manufacturing methods it also produces

- evaporation plants, protein plants and condensate treatment plants for the pulp industry
- evaporation plants, crystallizers and partial processes for the chemical, food-production and metallurgical industries
- steam boilers, special furnaces etc. thermal equipment for different branches of industry
- ethyl alcohol plants

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ROSENLEW 125

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Dorr-Oliver is one of the world's leading equipment manufacturers for sugar and other food processing. But did you know that for the past 60 years we also have been the global leader in wastewater treatment? Ever since J. V. N. Dorr invented the first continuously operating clarifier and truly revolutionized the industry.

Today, Dorr-Oliver is still the world leader in clarifiers. We also make a full line of wastewater treatment equipment — centrifuges, filters, thickeners, screens, pumps — just about everything you need for treatment of process water and all phases of physical and biological treatment of industrial wastes. In short, nobody can match Dorr-Oliver's record of achievement in water pollution control, or has as much experience in helping food processors deal effectively with regulatory effluent requirements.

If you are planning to design a wastewater treatment system, or would like to solve the problems in your present system, talk to Dorr-Oliver. We not only are experts in wastewater treatment, but we have years of experience in the food processing business. Contact the nearest Dorr-Oliver sales office. Or Dorr-Oliver Global Headquarters, Stamford, CT 06904.

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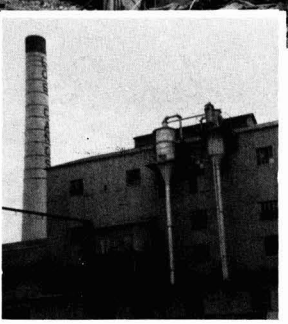
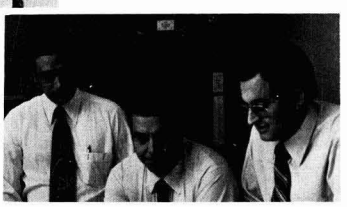
A step ahead in process and environmental equipment.

Why CODESA called IPS

When CODESA wanted to move a sugar factory from Puerto Rico to Costa Rica, they came to International Planning Services, Inc. They came to IPS because they know IPS has the experience, know-how and resources to get the best job possible at the lowest cost available. International Planning Services, Inc., offers consulting, design, engineering and construction supervision services to the sugar industry the world over. Drop us a line or give us a call at any of our three offices and you'll see why if you've got a problem related to the sugar industry, you should be talking to IPS.





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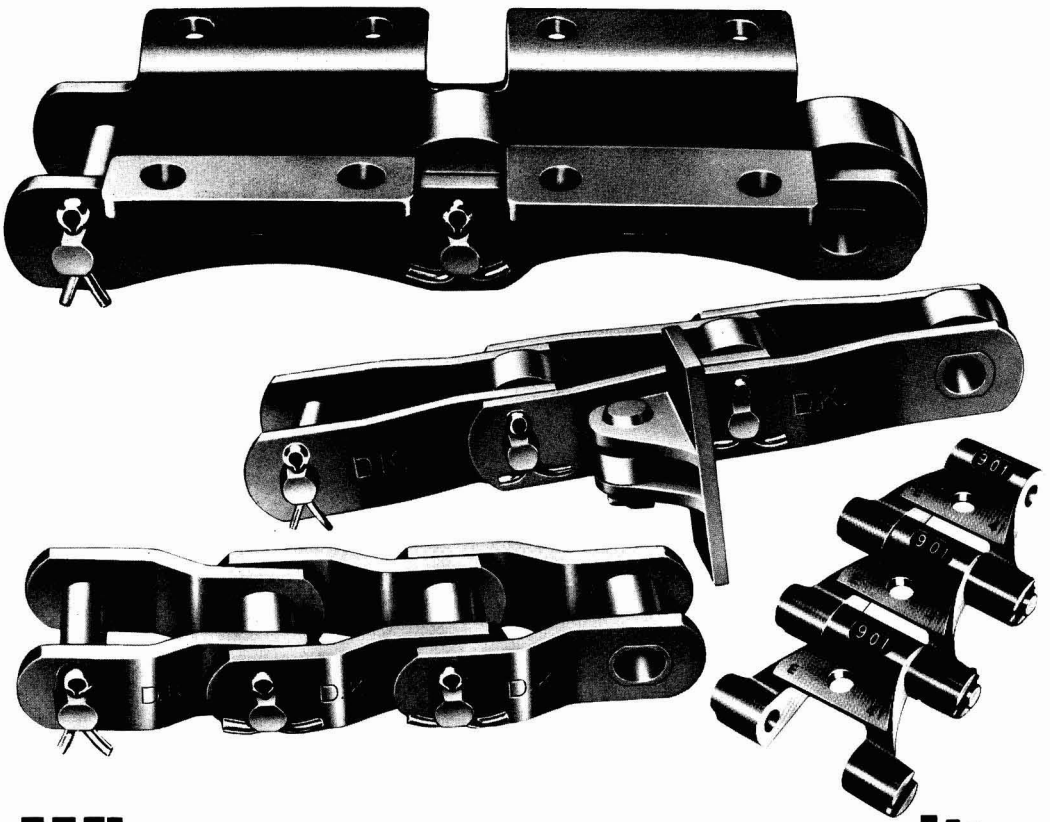

When you compare quality, dependability and service, Daido comes out first.

In the sugar business, you can't afford shutdowns due to equipment failure. And that's one reason why more and more mill operators are specifying Daido chains. For almost 70 years, Daido has been producing chains noted for quality and reliability, advanced design and technological excellence. Today, Daido offers a comprehensive line of specialized and general purpose sugar mill chains, all built to work harder and last longer. So, if you're in the market for replacement chains or building a new mill, look first to Daido...for quality, dependability and service.

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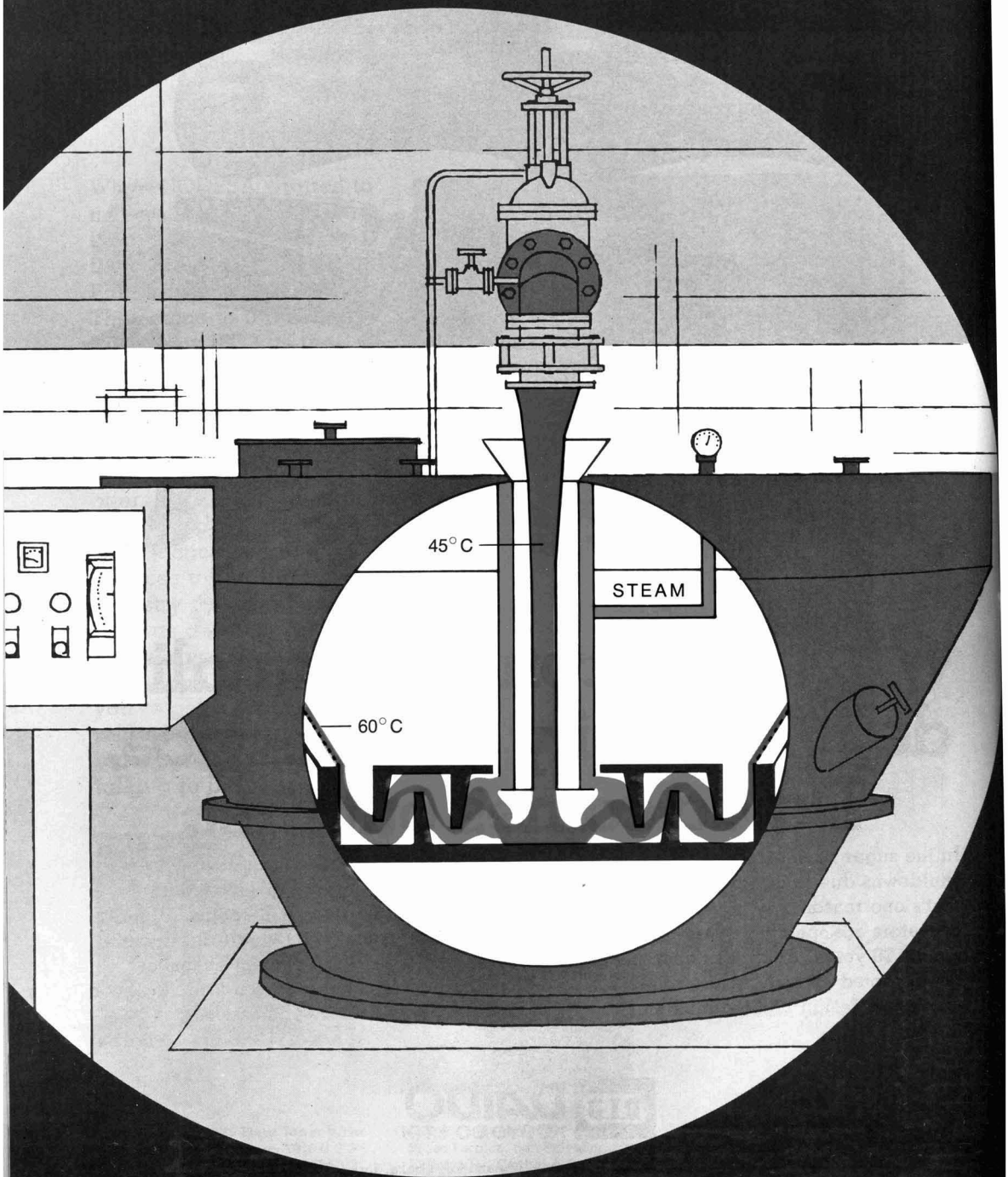

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NOTES AND COMMENTS

World sugar balance

First predictions of a world sugar balance have been published by *World Sugar Journal*[1] for the period covering the individual countries' crop years of 1978/79. The estimates may be summarized as follows, with comparative figures for the previous two crops years:

	1978/79	1977/78	1976/77
		tonnes, raw value	
Initial stocks	21,214,000	18,746,000	16,125,000
Production.....	89,081,000	91,440,000	87,270,000
Imports	25,000,000	23,598,000	23,674,000
	135,295,000	133,784,000	127,069,000
Consumption	89,395,000	87,092,000	83,758,000
Exports	24,500,000	25,478,000	24,565,000
Final stocks	21,400,000	21,214,000	18,746,000
Commercial stocks	14,884,000	14,508,000	13,946,000
Real surplus	6,516,000	6,706,000	4,800,000

It is, of course, early to predict production figures since the Southern Hemisphere countries began their harvests only in the middle of 1978 and the Northern Hemisphere countries' crops generally start later in the year. Nevertheless, enquiries made by *World Sugar Journal* indicate that production and consumption for the period will be in rough balance, owing to limitation of production because of low prices and ISA quota restrictions, and to steadily increasing consumption. The rate of consumption increase is, however, expected to be low, partly owing to dietary considerations and adverse publicity in developed countries and the increased usage of HFCS, lack of available sugar in some exporting countries which oversold before last January ahead of the ISA, and a high relative price in certain countries.

The rough balance means, however, that the surplus on the world market, i.e. the excess of available sugar over that needed for commercial purposes, in transit, etc., will be only slightly reduced from the very large excess of 1977/78. As a consequence its bearish effect on the market seems likely to continue.

US sugar legislation

The House Ways and Means Committee Trade Sub-Committee started hearings on 14th August on a bill introduced by Rep. Vanik, on behalf of the Administration. This seeks to help domestic producers by establishing a domestic market price objective of 14·5 cents/lb, as against the 16 cents objective of the bill supported by the House Agriculture Committee[2]. The Sub-Committee voted, however, to approve a bill having an objective of 15 cents, to be accomplished by imposing fees and, if necessary, quotas with import rights being subject to an auction. The full Ways and Means Committee was to examine the bill on its return on 6th September from the Labor Day recess and the resultant bill brought to the floor of the House during the week starting 18th September. There will have to be a Conference Committee later to resolve differences between the final House Bill and the proposals put forward by the Senate and time will be short for reaching the necessary compromises and enacting the legislation so as to permit US ratification of ISA membership by 1st October 1978.

In the meantime, although by 4th August beet sugar producers had redeemed almost a third of the sugar they had stored under the CCC price support loan programme, the unredeemed beet and cane sugar amounted to 781,451 short tons, raw value, at that date, and loans of more than $219 million were outstanding. To ease redemption, it was made permissible for processors to sell sugar under loan without first having to redeem, the purchaser having to pay the CCC (Commodity Credit Corporation). The CCC has the right to leave the sugar where it is stored, even if it takes title to the sugar because of loan defaults, but this would cause great difficulty to the processors who have to find space for the new crop sugar to start production in September/October. The Administration could then blame opposition to its proposals on sugar legislation for holding up the Vanik bill and so preventing disposal of the old-crop sugar and thus the sugar producers' difficulties.

World sugar prices

The bullish sentiment in the world sugar market continued during August and prices improved very gradually up to the middle of the month when, largely as a result of currency fluctuations, there was a small slide in the LDP from £94 to £91, after which the improvement continued and the month ended with a level of £94 per ton against £85 on the 1st August.

The LDP(W) also improved during the first part of the month and held up well during the third week, with demand from final buyers helping to maintain values. At the very end of the month, however, confidence waned and the price, which had been up to £104.50 during the month, fell to £101, only £1 per ton more than at the beginning of the month.

Finnish Sugar Co. Ltd. 1977 Report

The sugar beet crop in Finland in 1977 was a complete failure, owing to bad weather. Despite all progress in cultivation techniques, the crop yield per hectare was scarcely more than that registered twenty years ago at 18·24 tonnes. The average sugar content, at 15·4%, was slightly lower than the 15·6% average of recent years. Rain delayed sowing and emergence was poor. Harvesting of the 30,300 ha cultivated was also slowed by rain and extended to late November when frosts occurred. The roots were of high dirt tare and this caused difficulty in the factories. The factories produced 68,654 tonnes of sugar, white value, and 25,452 tonnes of molasses, most of which was used in animal fodder mixtures.

A total of 213,713 tonnes of raw sugar was imported in 1977, of which 136,775 tonnes came from Cuba, 36,815 tonnes from Brazil, 12,421 tonnes from Dominican Republic, 11,413 tonnes from Argentina, 10,649 tonnes from Belgium and 5640 tonnes from West Germany. Two-thirds of this was refined for domestic consumption while the remainder was exported.

[1] 1978, **1**, (2), 10–13.
[2] *I.S.J.*, 1978, **80**, 258.

A new molasses desugarization plant was started-up at the Porkkala refinery and went into full operation on 1st June 1978; 13,822 tonnes of cane molasses was imported in 1977 as feedstock for sugar recovery. Sugar exports totalled 54,270 tonnes of which a quarter was as cube sugar. This was 29,443 tonnes more than the quantity exported in 1976 and accounted for 26·8% of the company's total sales volume. The Fermion Oy. penicillin factory at Hanko was purchased towards the end of the year in order to develop a new, viable fermentation industry that will use sugar as its main raw material as well as to start the industrial hydrolysis of cellulose wastes into glucose for isomerization and production of fructose and liquid sugars.

HFCS production cost study

The EEC Commission ordered a study to be made on the comparative production costs of beet sugar and high fructose corn syrup (HFCS) but has now stated that it will not be published as it contains information which was submitted on a confidential basis[1]. The comparative costs will play an important role in the decision whether the production levy imposed on HFCS production constitutes unfair discrimination against the producers. At the end of June the Advocate-General of the European Court of Justice presented an opinion favourable to the levy of 50 U.A. per tonne after hearing the cases of the Commission and the HFCS industry. Although the Court's judges usually accept recommendations of their Advocate-General it is not obligatory and they could rule that the levy is discriminatory since it is applied to every tonne of HFCS produced whereas EEC beet sugar producers only pay a production levy on the sugar produced outside the basic quota. Industry sources say that, if the levy is not abolished, it may be difficult to maintain HFCS production within the EEC. According to unconfirmed reports, production has stabilized at around 110,000 tonnes following implementation of the production levy whereas capacities at the end of 1977 were estimated at around 400,000 tonnes. Original plans called for a total capacity of one million tonnes by 1980.

Florida sugar storage problems[2]

The cane sugar producers in Florida have appealed to the USDA for help in alleviating an "emergency" situation in the storage of raw sugar in the state. In a letter to the Department's Director of Economic Affairs, the producers said their inability to store or sell raw sugar "could close down our industry". George H. Wedgeworth, President of the Sugar Cane Growers' Cooperative of Florida, said that sugar warehouses of four companies, including his own, were full to capacity and held 332,000 short tons. Movement out of the warehouses under present sales contracts would still leave 253,485 tons in storage by 1st January while they would also hold two months production from the new crop which starts in November. Because of their inability to sell raw sugar at prices equal to the USDA Loan Programme, the Florida companies would have to find storage for the 1978/79 crop.

Meanwhile the USDA said that it was studying ways to alleviate the problem. Present indications were that a large part of sugar currently under price support loans would be forfeited to ownership by the Commodity Credit Corporation which would move the sugar from its present storage facilities, releasing capacity for the new crop sugar. Finding freight cars for removal of the sugar could be a major obstacle, however.

Brazil sugar statistics 1977[3]

The nature of the problems facing some of the major exporters and the extent of the sacrifices in terms of tonnage which they are making in accepting the quota provisions of the International Sugar Agreement can be recognised from a glance at the statistical position of Brazil recently published by the ISO and reproduced elsewhere in this issue. Exports from that country fluctuate quite widely from one year to another, but last year they amounted to just short of 2·5 million tonnes. Stocks, however, rose by about 1·2 million tonnes during the year and stood at the end of December at almost 3·9 million tonnes. Meanwhile this year's International Sugar Agreement export quota for Brazil is currently only about 1,915,000 tonnes. Clearly, if stocks are not to remain at such a very high level, or even increase, production will have to be cut back.

It was no doubt with this in mind that it was recently announced that sugar cane from which the equivalent of nearly 2·1 million tonnes of sugar might have been produced will be utilized for the manufacture of alcohol. Brazil has for some time been in the forefront in the manufacture of alcohol from sugar cane; nevertheless, this represents a substantial increase in the programme this year. The target for the production of sugar for export has been set at 1·68 million tonnes, tel quel, or some way below the export quota which might enable some inroads to be made into stocks, but on the other hand the production of more than 5·5 million tonnes has also been scheduled for the domestic market and, as this might prove to be more than is actually needed, it could lead to a corresponding increase in the stock position.

EEC sugar surplus[4]

Officials of the EEC estimate that the Community's surplus of sugar for export in the 1978/79 season will be up to 2·7 million tonnes. The *A*- and *B*-quota surplus is expected to be about 2·4–2·5 million tonnes and *C*-quota sugar is estimated at 200,000 tonnes. The latest estimate of EEC white sugar production, at 10·8 million tonnes, will be 740,000 tonnes down on that of the last campaign. The area under beet has fallen by 23,000 hectares to 1,756,000 ha, according to provisional figures. The 2·7 million tonnes export surplus is made up of a 1·4 million tonnes difference between estimated production and consumption, plus the 1·3 million tonnes of raw cane sugar to be imported from the ACP countries. The Community exported about 3·5 million tonnes of white sugar during the 1977/78 season.

Cuba-Portugal trade agreement[5].—Under an agreement signed in April, a minimum of 280,000 tonnes of Cuban sugar will be exported to Portugal between 1978 and 1981. In exchange, Cuba will import at least $3 million worth of Portuguese goods.

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[1] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (22), 13.
[2] *Public Ledger*, 22nd July 1978.
[3] C. Czarnikow Ltd., *Sugar Review*, 1978, (1395), 123.
[4] *Public Ledger*, 5th August 1978.
[5] *Bank of London & S. American Review*, 1978, **12**, 386.

Formation of colour in cane juice by enzyme-catalysed reactions

Part I. Mechanism and chemical inhibition

By J. COOMBS and C. W. BALDRY

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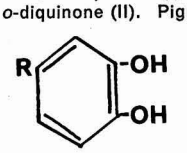
Introduction

IT is generally recognised that the brown colorants present or formed in raw sugar factories and in refineries consist of a highly complex mixture of compounds, many of which are similar in physical and chemical properties[1]. These compounds may be derived from at least three distinct sources: (*a*) plant pigments which absorb light in the visible wavelengths are released into the sugar stream during crushing; (*b*) colour may be formed from non-coloured precursors present in the raw juice, in reactions catalysed by a specific enzyme (*o*-diphenol:O_2 oxidoreductase—E.C. 1.10.3.1); and (*c*) colorants may be produced by non-biological reactions in which colourless plant constituents react to form melanoidins, caramels and alkaline degradation products.

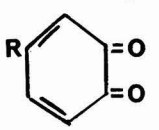
Direct chemical analysis, following separation by chromatography, electrophoresis, ion exchange or gel filtration has failed to characterize fully sugar colorants[2,3]. Hence, it is not possible to assess the relative importance of these varying types of colour to the refining process. An alternative approach is to investigate the nature of the chemical reactions which lead to colour formation, starting with known ingredients in model reactions. The physical and chemical properties of these artificially generated products may then be compared with those isolated from raw juice or produced under refinery conditions. This approach has been used in particular to study colorants produced during degradation of sugar[4,5]. A similar approach has been used to show that colorants can be produced in a model system using purified *o*-diphenol oxidase from sugar cane and chlorogenic acid and amino acids[6].

It is, of course, well known that cellular injuries inflicted during harvesting, processing and storage of plant materials can promote enzyme-catalysed browning reactions. Such reactions are known to occur in fruits, vegetables, mushrooms, etc., and are of importance in the formation of flavour and quality of beverages such as tea, coffee, wine and beer. Similar reactions are involved in the formation of the brown and black melanin-type pigments found in fungi, insects, etc. The formation of similar black pigments in sugar beet juice is well documented.

Although the mechanism of formation of these pigments differs in the nature of the specific substrates involved in the various examples cited above, they all have an initial reaction in common. This is the oxidation of an *o*-diphenol (I) to the chemically more reactive *o*-diquinone (II). Pigments and high molecular weight colorants are formed in the subsequent further enzymic or chemical reactions in which these quinones participate.

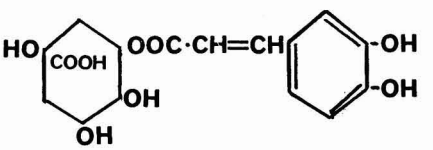


(I)



(II)

We have previously isolated an active *o*-diphenol oxidase, with a high specificity for chlorogenic acid (III), from sugar cane tissue[6,7] and furthermore demonstrated the presence of high levels of chlorogenic acid in cane[8]. The present series of papers reports experiments designed to investigate the relative importance of colour from this source as compared with that derived from plant pigments or chemical reactions.



(III)

Experimental

Preparation of cane juice.—Greenhouse-grown sugar cane, of variety B 49119, 3 to 6 months old, was used in these experiments. About 10 to 50 cm^3 of juice was expressed from short lengths (15 cm) selected from the top of the stems including the growing point, using a small stainless steel roller mill. In control experiments, juice at pH 4·6 to 5·6 was left open to the air at room temperature for 10 to 20 min and then inactivated by addition to four volumes of ethanol to give an 80% v/v mixture. In other experiments the juice was collected in a beaker containing a small volume of thioglycollate such that the final concentration of inhibitor in juice was about 0·1%. Juice samples were filtered through muslin to remove large debris, centrifuged and the clear supernatant concentrated *in vacuo*.

Column chromatography.—Aliquots were applied to columns (1·8 × 38 cm) of various "Sephadex" chromatographic media and eluted with solutions which included water, salt solutions, dilute alkali and ethanol, at a rate of about 4 $cm^3.min^{-1}$ as described in more detail in the results section below. The effluent from the columns was passed through a flow cell (volume 0·1 cm^3) and absorbance measured at selected wavelengths (320 and 420 nm) using a Perkin-Elmer 124 recording spectrophotometer.

Analysis of components.—Fractions corresponding to the recorded peaks of absorbance at 420 nm were

[1] Carpenter *et al*: *I.S.J.*, 1975, **77**, 9–12.
[2] Gross: *ibid.*, 1967, **69**, 323–328, 360–365.
[3] Smith *et al.*: *Proc. 14th Congr. I.S.S.C.T.*, 1971, 1415–1425.
[4] Parker *et al.*:*Proc. Tech. Sess. Cane Sug. Ref. Res.*, 1968, 117–128.
[5] Williams: *Proc. 15th Congr. I.S.S.C.T.*, 1974, 1402–1411.
[6] Gross *et al.*: *I.S.J.*, 1976, **78**, 69–73, 106–109.
[7] Coombs *et al.*: *Phytochemistry*, 1974, **13**, 2703–2708.
[8] Gross *et al.*: *I.S.J.*, 1971, **73**, 100.

bulked, reduced in volume *in vacuo*, and applied to papers (Whatman 3MM). Constituents were resolved using high voltage paper electrophoresis with carbonate buffer at pH 8·9. Compounds were detected under visible or UV irradiation and, in the latter case, recorded photographically using a Kodak Wratten 2B filter. The fluorescing compounds were eluted from the papers using ethanol/water mixtures and the absorption spectra determined. Chromatographic, electrophoretic and spectrophotometric properties of the main UV fluorescent component were compared with, and found identical to, those of authentic chlorogenic acid. The level and identity of amino acids present in juice samples was determined using a Technicon TSM amino acid analyser.

Radio-tracer experiments.—A mixture of radioactive amino acids (10 μCi of 14C-U-hydrolysed protein, Radiochemical Centre, Amersham) was added to the juice after crushing, or incubated with slices of cane stem for periods of up to 12 hours prior to grinding with a small glass pestle and mortar. Products were resolved by column chromatography.

Clarification.—Juice was clarified at 75°C by addition of phosphoric acid followed by lime slurry to pH 7·0 and maintained at this temperature for about 30 min. The precipitate was removed by centrifugation. Absorption spectra of both control and thioglycollate-treated samples were recorded in the visible region.

Results and discussion

Resolution of products.—When concentrated samples of untreated cane juice were applied to columns of "Sephadex G 25" the observed separations were in general similar to those reported by others[2,3] who have used these cross-linked dextrans as a means of resolving cane colorants. However, both the appearance of the elution profiles and the apparent distribution of products determined from their UV absorption spectra following elution from high voltage paper electrograms depended to a large extent on the nature of the eluant used and the wavelength used to monitor the effluent from the column (Figs. 1 and 2).

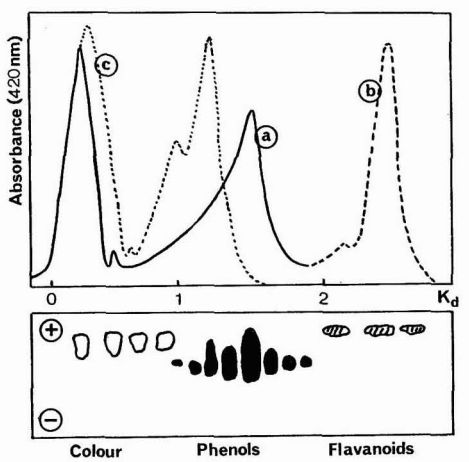


Fig. 1. Elution profiles obtained when concentrated cane juice, clarified by centrifugation, was applied to a column of "Sephadex G 25" and eluted with (*a*) water, (*b*) 0·1M NaOH, (*c*) 0·1M NH_4OH.

Electropherogram for eluate fractions from traces *a* and *b*. ○ = Brown, ● Fluorescing, //// = Yellow. Only main spots shown.

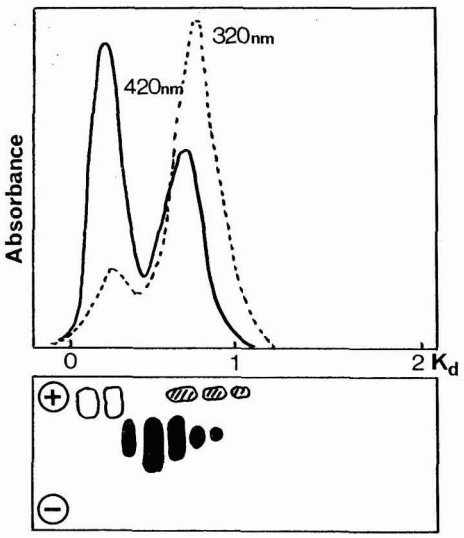


Fig. 2. Elution profiles obtained when concentrated cane juice was applied to a "Sephadex G 25" column and eluted with 8M urea. Solid line—absorbance at 420 nm; broken line—absorbance at 320 nm.

Electropherogram for eluate fractions ○ = Brown, ● = Fluorescing, //// = Yellow.

In principle it is expected that compounds of high molecular weight will be completely excluded by the column packing and eluted in a volume V_o, whereas low molecular weight non-excluded substances will be eluted in a larger volume V_t. If the only separation principle that applied was gel filtration the volumes (V_s) in which all compounds applied were eluted should lie between these values, allowing them to be described in terms of their characteristic K_d values, where $K_d = V_s - V_o/V_t - V_o$. However, the process of manufacture of the "Sephadex" packings is such that some cross links remain incomplete, giving the column the property of adsorbing certain chemical species, phenols in particular.

When the column was eluted with water (Fig. 1 trace *a*) chlorogenic acid was eluted at a K_d value between 1 and 2 and flavanoids remained bound to the column. However, these could be removed by subsequent elution with 0·1M NaOH (trace *b*). The use of 0·1M NH_4OH was found to give an adequate separation of the phenolics from the colorants (trace *c*). This eluant had the advantage that the ammonia could be removed when the fractions were evaporated and was used in the inhibitor experiments. If 8M urea was used as eluant the absorptive forces were largely overcome and components were resolved as expected on the basis of their molecular weight (Fig. 2).

Effects of thioglycollate.—Thioglycollate is a specific inhibitor of the *o*-diphenol oxidase present in sugar cane[7], causing 50% inhibition in a non-competitive manner at concentrations between 10^{-4} and 10^{-5} M. This same compound, in common with a number of related thiols or mercaptans, will also prevent the

development of colour in cane juice. The nature of compounds which could be detected in samples of cane juice treated with thioglycollate was therefore investigated. It was assumed that a greater proportion of the non-coloured precursors would be present in such samples, appearing in the phenol peak detected in the elution profile from the G 25 column. However, as shown in Fig. 3A, this simple result was not observed. The trace from the thioglycollate-treated sample showed a new, strongly-absorbing peak of higher K_d value. Material from this peak was collected, reduced in volume and applied to a small column of "Sephadex LH 20," equilibrated and eluted with ethanol. This procedure separated thioglycollate and the phenols. When the main UV absorbing fractions were collected, bulked, concentrated and re-applied to the G 25 column it was found that the elution profile (Fig. 3B, trace *a*) now contained a single major peak which coincided with the peak of higher K_d value in the control sample. If thioglycollate-treated juice was mixed with untreated juice and applied to the G 25 column the expected peak of low K_d corresponding to the brown colorants was seen. However, the bulk of the phenolic constituents were now detected in a position corresponding to the high K_d peak observed in the thioglycollate-treated sample. The chemical characteristics of the main component of this peak corresponded to those of authentic chlorogenic acid. These results indicate that addition of thioglycollate to cane juice prevents the formation of colour and increases the amount of chlorogenic acid which can be detected. However, the resolution of the components of the system on the G 25 column is complicated by an interaction between chlorogenic acid and thioglycollate

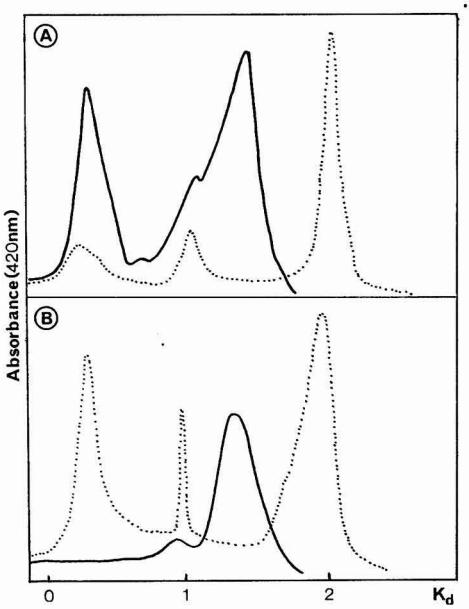


Fig. 3. (*A*) Elution profiles obtained with concentrated cane juice with or without thioglycollate (0·1%) applied to a "Sephadex G 25" column and eluted with 0·1M NH_4OH. Solid line—control. Broken line—with thioglycollate.

(*B*) Elution profiles obtained from a mixture of control and thioglycollate-treated juice (broken line) or when a sample of the phenolics (purified on "Sephadex LH 20") from the thioglycollate-treated juice was applied to a G 25 column and eluted with 0·1M NH_4OH.

Reaction with amino acids.—Previous results obtained using a purified *o*-diphenol oxidase from sugar cane, incubated with chlorogenic acid and a mixture of amino acids, indicated that colour formation may involve their interaction. Although this suggestion is consistent with other observations which show that inclusion of trash and green cane increases colour in raw juice it proved difficult to demonstrate the involvement of amino acids experimentally. Comparisons of the levels of amino acids recovered in samples of untreated cane juice, and thioglycollate-treated juice were inconclusive. Problems arose owing to effects of thioglycollate on the resolution of individual amino acids on the TSM amino acid analyser from crude samples. This problem could be overcome by cleaning up the samples by resin pretreatment ("Dowex 50"). However, inaccuracies arising from this procedure were greater than the recorded differences. Some evidence for the involvement of amino acids was obtained using radioactive tracers as follows.

Radioactive-labelled (^{14}C) hydrolysed protein, which included the common amino acids in ratios similar to those found in cane juice, was added to the juice and the products separated on a column after a period of incubation (Fig. 4). The radioactivity present in the various fractions was determined and the elution profile for radioactivity in the experimental sample compared with that for the unreacted amino acid mixture and for colour

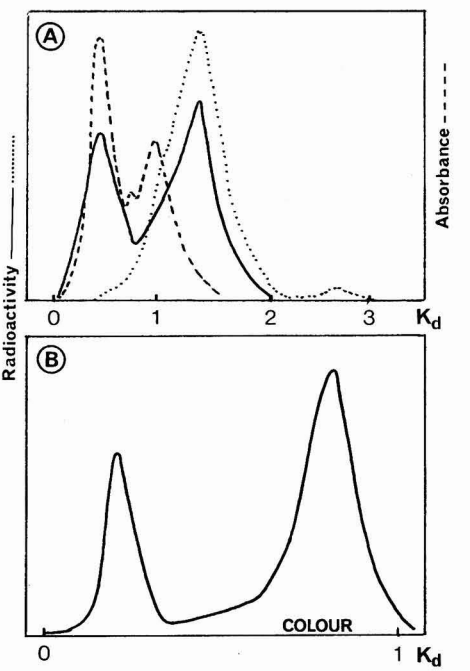


Fig. 4. (*A*) Elution profile of radioactive amino acid mixture (.....) and products following reaction in cane juice (——). The colour profile is also shown (-----). G 25 column eluted with 0·1M NH_4OH.

(*B*) Elution profile of radioactive products obtained by incubating radioactive amino acids with a small piece of tissue from the growing point of a cane stem. Separated on a "Sephadex G 100" column eluted with water.

recorded at 420 nm. Two peaks of radioactivity were observed, one corresponding to the colour peak of low K_d value, the other to the main peak of unreacted amino acids. Although the amino acid mixture had contained phenylalanine and tyrosine (precursors of melanine formation), these were not detected in the eluate from the column.

It is also possible for the diquinone to react with free amino groups present on peptides or protein released into the juice. To test this possibility small pieces of tissue taken from the growing apex of the stem were incubated with ^{14}C-amino acids for about 12 hours. During this time some of the amino acids were incorporated into protein. Hence, when these samples were crushed and the products separated on Sephadex G 100, a high molecular weight radioactive protein peak was obtained (Fig. 4B). This peak of radioactivity was quite distinct from the lower molecular weight radioactive coloured peak, which probably corresponds to the totally excluded brown colorants detected on the G 25 column. These results support the suggestion that colorants are generated by the interaction between the enzyme-generated chlorogenic quinone and free amino acids rather than proteins.

Processing of thioglycollate-treated juice.—Expressed juice was treated in such a way as to simulate crudely clarification by phosphatation. The amount of colour in control and thioglycollate-treated samples was measured by scanning through the visible region between 400 and 700 nm. The control sample is represented by trace *a* in Fig. 5 and the thioglycollate-treated sample by trace *b*. Comparison of the traces clearly shows the initial benefit of including the phenol oxidase inhibitor in the reaction mixture.

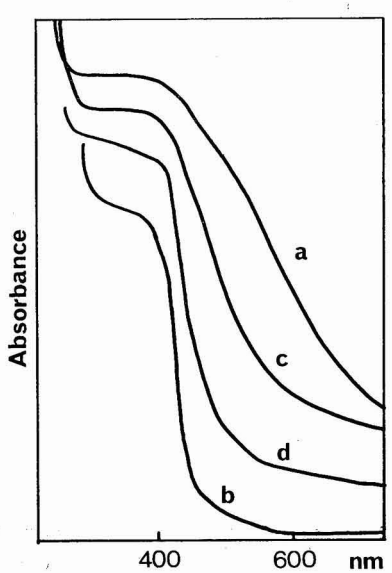


Fig. 5. Absorption spectra recorded at pH 7 for (*a*) control juice, (*b*) thioglycollate-treated juice, (*c*) control juice after clarification by phosphatation and (*d*) thioglycollate-treated juice after clarification by phosphatation.

Following clarification the amount of colour in the control sample dropped (trace *c*), but that in the thioglycollate-treated juice samples increased (trace *d*). It would appear that the processing resulted in further colour being formed from the phenols in the thioglycollate sample. If this is the case then the potential benefits to be derived from inhibition of such enzyme-catalysed colour depends on the extent to which the alternative phenolic degradation products may be formed or removed in further processing. This has not yet been established.

Summary

Raw cane juice has been treated with thioglycollate, an inhibitor of enzyme (*o*-diphenol oxidase)-catalysed colour formation. Separation of products by gel filtration and electrophoresis indicated that both chlorogenic acid and amino acids contribute to colour formation. Although initial colour levels are low in the treated samples, colour may be generated during further processing of juice.

La formation de la coloration dans le jus de canne par des réactions catalysées par des enzymes. 1ère partie. Mécanisme et inhibition chimique

Du jus brut de canne a été traité au thioglycollate, un inhibiteur de la formation de coloration catalysée par enzyme (*o*-diphénol-oxidase). La séparation des produits par la filtration sur gel et l'électrophorèse ont révélé qu'à la fois l'acide chlorogénique et les aminoacides contribuent à la formation de la coloration. Quoique les taux de coloration initiaux des échantillons soient faibles, il peut y avoir production de couleur au cours du traitement ultérieur du jus.

Farbbildung in Rohrsaft durch enzymatische Reaktionen. Teil I. Mechanismus und chemische Inhibition

Roher Rohrsaft wurde mit Thioglycollat, einem Inhibitor der enzym-(*o*-diphenol-Oxidase)-katalysierten Farbbildung behandelt. Die Trennung von Produkten durch Gel-Filtration und Elektrophorese zeigten an, dass sowohl Chlorogensäure als auch Aminosäuren zur Farbbildung beitragen. Obwohl anfangs wenig Farbe in den behandelten Proben vorhanden war, kann Farbe während der weiteren Saftverarbeitung entstehen.

Formación de color en jugo de caña por reacciones catalizado por enzimas. Parte I. Mecanismo y inhibición química.

Jugo crudo de caña se ha tratado con tioglicolato, un inhibidor de la formación de color catalisado por enzima (oxidasa para *o*-difenol). Separación de productos por filtración sobre materia gelatinosa y por electroforesis indicó que ácido clorogénico y amino ácidos contibuieron ambos a la formación de color. Mientras niveles iniciales de color estan bajos en las muestras tratadas, es posible generar color durante el tratamiento subsecuente del jugo. □

The assessment of the inventory of bulk sugar with particular reference to compressibility

By D. F. BAGSTER

(Department of Chemical Engineering, University of Sydney, Australia)

Introduction

IT is well known that the difficulties of finding the quantity of material do not end with a survey of the pile to obtain the volume. The average bulk density of the stockpile must be provided.

One method of obtaining an estimate of the bulk density of material in an ore heap is to place an open box on the floor or ground before storing the material. When the material is reclaimed, the contents of the box may be weighed. This, of course, provides but a rough measure, for the bulk density will vary through a heap of material and will depend on many factors:

(1) The height of the heap.

(2) The method of loading a stockpile, particularly if segregation occurs down the face.

(3) Vibration may cause particle percolation, as indeed can rain in outside storage.

(4) The method of unloading, e.g. from a tunnel underneath or by grab from the top, if indeed any unloading has occurred.

(5) The presence of vehicles on the heap itself, causing disturbance and localized compaction.

(6) Ground subsidence.

Furthermore, there may be a time dependence if the material compacts slowly.

Table I. Sieve analysis of materials tested

Material	*Sieve aperture, mm*	*% retained*
Brand 1 Raw	1·68	2·0
	1·00	46·2
	0·707	43·0
	0·500	7·8
	0·297	1·0
	0·149	0·2
	<0·149	0
JA Raw	1·68	29·4
	1·00	34·6
	0·707	24·2
	0·500	10·6
	0·297	1·4
	0·149	0·2
	<0·149	0
1A Refined	1·68	0·2
	1·00	0·8
	0·707	17·4
	0·500	38·4
	0·297	32·2
	0·149	11·2
	<0·149	0
Caster	1·00	0
	0·707	0
	0·500	0·4
	0·297	40·0
	0·210	41·8
	0·149	14·0
	<0·149	3·8
Pyrmont Char	1·68	0·6
	1·00	15·8
	0·707	29·4
	0·500	35·0
	0·297	18·4
	0·149	0·6
	<0·149	0·2

Previous work by Bagster[1] on various granular materials investigated the first of these and showed that considerable errors could result owing to the variation of compaction with compression in the pile. The present paper reports the compressibility of various representative sugars, both raw and refined, and confirms the previous conclusions. Table I shows the particle size distributions of the solids chosen. Both a Brand 1 raw and a JA raw are included, together with New Farm 1A refined and a caster sugar to see the effect of particle size. A bone char from Pyrmont refinery was measured for additional interest.

Determination and correlation of compressibility

The difficulties of measuring the compressibility of a soil or other granular material are well known and have been set out by Richards[2] who advocates the use of the triaxial test. The present investigation employed the simple technique used before by Jenike *et al.*[3], who used a simple cell loaded from the top by weights with the movement of the lid monitored by clock gauges. The reason for the adoption of a less ideal device was that the simple equipment would at least lead to the order of magnitude of error resulting from compressibility in a stockpile.

Further, the simple container does not have any lateral strain, and this is consistent with the findings of Tschebotarioff[4] for top-loaded soils, where there is little lateral strain. The simple container would thus tend to simulate the stress and strain system of a stock pile.

A standard Jenike cell with its upper and lower portions was used together with the twisting lid to transmit the load. An Amsler compression tester was used in the Structures Laboratory of the Department of Civil Engineering, University of Sydney. A maximum average normal pressure of 631 kPa was used (approximately 92 psi), well beyond what can be expected in a storage heap.

As previous work[1] had found that the equation of Cooper & Eaton[5] was most suitable to correlate bulk density with pressure, it was also employed here. The movement of the top lid of the cell was registered on two dial gauges. The readings obtained were averaged and converted to a decrease in the initial filled and levelled volume of material in the cell. In turn this could be put into a dimensionless form:

$$V^* = (V_\circ - V) / (V_\circ - V_\infty) \quad \text{.....(1)}$$

where V^* = fractional compaction,

---

[1] *Powder Technol.*, 1977, **16**, 193–196.

[2] "The storage and recovery of particulate solids" (Instn. Chem. Engrs., London) 1966.

[3] Jenike, Elsey & Woolley: *Univ. Utah Eng. Expt. Sta. Bull.*, 1958, 95.

[4] "Soil mechanics, foundations and earth structures" (McGraw-Hill, New York) 1951.

[5] *J. Amer. Ceram. Soc.*, 1962, **45**, 97–101.

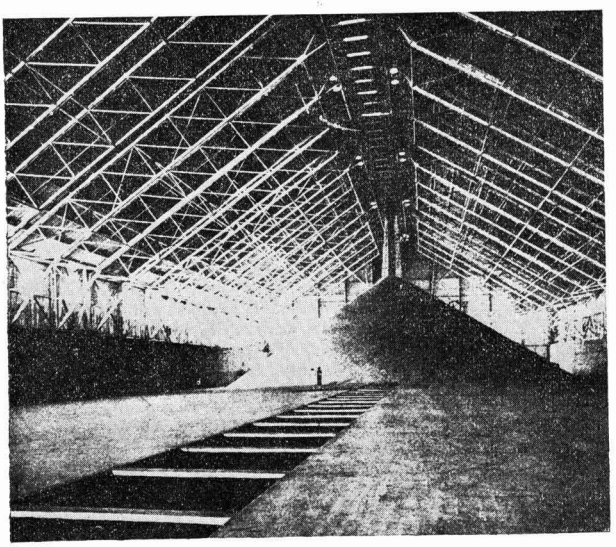


Fig. 1. Prismatic ore heap
(Photograph supplied by MacDonald, Wagner & Priddle Pty. Ltd., Sydney)

V = volume of the compact at some pressure P,

V_o = volume of compact at zero pressure

V_∞ = volume of compact if crushed until all the voids were filled.

Cooper & Eaton[5] used this dimensionless volume in the form

$$V^* = a_1 \exp(-k_1/P) + a_2 \exp(-k_2/P) \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Figure 2 shows the values of V^* found for the various solids together with the corresponding pressures registered on the compression tester.

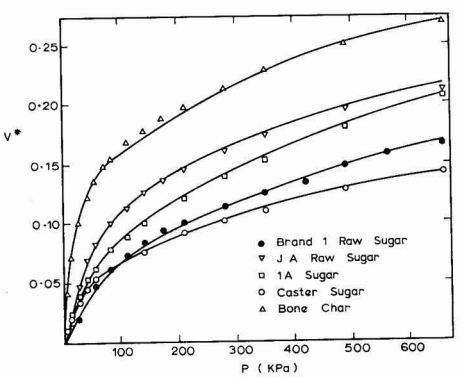


Fig. 2. Fractional compaction in pressure

Cooper & Eaton sought to describe the compaction of solids as a combination of two distributed processes: filling up of the voids by smaller particles and, at high pressures, by fragmentation and plastic flow. They used pressures of up to approximately 600,000 kPa, many orders of magnitude greater than the range of the present work, but nonetheless a two-mechanism approach appears relevant.

Although there is no assurance that compaction at the lowest pressures is dominated by a simple compaction process, extrapolation of these values, point *B*, does establish an approximate value for a_1. The value of a_1 allows fixing of coefficient k_1 to fit the compaction results at low pressure under the assumption that at low pressure almost the entire compaction process can be attributed to one process. With a_2, a_1, k_1 established, coefficient k_2 can be found for fractional compaction at high pressure. The solid curves in Fig. 3 show how well the method correlates the values of V^* and P, these curves being calculated using the values of a_1, a_2, k_1, k_2 found as above and presented in Table II.

Discussion

Some calculations were made using the data in Table II to establish the effect of compressibility on average bulk density of heaps of material. Simple conical and prismatic heaps were assumed with an angle of repose of 30° being assumed for all materials.

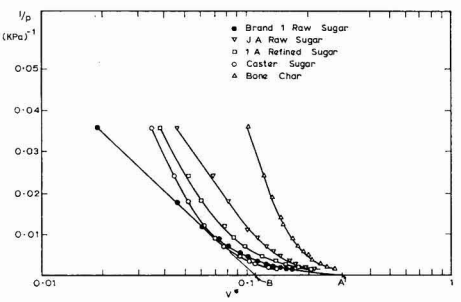


Fig. 3. Technique of Cooper & Eaton

Table II. The constants in the equation of Cooper & Eaton

	ρ_s, kg.m^{-3}	ρ_o, kg.m^{-3}	a_1 —	a_2 —	k_1, kPa	k_2, kPa
Brand 1 raw	1580	899	0·110	0·170	49·87	613·42
JA raw	1580	884	0·147	0·158	32·78	477·83
IA refined	1580	1024	0·112	0·188	30·40	405·20
Caster	1580	1002	0·078	0·122	22·81	380·65
Pyrmont char	2356	1112	0·178	0·177	15·27	397·93

An assumption was made that the pressure at a point in a stockpile is that of the weight of material above that particular level. Thus the pressure at the base is proportional to the profile of the heap. This assumption may be justified by referring to the work of Lee & Herrington[6] and of Clough & Woodward[7], who show such behaviour for embankments and dams respectively.

Figures 4 and 5 show the increase in average bulk density of heaps of material for heaps up to 40 m in height. It is seen that increases of several percentage

[6] *Proc. 1st Aust. N.Z. Conf. Geomech.*, 1971, **1**, 291.
[7] *J. Amer. Soc. Civ. Eng. Div. SM4*, 1967, **93**, 529–549.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points can occur over that of loosely poured material. The density of loosely poured material is variable so that the position of the abscissa of Figs. 4 and 5 is indefinite. Furthermore, in seeking a bulk density, one would certainly use a sample which had been compacted under some height of material. Even so, it is readily appreciated that errors of about 2% may occur in estimating the contents of a large heap, and much greater errors can occur in small heaps.

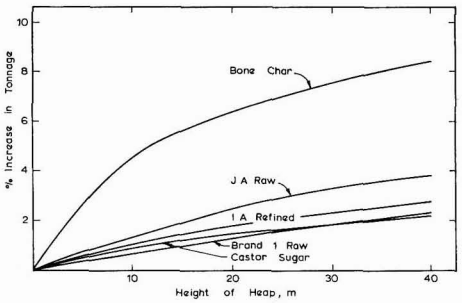


Fig. 4. Increase in average bulk density of conical stockpile with height

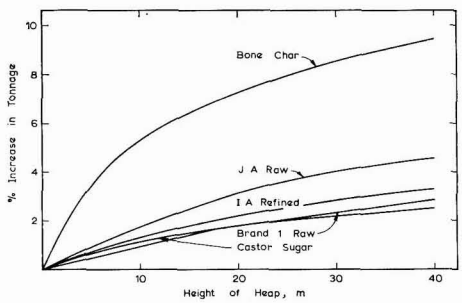


Fig. 5. Increase in average bulk density of prismatic stockpile with height

One observation of considerable interest was made on releasing the pressure on the samples. There was almost no relaxation of the volume of the cell, indicating a nearly complete absence of elastic component of strain. Hence, if in estimating the bulk density of a material, a box is placed at the bottom of a heap and the contents weighed when the heap is removed, the measure of bulk density will not be subject to error due to elastic expansion of the material.

It will be noticed that the char sample was much more compressible than the sugars. This is consistent with the observation of Cooper & Eaton that a sample is more compressible if its particles are softer.

On comparing the compressibilities of 1A refined sugar and caster sugar it is seen that the latter is less compressible. This is consistent with the fact that the caster sugar has fines which are absent in the 1A; these are able to fill up voids and render the material less compressible.

Conclusion

Great care should be exercised in using a single bulk density figure in estimating the contents of a heap of material in storage. The error involved may be tolerable in one circumstance but not in another. The techniques outlined here can be applied to give a close estimate but suffers from the following disadvantages:

(*a*) The compressibility/pressure function is heavily dependent on particle properties and particle size distribution as seen for instance in Fig. 3. It is therefore not wise to use results from one type of sugar to predict the behaviour of another type.

(*b*) The technique for establishing the numerical relationship between V^* and P necessitates the use of a compression tester, which may not be available.

(*c*) The calculated results such as appear in Figs. 4 and 5 are subject to the additional variable factors mentioned in the introduction to this paper.

However, if one is dealing with a single material, e.g. Brand 1 raw sugar, in a consistent fashion, the method discussed here will have a greater chance of being accurate. This work should provide some guide to the order of accuracy necessary in surveying a sugar heap for volume, for there is little point in having the order of magnitude of the volume error smaller than that of the average bulk density error.

Acknowledgment

Dr. R. Q. Bridge very kindly helped in using the compression tester, enabling the stress-strain data to be gathered quickly and efficiently.

The sugar used in the tests was donated by the Central Laboratories of CSR Ltd.

Summary

Bulk granular solids have a finite compressibility even with the relatively low pressures that occur in storage. Various raw and refined sugars have been tested in a compressive test machine and the compaction correlated with pressure using the technique of Cooper & Eaton. The data were then used to estimate the effect of compressibility on the average bulk density in heaps of sugar, leading to an assessment of possible errors in using an average bulk density combined with a volume obtained by survey. Errors of several percent are possible.

L'estimation de l'inventaire du sucre en vrac, compte tenu de la compressibilité

Les solides granulés en vrac possèdent une certaine compressibilité, même aux pressions relativement faibles qui se produisent au cours du stockage. Divers sucres bruts et raffinés ont été essayés dans une machine d'essai de compression et la compacité mise en corrélation avec la pression en utilisant la technique de Cooper et Eaton. Ensuite ces données ont été utilisées pour estimer l'effet de la compressibilité sur la densité moyenne en vrac dans des tas de sucre, ce qui a permis de supputer les erreurs possibles lorsqu'on utilise une densité moyenne en vrac en combinaison avec un volume obtenu par jaugeage visuel. Des erreurs de plusieurs unités pourcent sont possibles.

The assessment of the inventory of bulk sugar with particular reference to compressibility

Die Schätzung des Lagerbestandes von losem Zucker unter Berücksichtigung der Kompressibilität

Lose granulierte Feststoffe haben selbst bei den relativ niedrigen Drücken, die bei der Lagerung auftreten, eine begrenzte Kompressibilität. Verschiedene rohe und raffinierte Zucker sind in einer Druckprüfmaschine untersucht worden. Die Verdichtung wurde mit dem Druck korreliert nach der Methode von Cooper & Eaton. Die Daten wurden dazu benutzt, um den Effekt der Kompressibilität auf die durchschnittliche Dichte von losem Zucker in Haufen zu schätzen und um den möglichen Fehler zu ermitteln, der sich ergibt, wenn man nur die Durchschnittsdichte von losem Zucker mit dem gemessenen Volumen kombiniert. Fehler von einigen Prozent sind möglich.

La valoración de las existencias de azúcar a granel con referencia especial a compresibilidad

Sólidos granulares tienen una compresibilidad finita aun con las presiones bastante bajo que ocurren en almacenaje a granel. Se han probado varios azucares crudos y refinados en un equipo para ensayos de compressión, y se ha correlacionado la compactación con presión por medio de la técnica de Cooper & Eaton. Entonces, se han usado los dados para estimar el efecto de compresibilidad sobre la densidad media del volumen de montónes de azúcar. Esto conduce a una valoración de errores posibles en el uso de una densidad media de un volumen, combinado con el volumen obtenido por medición. Hay una posibilidad de errores de unas porcientos.

British Sugar Corporation 24th Technical Conference

17th—20th July, 1978

ONE THIRD of the hundred participants in the British Sugar Corporation's 24th Technical Conference came from outside the Corporation, with visitors from ten Continental countries, from Canada and the USA. They gathered during the 17th July at the Grand Hotel Eastbourne where, when the Conference opened the following morning, they were welcomed by the Chairman, Mr. T. Rodgers, Assistant Chief Executive of the Corporation. Mr. Rodgers introduced Mr. M. Shore, Head of British Sugar's Research Laboratories, who presented a paper on the Quentin process for sugar recovery from molasses, as modified and developed by himself and his colleagues.

Mr. T. P. J. Dyke, Director of Agricultural Services in the Corporation, then presented his paper "From field to factory" which described the changes which have come about in the past twenty years in beet agriculture, with the wide application of mechanical means of cultivation and harvesting, use of chemicals for weed control, use of monogerm varieties and drilling to stand. He discussed the drawbacks to mechanical harvesting in respect of topping efficiency and losses and pointed out the need to permit operation of transport vehicles over a longer working day so as to increase their utilization and reduce unit load costs.

Mr. J. F. T. Oldfield, Executive Director of the Corporation, and Mr. H. J. Teague, of the Research Laboratories, next presented a paper on the association between juice quality and factory performance in 1976 and 1977. Some twenty years ago the Research Laboratories reported studies on the composition of the sugar beet and the changes occurring during processing. Many changes in equipment and techniques have been introduced, while there have been corresponding advances in agricultural practices and improved varieties. Nevertheless, examination of factory performance and juice quality of the two past campaigns has shown that the basic chemistry is still valid and applicable to contemporary processing and problems. The last paper of the morning was a report by Mr. Dyke on crop prospects for next campaign in the UK and was followed by an assessment for each of their countries by the technologists from other parts of the world.

After lunch, Mr. U. Curdts of Pfeifer & Langen described his company's new raw sugar factory at Appeldorn in the Lower Rhine area of Germany. This factory slices some 4500 tonnes of beet per day and provides the raw material for Elsdorf refinery. It has been designed for easy expansion in line with the availability of beet as more land comes under cultivation in the area. The reconstructions of the Newark factory was then described by Mr. F. Robson (Works Manager) and Mr. M. Flack (Reconstruction Manager), who told of the constraints involved in the factory's location in the flood plain of the River Trent, with the need to maintain production while virtually replacing every part of the old factory during a phased programme.

In the evening, the Conference Dinner was given for delegates by the Corporation, Mr. J. M. Beckett, Chief Executive of British Sugar, making a speech of welcome to which replied Mr. G. M. L. van Loon, of N.V. Centrale Suiker Mij., Holland, on behalf of the Corporation's guests.

The first paper of the next morning, presented by Mr. D. F. A. Horsley, Chief Chemist, described a computerized data collection and processing system which has been developed over the past four years at Ipswich sugar factory. Unlike the systems operating at the other factories the new one is processed on site, rather than in the Corporation's head office, and can provide reception information on a single tape which is available to operators on a current basis and provides immediate statistical data, so providing better control of beet purchasing.

Mr. B. Karren, of British Columbia Sugar Refining Co. Ltd., Canada, which operates beet sugar factories at Winnipeg and Taber as well as their Vancouver refinery, then described a system developed for accumulating and processing laboratory data by means of a computer

which has greatly reduced the calls on the statistician's time and enabled production of shift reports (instead of only daily reports) which permits identification of trends previously hidden in averages and gives closer control. The computer also receives factory data and can produce directly station reports such as material usages; sugar, molasses and pulp production; boiler house data, etc.

Automation and data processing in the factory laboratory was also the subject of a paper presented by Mr. P. W. van der Poel of N.V. Centrale Suiker Mij., whose company has installed equipment at its factories for direct measurements whereby automatic analyses are made of 20-25 samples per hour for sugar content, dry matter content and colour. With little additional cost or maintenance the same system can be used for additional automatic determinations of conductivity ash and pH. The figures are processed automatically to shift, daily and weekly reports.

The last paper of the morning was presented by J. R. Vyse, Works Chemist at Newark sugar factory, who described trials made with a number of programmable calculators by means of which daily extraction statements could be produced instead of weekly, most information being given on a "Tektronix 31" unit with its own built-in printer and magnetic tape information and programme storage unit.

After lunch the afternoon was free so that delegates were able to visit a number of places of interest, including Sheffield Park, Lewes Castle, Herstmonceux Castle (home of the Royal Observatory), or Drusillas, while some took the opportunity to visit the local golf course.

On the following morning, however, work recommenced with presentation by Mr. N. W. Broughton of the Research Laboratories of a paper describing supplementary studies on mid-bay diffuser acidification. The effects of adding a 5% solution of sulphuric acid so as to maintain a suitable pH profile in the diffuser, which gives optimum pulp pressing, were examined. The acid produces an increase in sucrose inversion to the extent of up to 0·05 g invert sugar per 100 g of apparent sucrose; it also involves a slightly greater molasses loss and costs total some £320 per day for a factory with a 200 tonnes.hr^{-1} slice. The better pressing of the pulp, however, reduces the fuel requirement for its drying, with a saving very much in excess of this cost.

Mr. N. B. Davis, British Sugar's Director of Animal Feed Sales, and Mr. P. Tory, Industrial Engineering Manager, then presented their paper on the marketing of dried molassed beet pulp and some aspects of producing pulp nuts and pellets. The first part of this paper referred to production of dried pulp products, expected to be 715,000 tonnes in 1978/79, and its various forms, with a note on the increasing acceptance of 12·5 mm and, more recently, 8 mm extruded pellets. Mechanical information was presented in the second part on the types of press used in the Corporation and the design of dies, use of motorized feeders and steam conditioning, etc.

The last paper of the Conference, presented by Mr. T. A. Field, Packaging Technologist, described the development of palletized deliveries of sugar packets to meet the demands of supermarkets where the traditional 15-packet parcels were no longer acceptable because of their weight and need for continual replenishment to meet rapid turnover of stocks. A system of cages was first developed but proved unsatisfactory; a system with a shrink-wrapping wound around about 1000 packets followed and was very successful but hand packing could not meet the demand. An automatic palletizer was therefore designed and is described which is controlled by a programmed logic unit and supervised by a single operator. The cost of the new system is £1·0004 per tonne of sugar, against £1·2182 per tonne under the old system of 15-packet parcels.

After this presentation, the Conference Chairman thanked all those who had presented papers, those who had organized the Conference, particularly Mr. D. Garside and Mrs. J. E. Foxon, and those who had participated. He announced that the next would be held at the end of June or beginning of July 1980 and then closed the Conference.

Effects of irrigation level and trash management on sugar cane

By J. M. GOSNELL* and J. E. LONSDALE†
(Rhodesia Sugar Association Experiment Station, Chiredzi)

Paper presented to the 16th Congress, I.S.S.C.T., 1977.

PART II

During the 8th ratoon, when the original treatments were re-applied, the response to increasing pan factors tended to be curvilinear and not linear as in earlier crops, particularly for cane which was irrigated in the preceding crop (Fig. 6). This may be due to the high rainfall received during the 8th ratoon. Below 0·68 × Pan, yield dropped sharply while sucrose content was relatively unaffected. Irrigation of the preceding crop increased sucrose and fibre % cane slightly but significantly (Table XIII), but had only a slight effect on cane yield or other parameters.

A remarkable feature of the results is that the driest treatments produced significantly more stalks than the wetter treatments after application of restriction treatments for a year (Table XIII).

Sucrose % cane and Brix % cane were similar in all treatments except for the 0·84/0·60 × Pan treatment in which they were significantly greater. The fibre % cane and juice purity tended to decline with drier treatments.

The driest treatments produced the highest yields of sugar per unit of irrigation water because of the exceptionally wet season.

Table XIII. Effect of irrigation levels re-imposed in 8th ratoon

	Irrigation treatments						*L.S.D(W)*		*C.V.*	*Restriction to preceding crop*	
	W1	W2	W3	W4	W5	W6	5%	1%	%	R0	R1
Pan factors	1·0	0·84	0·84/0·60	0·68	0·53	0·37					
Irrigation, mm	1180	925	772	721	466	313				0·0	0·37
Irrigation and rainfall, mm	1811	1556	1403	1352	1097	944				Not applied	
Tons cane/hectare	108·0	101·9	96·4	93·6	74·8	51·3	12·05	16·67	8·63	86·7	88·7
Estimated recoverable sugar % cane	13·52	13·17	14·23	13·35	13·66	12·90	0·84	1·16	3·48	13·37	13·58
Tons estimated recoverable sugar per hectare	14·60	13·42	13·73	12·55	10·23	6·68	1·86	2·57	10·29	11·63	12·09
Stalk counts (000's/hectare)	165·9	163·4	163·4	164·0	174·4	177·8	10·88	15·05	6·14	167·9	168·4
Lodging %	69	54	28	38	1	0	28	39	73	35	29
Sucrose % cane	15·51	15·27	16·27	15·36	15·69	15·15	0·69	0·96	2·57	15·39	15·70
Brix % cane	17·2	17·3	18·2	17·3	17·7	17·3	0·53	0·74	2·49	17·4	17·6
Fibre % cane	15·9	15·3	15·1	14·9	14·8	14·0	0·99	1·37	4·95	14·7	15·3
Purity %	90·1	88·2	89·2	88·9	88·8	87·7	2·08	2·88	1·21	88·4	88·9
Kg sugar per m³ irrigation	1·24	1·45	1·78	1·74	2·20	2·13	—	—	—	—	—

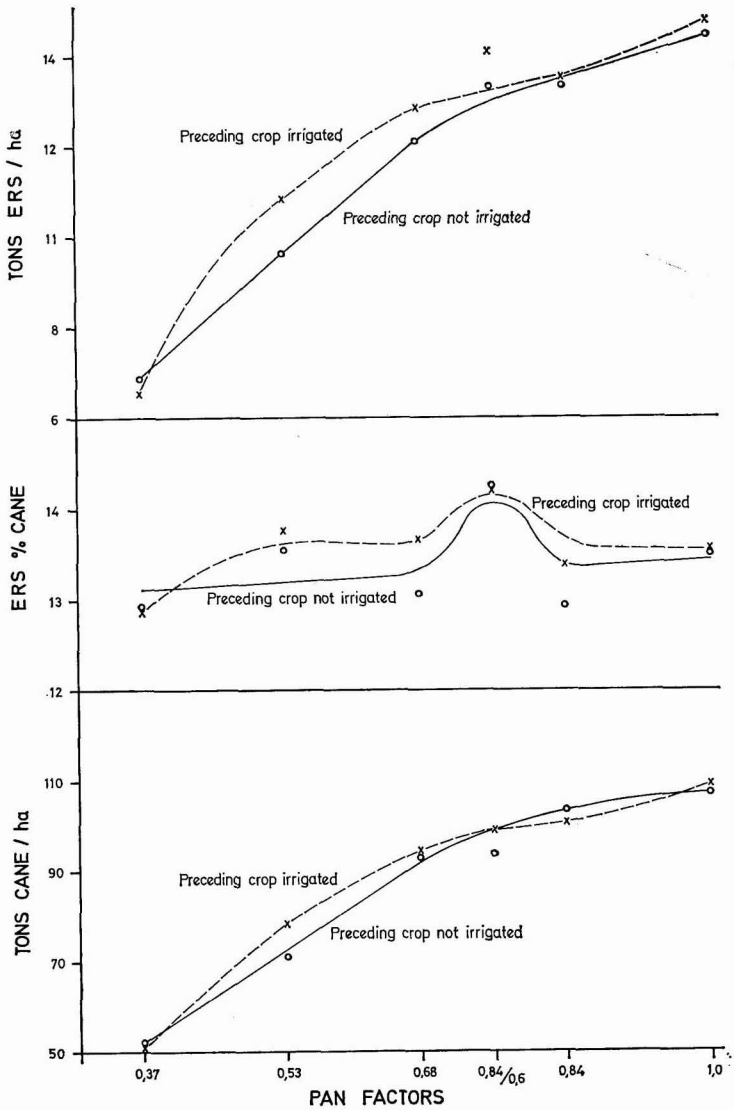


Fig. 6. Effect of previous water restriction on the response of cane and sugar yield and cane quality to varying irrigation levels.

DISCUSSION

Trash vs. burning

These results confirm those of Boyce[2] that trashing substantially decreases yields of cane and sugar at optimum levels of irrigation. As trashing also materially increases costs of harvesting, it cannot be recommended for adequately irrigated sugar cane. By contrast, at lower levels of irrigation, where trash conservation gives increased yields, the advantages of trashing is evidently entirely due to its effect on moisture conservation, confirming results of Thompson[3].

The effect of trashing in reducing stalk population is well known (Thompson[3]) and this reduction partly explains the increase in stalk diameter and consequently the lower fibre and greater lodging under trashed conditions. However, trashing also increases stalk diameter under conditions of extreme drought where there are no differences in stalk population between burnt and trashed plots; under these circumstances the thicker stalks must be due to improved moisture conservation.

Burning reduced smut incidence, compared with trashing, possibly because of destruction of spores by fire; as this effect was most obvious at 0·57 × Pan, it seems possible that extreme drought and lodging may inhibit either smut or its expression in terms of whips per hectare.

The latter observations are added disadvantages of trashing and reinforce the conclusion that irrigated cane should be burnt.

[2] *Proc. S. African Sugar Tech. Assoc.*, 1969, **43**, 35–52.
[3] *ibid.*, 1965, **39**, 143–157.

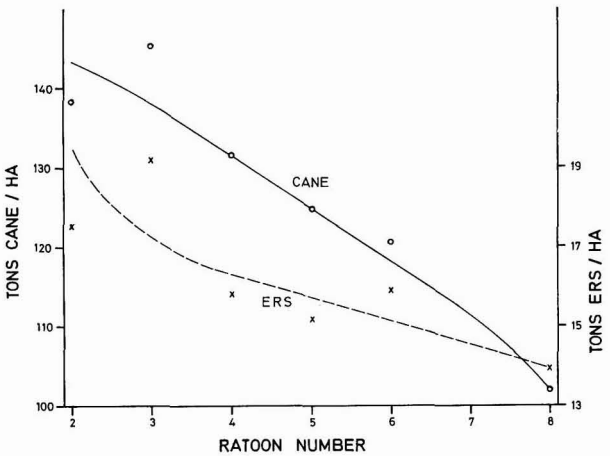


Fig. 7. Effect of ratoons on cane yield of three best treatments

There was a marked variation in water use efficiency of burnt cane with varying irrigation levels (Fig. 2). It is clear that the water use efficiency of the driest treatment is very poor and that under arid conditions it does not pay to "stretch" available water beyond the optimum water duty.

More smut whips were rogued at intermediate levels than at the highest or lowest levels of irrigation. It seems possible that lodging may have reduced smut at the high levels of irrigation and extreme drought may have reduced it at the other end of the scale.

The recoverable sugar content of cane declined rapidly below 0·68 × Pan owing to a decline in juice purity and there was also a decrease at high levels of irrigation associated with an increase in fibre % with increasing water stress.

Irrigation level

Potential evaporation of fully canopied (unlodged) sugar cane has been shown to be close to 1·0 × Pan (Thompson & Boyce[4], McGugan[5]). With the advent of lodging, potential ET drops substantially (Thompson & Boyce[6]). This is confirmed by non-weighing lysimeter results taken from the same field as the current experiment and summarized in Table XIV (Anon[7]).

Table XIV. E_T/E_0 ratios for different ages of cane

Age, months	E_T/E_0 *ratios*	*Age, months*	E_T/E_0 *ratios*
4	1·0	10	0·6
5	0·9	11	0·8
6	1·0	12	0·8
7	1·0	13	0·5
8	1·1	14	0·7
9	0·9	15	0·7

There are thus two probable causes for the fact that the optimum level of irrigation (0·84 × Pan) is below that of potential ET: one is the effect of lodging and the other is the improvement in cane quality obtained with a slight degree of stress.

The advantage of drying-off is well demonstrated by these results as this treatment which was irrigated at 0·84 × Pan for the first 8 months and dried-off at 0·6 × Pan produced a markedly higher recoverable sugar content and higher yields of sugar per unit of irrigation water than any other treatment. Sugar yields compared favourably with the two wettest treatments. However, from the work of Gosnell & Lonsdale[8], it appears that 0·6 × Pan results in excessive drying-off at the end of the season and the mean of the 0·84 and 0·6 treatments, i.e. 0·72, seems advisable for this time of the year. The excessive drying-off may explain the apparently more rapid decline in yield with ratoons of the drying-off treatment as compared with the treatment at 1·0 × Pan. It may also explain the low yields in the extremely dry third ratoon.

There is an indication that the ratoon yields with the 0·84 treatment declined more rapidly than with the wettest treatment; whilst even the wettest treatment showed a general decline, it was not as uniform as the others.

In this trial, pan factors were tested under what was assumed to be an irrigation efficiency of 85%. Therefore, when using pan factors, an efficiency factor should be applied to the quantity of water applied per irrigation.

Water restrictions

Although in the 7th ratoon the irrigated restriction treatment (R1) yield was highly significantly better than the treatment which was not irrigated (R0), there was little difference in the effect of these two treatments on the subsequent crop (8th ratoon). This is because of the high rainfall (811 mm) in the 7th ratoon, which allowed the crop to survive well in spite of lack of irrigation.

Up to 6th ratoon, stalk counts in the driest treatments were significantly lower, and it is remarkable that after the restriction treatments were applied, these treatments produced significantly more stalks (Table XIII). This was because, by the late ratoons, there was a marked increase in the size of stools in the dry treatments.

Water requirements of cane

In order to calculate the nett water requirement of sugar cane, the rainfall efficiency was calculated from soil moisture profit and loss accounts for the three wettest treatments. The mean efficiency (62%) was used for these treatments and gave total water uses as follows:

0·84 × Pan 1564 mm

0·84/0·60 × Pan 1422 mm

The average of these two, i.e. 1493, say 1500 mm, would appear to be the most accurate figure, and may be regarded as the nett requirement.

Soil and foliar analysis

The most notable effect observed in the experiment was the decline in pH over the 7 years. This was pre-

[4] *Proc. 14th Congr. I.S.S.C.T.*, 1971, 813–836.
[5] *Ann. Rpt. Lowveld Research Sta.* (Rhodesia Ministry of Agric., Dept. Research & Specialist Service), 1966/67, 44–47.
[6] *Proc. S. African Sugar Tech. Assoc.*, 1971, **45**, 169–177.
[7] *Rhodesia Sugar Assoc. Expt. Sta. Quarterly Rpt. & Newsletter*, 1968, **10**, 2.
[8] *Proc. 15th Congr. I.S.S.C.T.*, 1974, **2**, 701–712.

sumably due to leaching of cations out of the soil profile, but there is no real evidence to confirm this. There were no marked differences between different levels of irrigation, but exchangeable K, Ca and Mg tended to decline with higher levels of irrigation, as might be expected.

There was a marked increase in leaf calcium with dry irrigation treatments, which is presumably due to a higher proportion of cell walls rich in calcium pectate. There was a reduction in N and K levels with reducing water applications, with the exception of the driest level at which they were higher. This apparently anomalous result was evidently partly due to the relatively short interval between the last irrigation and sampling[9].

Acknowledgments

The authors are indebted to Armen Mbobola, Tauzen Fani and the irrigation department at Rhodesia Sugar Association for the irrigation of plots, which was often done at night because of wind. They are also indebted to the farm section who supervised harvesting and the sucrose laboratory for sucrose determinations.

Summary

Results are presented of a 7-year investigation into the effects of varying irrigation levels under burnt and trashed conditions. The levels were based on Class "A" Pan evaporation, the factors being 1·0; 0·84; 0·84 with drying-off of 0·6 for the last 4 months; 0·68; 0·53; 0·37. In one year, two extreme water deficit treatments were compared: 0 and 0·37 × Pan. At optimum levels of irrigation (0·84 and 1·0 × Pan) burning was superior to trashing in yield of cane and sugar per hectare as well as in stalk count, smut count and most other parameters. However, at low levels of irrigation, retaining the trash produced increased yield of cane and sugar per ha owing to moisture conservation. Trashing resulted in thicker stalks and lower fibre % cane than did burning at all levels of irrigation. As all irrigated cane is burnt in Rhodesia, the results discussed refer only to burnt cane. Increasing the pan factor from 0·37 to 0·84 produced linear increases of cane and sugar yields/ha with little or no further increase to 1·0 × Pan. Recoverable sugar % cane peaked at the 0·84/0·6 treatment as did the kg sugar produced/m³ water applied. Stalk counts were reduced at low pan factors, while stalk diameter was maximized at intermediate pan factors. Lodging occurred only at the higher levels of irrigation. Fibre % cane increased with increasing levels of irrigation. Low levels of irrigation reduced N and K and increased Ca foliar contents. Irrigation at 0·37× Pan for one year proved superior to no irrigation during that crop but there was no residual effect.

Les effets du niveau d'irrigation et de l'utilisation des pailles sur la canne à sucre

On présente les résultats d'un essai poursuivi pendant 7 ans concernant les effets de divers niveaux d'irrigation dans des conditions de brulage et d'épaillage. Les niveaux étaient déterminés par évaporation au bac classe "A", les facteurs étant de 1,0; 0,84; 0,84 avec dessication de 0,6 au cours des 4 derniers mois; 0,68; 0,53; 0,37. Une année, deux traitements d'extrême déficit en eau ont été comparés: 0 et 0,37 × bac. Aux niveaux optimals d'irrigation (0,84 et 1,0 × bac), le brulage se révéla supérieur à l'épaillage pour le rendement en canne et en sucre à l'hectare tout comme pour le nombre de tiges, l'incidence de charbon et la plupart des autres paramètres. Cependant, aux faibles niveaux d'irrigation, la conservation des pailles assura un rendement supérieur en canne et en sucre à l'hectare, du fait de la conservation de l'humidité. L'épaillage a fourni des tiges plus grosses et moins de fibre % canne que le brulage et cela à tous les taux d'irrigation. Comme en Rhodésie toute la canne irrigée est brulée, les résultats discutés se rapportent uniquement à la canne brulée. En portant le facteur bac de 0,37 à 0,84 on a obtenu des augmentations linéaires du rendement en canne et sucre/ha avec peu ou pas d'augmentation jusque 1,0 × bac. Le sucre récupérable % canne montre un pic au traitement 0,84/0,6 tout comme le kg de sucre produit/m³ d'eau appliquée. Les comptages de tiges diminuaient aux faibles facteurs bac, tandis que le diamètre des tiges était maximal aux facteurs bac intermédiaires. La verse ne se produisait qu'aux taux d'irrigation élevés. La fibre % canne augmenta avec l'augmentation des taux d'irrigation. De faibles taux d'irrigation faisaient baisser les teneurs en N et K et augmenter celle du Ca dans les feuilles. L'irrigation a 0,37 × bac durant un an s'est révélée supérieure à l'absence d'irrigation au cours de cette récolte, mais il n'y eut pas d'effet résiduel.

Einflüsse der Bewässerung und Handhabung des Trash auf das Zuckerrohr

Die Ergebnisse siebenjähriger Untersuchungen über den Einfluss von variierenden Bewässerungsmengen auf gebranntes und ungebranntes Rohr werden beschrieben. Die Bewässerungsmengen basierten auf den "Class A pan" Verdunstungsfaktoren 1,0; 0,84; ,084 mit Austrocknen auf 0,6 für die letzten 4 Monate; 0,68; 0,53; 0,37. In einem Jahr wurden zwei extreme Wasserdifizite verglichen: 0 und 0,37 × Pan. Bei optimalen Bewässerungsmengen (0,84 und 1,0 × Pan) war das Brennen dem "Trashing" inbezug auf Rohr- und Zuckerertrag je Hektar sowie hinsichtlich Stengeln, Schmutzauftreten und den meisten anderen Parametern überlegen. Jedoch bei niedrigem Bewässerungsniveau förderten die Blätter den Anstieg des Rohr- und Zuckerertrages je Hektar infolge Feuchtigkeitskonservierung. Das "Trashing" ergab dickere Stengel und einen niedrigeren Fibergehalt als das Brennen bei jedem Bewässerungsniveau. Da in Rhodesien alles bewässerte Rohr gebrannt wird, beziehen sich die diskutierten Ergebnisse nur auf gebranntes Rohr. Die Erhöhung des Pan-Faktors von 0,37 auf 0,84 verursachte eine lineare Zunahme des Rohr- und Zuckerertrage je ha, eine Erhöhung bis auf 1,0 bewirkte nur eine geringe oder gar keine Zunahme. Das Maximum des gewinnbaren Zuckers im Rohr lag bei der 0,84/0,6-Behandlung, desgleichen der erzeugten kg Zucker je m³ verwendeten Wassers. Die Zahl der Stengel war bei niedrigen Pan-Faktoren geringer, während das Maximum der Stengeldurchmesser bei mittleren Pan-Faktoren lag. Nur bei stärkerer Bewässerung legte sich das Rohr um. Geringe Bewässerung verringert den N- und K-Gehalt und erhöht den Ca-Gehalt der Blätter. Die Bewässerung bei 0,37 × Pan während eines Jahres war besser als keine Bewässerung.

Efectos del nivel de irrigación y tratamiento de materia extranea sobre caña de azúcar

Se presentan resultas de un investigación, que ha ocupado siete años, de los efectos de variación del nivel de irrigación en condiciones de la quema y de

[9] *Proc. S. African Sugar Tech. Assoc.*, 1971, **45**, 217–232.

SUGAR CANE AGRONOMY

Some chemical properties and sugar cane yields of selected soil series in Batangas. M. A. Baclig and L. A. Montecillo. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 44-53.—The three soil types of the Batangas area have been analysed for pH, N, P, K, Ca, etc. and the main deficiency shown to be in N, other nutrient levels being adequate.

Factors affecting yield of sugar cane. I. Plant characters associated with yield among HYV's (high yielding varieties). V. G. Dosado, E. Geolingo and R. Geolingo. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 67-75.—Characters affecting cane sugar content and cane and sugar yields per hectare have been studied in eleven recommended varieties. Those with long stalks and leaves had significantly lower cane sugar content, while sugar content at harvest was significantly higher with freely flowering varieties. Varieties with longer stalks, more millable stalks per stool and dark green leaves produced more tonnes per hectare, while those with greater stalk diameters and wider leaves gave significantly greater sugar yield. Those characters closely associated with yield determinants may be used as a guide in selecting desirable hybrids.

A concept in sugar cane weed control. J. N. Gibe. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 86-91.—A programme is proposed for weed control in cane up to 18 weeks after planting or ratooning, when the canopy closes in. In plant cane, the seedbed should be well prepared without clods, which reduce the effectiveness of herbicide sprays. Pre-emergence herbicide should be applied within 4 days; if this is not done, post-emergence herbicide application must be made within 2-4 weeks after planting. The cane is susceptible to herbicides at 4-5 weeks after planting, and if replanting is necessary at this time it should be with the use of trowels to minimize soil disturbance. The second herbicide application should be 5-9 weeks after planting in fields treated with pre-emergence herbicides or 7-10 weeks after planting in fields previously given the post-emergence treatment. Timing should depend on the weed species present and prevailing weather conditions, i.e. rainy conditions require a closer interval between applications. At this stage, the inter-row can be weeded by mechanical cultivation combined with fertilizer application, and this immediately followed by spot weed control in the cane rows with herbicide or manually. The former is preferable with dense growth or weeds such as *Cyperus* spp. The final weed control treatment, which may be a combination of chemical and manual methods, is carried out at 10-13 or 12-15 weeks after planting for the pre- and post-emergence treated cane. With ratoon cane, trash is burnt and stubble shaving carried out, subsoiling being used where necessary. Missing canes are replanted within a week and the inter-rows cultivated simultaneously with fertilizer placement. Early post-emergence herbicide is applied 2-3 weeks after stubble shaving and the balance of fertilizer application made at 6-8 weeks, when spot weeding in the rows is done, either manually or chemically. At the age of 11-14 weeks the inter-rows are cultivated and the rows weeded chemically or manually. Finally, in both cases, field edge weed control is carried out with herbicides when the canes have closed-in at 16-18 weeks.

Performance and NPK composition of Phil 55-226 ratoon under different fertility levels and moisture regimes. N. C. Fernandez, A. R. Ismael, T. B. Perez and P. S. Davide. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 92-104.—Comparisons showed that a good ratoon crop in a clay loam soil required higher irrigation than in a sandy loam. Provided adequate P and K were applied in the plant cane, only N was needed for a good ratoon crop in the clay loam whereas both N and P were required for the sandy loam unless plant cane fertilization was higher than necessary. Balanced N-P-K fertilization was needed for good juice quality and high Brix, the latter also being given in high-irrigation plots.

EFFECTS OF IRRIGATION LEVEL—

(*Continued from previous page*)

retención de materia extranea. Los niveles se basaron sobre evaporación de un tanque Clase A, siendo los factores 1,0, 0,84, 0,84 con desecación a 0,6 para los últimos 4 meses, 0,68, 0,53 y 0,37. En uno de los años se han comparado dos tratamientos extremos de déficit de agua: 0 y 0,37 × Evaporación del Tanque. A niveles óptimos de irrigación (0,84 y 1,0 × Evaporación del Tanque) el quema de la material extranea estuvo superior a su retención en términos de rendimiento de caña y de azúcar por hectárea, tanto como número de tallos, infestación con carbón, y la mayor parte de otros parametros. Sin embargo, con niveles menores de irrigación, retención de la materia extranea produció rendimientos más altos de caña y de azúcar por hectárea como resulta de conservación de humedad. Retención de materia extranea resultó en tallos más espesos y caña con menos contenido de fibra que con quema a todos niveles de irrigación. Porque se quema toda caña irrigada en Rodesia, las resultas tratadas no refieren que a caña quemada. Aumento del factor de tanque de 0,37 a 0,84 produjo aumentos lineales de producción por hectárea de caña y de azúcar con poco aumento adicional en producción por aumento a 1,0 × Evaporación del Tanque. Azúcar recuperable % caña registró su máximo en el tratamiento de 0,84/0,60 como ocurrió en la producción de azúcar por m^3 de agua aplicado. El número de tallos se redujo con factores bajos de tanque, mientras que el diámetro del tallo alcanzó el máximo en factores intermedios de tanque. La inclinación de la caña solo ocurrió en niveles altos de irrigación. El porciento de fibra aumentó con aumento en los niveles de irrigación. La absorción de nitrógeno y de potasio disminuyó con la reducción en los niveles de irrigación pero el calcio aumentó. Irrigación a 0,37 × Evaporación del Tanque para un año dió resultas superiores a ellas sin irrigación para la cosecha de ese año, pero no había efecto residual. □

Changes in juice quality of flowering canes with time. A. T. Barredo. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 105-110.—See *I.S.J.*, 1978, **80**, 142.

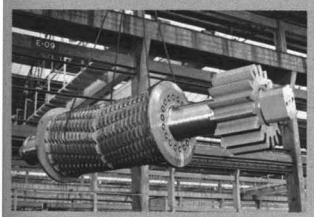
Sensitivity of selected local commercial varieties of sugar cane to "Polaris" (C.P. 41845) and "Ethrel" ("Ethepon") chemical ripeners. R. O. Javier, E. L. Rosario and E. V. Panelo. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 111-127.—The two ripeners were applied to 20 cane varieties and observations on the cane morphology made for three randomly picked stools in each plot, including number of tillers per stool, top visible dewlap leaf area of the primary tiller, total weight, stalk weight, weight of green top plus leaves, moisture content of leaves 3-6, Brix, and leaf sucrose and reducing sugars content. Details of the observations are given. No trends were noted in the morphological characters but the varieties differed in their sensitivity to the two ripeners in respect of the time when they took effect, and the duration and extent of the effect. Of the two, "Ethrel" had the greater and longer-lasting effects.

Sociological issues in the design of cane-growing systems. A. H. Barclay. *Paper presented at Joint UNEP/UNIDO Seminar on Implication of Technology Choice in the African Sugar Industry*, 1977, 18 pp.—The sociological aspects of cane growing by small farmers are contrasted with those of cane cultivation on factory-owned plantations. The author first examines the three most important factors to be considered in planning a cane supply system, viz. the degree of mechanization, the proportion of cane to be grown on a central plantation, and the proportion of total land area under cane, and briefly describes the systems adopted in four African countries—Ethiopia, Egypt, Ghana and Kenya. The impact of land acquisition for large-scale cane growing on the local population is indicated where (*i*) cane is to be grown under irrigation, and (*ii*) where rainfall will be adequate for cane growth. In (*i*), the typical African situation is one in which dry lands in a semi-arid river valley have not been previously cultivated but have served as grazing land for livestock of a pastoral population; irrigation will be introduced specifically for cane growing but not for a pastoral economy, yet it is usually the latter which the population will prefer to continue. In situation (*ii*) the land needed will usually be that of long-established sedentary farmers who will need resettling, possibly posing a number of problems, such as occurred in the case of the Mumias project in Kenya (for which the author carried out a detailed study of land acquisition). Because of enforced displacement of local populations, it is stated that many governments are reluctant (in the light of actual experience) to set land aside for new plantations. The question of labour on large plantations is discussed, whereby it is shown that adverse factors (including "seasonality") interact to make it difficult for plantations to compete with other types of employment, even where these are less rewarding financially. While the "outgrower" system of small farmers does not suffer from the same obstacles, it does have the disadvantage of substituting a factory-based monoculture for a flexible system of diverse crops which are easily sold at the local market. One answer is to combine smallholding and plantation growing of cane, as has been done in a number of African projects.

Environmental and economic impact of alternative agricultural sugar technologies. J. Pickett and F. Duguid. *Paper presented at Joint UNEP/UNIDO Seminar on Implication of Technology Choice in the African Sugar Industry*, 1977, 24 pp.—The economics of cane agriculture under African conditions were studied where comparison was made between mechanical and manual harvesting, loading and transport (or a mixture of these) for six different regimes (irrigated and rain-fed cane over a 216-day or 120-day season and grown on small farms or plantations, at two levels of wages as broadly prevails in East and West Africa). Results indicate that the costs of mechanical harvesting would be too great for its introduction in most African countries, would place excessive demands on skilled labour, would provide less employment for the unskilled worker and would apparently make less commercial profit than manual cane cutting. Moreover, it is considered that, since manual operations spread opportunities more widely, they probably contribute to social cohesion, so that they could be considered as socially preferable to mechanization. The effects on the physical environment of cane burning were also studied. Disadvantages of the practice include the destruction of cane tops, traditionally an important source of animal fodder, and of cane trash, which is useful as a surface mulch (in certain soils and under certain climatic conditions able to protect the soil from the effects of torrential rain, conserve moisture, suppress weeds and have a slight fertilizing effect, although surface litter has the major disadvantages of being able to sustain pests and diseases and inhibit ratooning if windrowing is not used). Possible air pollution by cane burning is also mentioned. Mechanization chiefly affects the soil, this effect depending not only on the local physical conditions of the soil and terrain but also on the prevailing climatic conditions and the need to carry out certain operations within a given time. Because of the need to attain economic goals with minimum environmental damage, thus placing demands on skills, local knowledge and equipment, under present African conditions manual cane cutting is considered preferable.

The long-term agricultural implication of cane growing. Z. A. Menshawi. *Paper presented at Joint UNEP/UNIDO Seminar on Implication of Technology Choice in the African Sugar Industry*, 1977, 41 pp.—The characteristics, limitations and agricultural implication of cane growing, either as a monoculture or as part of a traditional rotation, are surveyed with 45 references to the literature. The effects of long-term cane cropping on yield, soil fertility, compaction, plant-soil moisture relationships, disease and pest incidence are examined, and maintenance of soil productivity discussed in terms of crop rotation, green manuring, trash mulching, use of filter cake and factory effluent, intercropping and inorganic fertilizer application.

Preliminary indications on the effect of continuous cane cultivation on the chemical and physical properties of Mauritius soils. Y. Wong You Cheong and P. Y. Chan. *Rev. Agric. Sucr. Maurice*, 1977, **56**, 70-77.—Changes in the physical and chemical properties of the main soils of Mauritius following long-term cane cultivation were studied. Becase of difficulties in obtaining comparable samples of soil that had never been cultivated, the number of soils compared was small, although the results did give some general indications. The major changes in chemical properties were: a fall



El azúcar representa una importante fuente de energía en el mundo entero. El extraerlo de la caña de azúcar con eficiencia es siempre una tarea difícil que depende sobre todo de las características y de la calidad del equipo utilizado.

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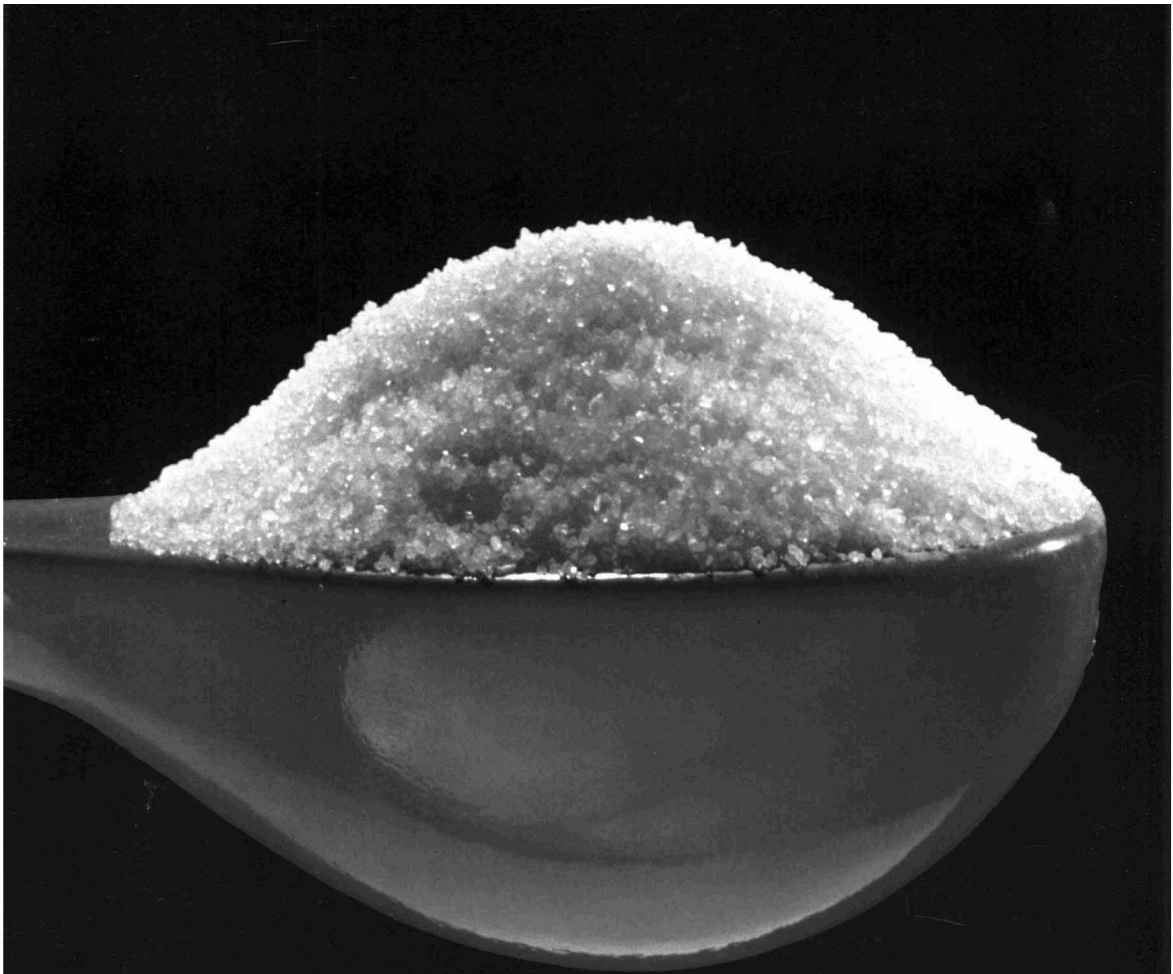

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in pH, organic matter content, exchangeable Ca and % base saturation, and an increase in exchangeable Al (probably as a result of the fall in pH). Loss of organic matter was high in soils under dry conditions, while the content did not change much in wet areas. The clay contents of two soils increased with cane cultivation, but those of two other soils fell; the aggregate stability of soils fell at all layers studied (down to 45 cm), but no overall trend in bulk density or porosity changes was observed. The available water holding capacity tended to fall with cane cultivation in three soils but increased in a fourth.

The influence of row spacing on sugar cane stalk population, sugar content and yield. R. J. Matherne and J. E. Irvine. *Sugar Bull.*, 1977, 55, (24), 13-18.—In studies conducted over 10 years, plant population increased per unit area as the inter-row spacing decreased in the range 84-12 inches. Increases in plant population were very closely associated with increases in yield, but neither row spacing nor population was related to sugar content. The greatest increases in yield resulted from spacings of 1 and 2 ft. However, radical changes in farming practices would be necessary for adoption of such close spacing by comparison with the normal Louisiana spacing of 6 ft, and these are mentioned. Calculation of the increased cost of growing cane at a 2-ft spacing shows that it is less than the greater return resulting from increased yield. On the other hand, a 10% increase in yield with no additional cost is possible by adoption of double-drill planting.

Drip ratoons. W. H. Frankenfield. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 124-127.—Factors to be considered in cane ratooning in drip-irrigated fields are discussed, including installation of tubing, means of increasing water movement to replanted setts where compaction has taken place, the elimination of volunteer stools which, if growing in the tube line, can cause pinching of the tubing, and the adverse effect of stones and trash on tube installation by replanters. One answer to the problem is a narrow rotary tiller, and this is discussed.

Minimum tillage and its application to sugar cane. G. Uehara. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 128-135.—The benefits of minimum tillage which are discussed include a reduction in soil compaction, run-off and erosion and improvement in water conservation and utilization. It is pointed out that minimum tillage has already been widely adopted, so that the question is not whether it should be used but how to increase the effectiveness of tillage. Since the movement of machinery over cane fields is unavoidable, so that resultant compaction cannot be prevented, it is necessary for greater control to be exercised over the use of machinery and the methods used in tillage. A programme should be devised which provides better tillage (possibly at lower cost), good tilth preservation for higher ratoon yields, and integration of tillage in an overall agronomic scheme which also covers irrigation and agricultural "traffic" control.

Machine- *versus* **hand-cutting of seed at the Lihue Plantation Company Ltd.** J. B. Thomson. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 136-140.—After a study had indicated that, at Lihue, seed cane should be cut either all by hand or all by machine but not by a mixture of mechanical and manual operations, it was decided to cut all the seed cane by hand. Advantages included a reduction in area required for seed cane as a result of a 100% recoverability of cane cut manually as opposed to only 78% harvested mechanically, while machines could not cope with recumbent cane where lodging was a natural characteristic of a given variety (so that, if harvested mechanically, it would have had to be cut earlier than the optimum date for maximum yield) or was the result of wind and rain. Moreover, ripe or older cane could be harvested manually, thus increasing yield. As a result of the reduction in area required for seed cane, it was predicted that, in 1977, an additional 400 acres would be available for normal crop cane cultivation, giving a net additional revenue of $820,566. The costs of manual and mechanical cutting of seed cane are compared, showing that the latter are almost $16 per acre greater than the former. Disadvantages of manual labour include the probability of more accidents, a rise in future labour costs (including fringe benefits) and the greater labour requirements than with mechanical operations.

Handling and distribution of fertilizer and chlorine for drip systems. L. R. Maurina. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 141-143.—Equipment and practices used to feed chlorine into drip irrigation tubing to prevent plugging are described, and briefer mention is made of fertilizer application via irrigation tubing.

Experiments in germinating and planting one-eye seed without prepackaging. S. Uyeda. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 155-156.—At McBryde it has proved difficult to establish a good stand of plant or ratoon cane in drip-irrigated fields, mainly because of sett moisture deficiency after planting and subsequent destruction by pineapple disease before emergence. To ensure that the sett has enough moisture, a system has been developed whereby the single-bud setts are treated with "Benlate" and stored under a cover of black polyethylene, which provides the required moist atmosphere and warmth for shoot and root elongation. The setts are ready for planting 5-10 days after such incubation and, because of the absence of soil, there is no risk of infection by pineapple disease. The pre-germinated setts must be planted in moist soil and immediately covered with at least 1-2 inches of soil, but they do not need immediate watering as do nursery-grown transplants, provided there is adequate soil moisture; otherwise, irrigation should be carried out within a few hours. Emergence is greater than 90% and is almost 100% under ideal conditions; the amount of seed material required for manual transplanting is very much smaller than with conventional mechanically planted setts (in one trial covering just over 1 acre only 950 lb of pre-germinated setts was needed compared with 6000 lb of conventional, mechanically planted setts). However, the pre-germinated setts do not give as good stands as do short, hot water-treated, machine-cut setts.

Concepts in automatic handling and metering of seed cane. J. F. Cykler. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 157-164.—While hand-cut seed cane is preferred to that prepared by mechanical cutters because of its higher quality and usually lower overall cost per ton, it is desirable to establish a means of providing uniform setts for automatic metering on planters, so that manual planting operations can be replaced by

mechanical ones and the performance thus raised. The objectives and requirements of various approaches to the problems of automatic preparation of uniform billets, handling and metering of setts and creation of a planter tube injector for setts are set out and a general development plan described for each case.

Is drip irrigation paying off? R. T. Hill. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 168–170.—The author's experience with drip irrigation at Wailuku Sugar Co. is recounted. Advantages of the system are briefly discussed, while mention is also made of expectations in certain directions which have not been fulfilled, e.g. conversion to rubber-tyred equipment and elimination of deep ploughing. By improved utilization of water with drip irrigation and more uniform fertilizer application through the system, it is shown that cane yield has increased by an average of 8·1 tons.acre^{-1} (99·8 tons.acre^{-1} compared with 91·7 tons.acre^{-1} using furrow irrigation) and sugar yield by 1·63 tons.acre^{-1} (13·14 compared with 11·51 tons.acre^{-1}).

Microbial processes in drip irrigation tube plugging. R. R. Roberts. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 171–172.—Investigations of several examples of orifice plugging in drip irrigation tubing showed that micro-organisms were not directly involved in most cases. However, in one case, which is discussed in greater detail, blockage of the smaller chamber in dual-chamber tubing was found to be caused by masses composed, of mycelium and soil; fungi in the soil were isolated. grown in pure culture and identified as *Aspergillus* spp Tests to determine the effect of chlorine showed that more than 10 ppm was required to kill the spores. In another case, water fed from a small reservoir directly to the irrigation tubing was not pre-treated in a sand filter which had become inoperable. After plugging of dual-chamber tubing had taken place, investigations revealed "stringy" material entwined with soil particles. Subsequently it was found that the stringy material was, in fact, hair roots of California grass with which the banks of the reservoir were overgrown. In most cases, use of sand filters and chlorine is adequate to ensure satisfactory drip irrigation, but increasing use of re-processed water containing high levels of organic material, etc. may lead to increased orifice plugging, so that the effect of the water on the system should be determined before its use.

Field water balance report. P. Dunham. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 173–176.—Details are given of the system used by Pioneer Mill Co. to record the moisture balance in drip-irrigated fields, the quantity of water applied and its distribution, quantity and frequency of chlorine and flushing water application, number of irrigations between these operations, rainfall, etc. Six pan evaporation stations have been established at sites throughout the plantation, and each field assigned to the station considered to be most representative of its evapotranspiration characteristics.

Subsurface irrigation in a seed farm—problems and solutions. R. C. Moore. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 177–179.—Information is given on the 386-acre subsurface irrigation system installed at the seed cane farm of Hawaiian Commercial & Sugar Co. in 1975. Problems which are described include damage by ants (particularly when the system is shut down during the seed cane drying cycle before it is cut), plugging by sand and bacteria (most of the sand being removed by flushing, while application of 10 ppm chlorine helps reduce the problem), compaction of soil around the tubing and resultant flow restriction, and the need for regular repairs to the polyethylene which soon became brittle and started splitting at the insert fittings and where any kinks occurred. A higher grade of polyethylene is used for the repairs, while flexible PVC (polyvinyl chloride) hose is being tested as a replacement for the polyethylene. Modifications made to reduce labour costs are mentioned. Despite the problems, the system functions "acceptably".

Evaluation of Wye strainers. C. S. Suzuki. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 180–183.—Wye strainers are used in drip-irrigated cane fields of Hawaiian Commercial & Sugar Co. to prevent plugging of the tubing resulting from a mainline break or failure at the sand filter. However, maintenance of the stainless steel 100-mesh strainer has created a major problem, and tests were conducted with screens of various mesh sizes to determine the best for the purpose of trapping particles that would plug the tubing but allowing passage of any particles that would pass through the orifices. Results are given in tabular form. It was finally decided to install 40-mesh screens and slotted PVC screens; the latter presented no problems after 10 months of operation and have required little maintenance. Although they and the 40-mesh screens had the largest openings of the screens tested, they still protected the tubing. The performances of the 40-mesh screens in a test field are to be investigated.

Filter equipment update. W. L. Pyle. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 184–186.—Information is given on sand filters used for drip irrigation water treatment in Hawaii. The ways in which they are used and problems which arise are described.

Design of an electronic controller for drip irrigation systems. G. E. Sloane. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 192–198.—An electronic control system based on a micro-processor has been developed. A description is given of the system and of the software, which permits the operator to control, in sequence, application of water and fertilizer to the cane, injection of chlorine, flushing of laterals to remove sediment and backwashing of sand filters and/or screens used for water pre-treatment.

Placement of drip tubes in an oxisol. L. Santo. *Rpts.* 1976 *Meeting Hawaiian Sugar Tech.*, 199–204.—It is stated that placement of drip irrigation tubing is dictated primarily by the distribution of the water in the soil, inadequate movement of water from the laterals to setts having an adverse effect on germination and shoot emergence and thus leading to poor yields. The economic aspects of tube placement are also important. The author presents wetting pattern data for an oxisol (Molokai soil) and discusses the relevance of these to tubing placement and emitter discharge rates, as well as tube economics (particularly favoured by the pineapple tube placement system).

SUGAR CANE MECHANIZATION

"Simple Sasex" cane cutter. Anon. *S. African Sugar J.*, 1977, **61**, 183.—An illustrated description is given of this simplified version of the cane harvester developed by the South African Sugar Association Experiment Station. It is suitable for farmers cutting up to 50 tonnes of cane per day and costs less than R 3500 (less than R 2500 if no topper is required).

Effect of mechanization on extraneous matter in cane. *S. African Sugar J.*, 1977, **61**, 448-451.—A 1-day symposium on the title subject included a paper by R. Campbell pointing to the adverse effect of pushpiling on harvested cane contamination with soil and other extraneous matter. Major factors to be considered with regard to the use of pushpilers are listed and recommendations given on their operation. C. Dent discussed the quality of extraneous matter picked up during transshipment of cane, and attributed increased cane losses and extraneous matter also to the dirty state of inadequately hardened or improperly drained sidings during wet weather. Cane burning and trash mulching were discussed by G. D. Thompson, who produced data to show the benefits of trashing on yield, soil conservation and weed control, although the alternative of cane burning was considered preferable where ratoon germination would benefit from a higher soil temperature, particularly in winter. Recommendations were to burn cane all the year round at high altitudes, only in the winter at intermediate heights (with trashing in the summer), and to trash all the year round in the coastal area. Burning should be carried out before the cane is ploughed-out, where the crop has been heavy (e.g. in valley bottoms) and in irrigated areas not subject to erosion. Types of harvesters and loaders to use with green and burnt cane are indicated. Results obtained with chopper harvesting of cane which had suffered severe flood damage were discussed by G. Slater. Despite the very adverse conditions under which harvesting took place (with the cane in a flattened state and muddy), the lowest amount and average quantities of extraneous matter were below the quantities obtained by hand cutting and hand cleaning; the greatest proportion of extraneous matter was cane tops, followed by green leaves clinging to the billets and loose leaves. However, burning erect, heavy canes causes the stalks to lean over, thus reducing the effectiveness of the topper, so that the possibility of using chemical ripeners as an aid to clean cane harvesting is suggested. J. Chance considered the problem as one of farm management and thought that the question of extraneous matter was not as difficult as it appeared.

Deterioration of chopper-harvested cane. J. T. d'Espaignet and M. Randabel. *Rev. Agric. Sucr. Maurice*, 1977, **56**, 78-84.—Samples of burnt, chopper-harvested cane from five factory areas in Mauritius (where chopper-harvesters were used for the first time in 1976) were analysed and compared with manually cut whole-stalk cane. The fall in quality of the chopped cane was noticeable, as indicated by juice purity, glucose ratio and pH, 13 hours after harvesting; there was then steady deterioration up to 55 hours after harvesting. The dextran content rose steadily from 249 ppm 1 hour after harvesting to 19,977 ppm 55 hours after harvesting; comparable values for whole-stalk cane were 124 and 2021 ppm dextran 1 and 55 hours after harvesting, respectively. Hence, in order to avoid loss of recoverable sugar and reduce risks of deterioration in factory performance, it is recommended to process chopped cane within 13 hours of harvesting.

Australian cane growing and sugar milling—some implications of the technology employed. G. Ferguson. *Paper presented at Joint UNEP/UNIDO Seminar on Implication of Technology Choice in the African Sugar Industry*, 1977, 18 pp.—The system used in Australia under which farmers have been encouraged to maintain cane yields and quality is described to show how problems often associated with individual cane farms as opposed to factory-owned plantations can be overcome. The method used for cane payment is also indicated. The effects of large-scale mechanization of the farm processes are discussed; while mechanization has provided economic benefits where labour is expensive, in some districts it has reduced the amount of land available for cane growing because of steep slopes and stony ground, so that the economic viability of some factories has been at risk, while the requirements for long cane rows and wide, safe headlands have necessitated heavy capital investment in equipment for earth moving and drainage on many farms. Other problems associated with cane mechanization are the impossibility of operating under wet conditions and high cane losses resulting from bacterial infection of chopped cane, operation of the harvesters themselves and transport delays. A further source of loss is post-burning deterioration; while burning has removed the risk of leptospirosis (transmitted by rodents in cane fields) and increased cane cutting rates to a considerable degree, it has necessitated imposing a 2-day limit between cane burning and delivery at the factory.

Economics of equipment fabrication. J. Bailey. *Rpts. 1976 Meeting Hawaiian Sugar Tech.*, 112-113.—A brief report is given on the savings at Olokele Sugar Co. made possible by manufacturing the company's own pieces of agricultural machinery.

Progress report on planter-replanter designed specifically for drip irrigation fields. C. J. Trenholme. *Rpts. 1976 Meeting Hawaiian Sugar Tech.*, 118-119. Details are given of a cane planter which enables cane to be planted in two rows at a time from bins located one on each side of the operator. The planter was bought for operation with the "pineapple" or with the "one-hose, one-line" cane planting arrangement used in conjunction with drip irrigation. The seed and injector ploughs and reels can be re-arranged for the appropriate planting method within 1 hour by means of an overhead crane. At a cane row spacing of 6 ft, the equipment has p lanted 50 acres in a week.

CANE SUGAR MANUFACTURE

Concept and design of vacuum pans. B. B. Paul. *Seminar, Sugar Tech. Assoc. India,* 1975, 6 pp.—Requirements of an ideal vacuum pan are listed and design features of calandrias, entrainment separators and pan bottoms discussed.

Crystallization and crystals of plantation white sugar. N. A. Ramaiah. *Seminar, Sugar Tech. Assoc. India,* 1975, 6 pp.—Thermodynamic aspects of sucrose crystallization and the energy levels involved are explained, and impurity distribution in plantation white sugar crystals discussed. The keeping quality of plantation white sugar (which usually has a purity of 99·8) is low because of colour formation during storage, and the reasons for this are examined.

Commercial production of crystal sugar. S. N. G. Rao. *Seminar, Sugar Tech. Assoc. India,* 1975, 5 pp. Sugar crystallization aspects examined cover inclusions and how to reduce them, white sugar crystal appearance and storage properties, and means of improving the surface quality of raw sugar crystals. Large crystal manufacture as carried out in India is discussed, and information given on the boiling practices at Ravalgaon.

Use of coal in sugar factory boiler furnaces. Anon. *Maharashtra Sugar,* 1977, **2,** (10), 7-8.—The use of coal as an alternative fuel to bagasse would permit greater quantities of the latter to be made available for paper production. However, consideration of the technical facets of boiler conversion and subsequent operation, as well as examination of the economics of coal burning implications for the Indian sugar industry, indicate that use of coal would be of disadvantage.

The effect of sugar cane quality on its processing parameters. B. N. Pandey and S. Srinivasan. *Maharashtra Sugar,* 1977, **2,** (10), 9-16.—The contents of mixed juice impurities, including reducing sugars, specific colorants, organic and inorganic acids, ash constituents and nitrogenous compounds and their effect on liming and sulphitation are examined, and possible remedies suggested. The influences of named pests and diseases and of N-P-K fertilization on cane are also indicated and means of controlling the first two listed.

The design features of the N.H.E.C. boiling house. G. G. Kakade and V. G. Khilari. *Maharashtra Sugar,* 1977, **2,** (10), 17-18.—Salient features of sugar factory equipment manufactured by the National Heavy Engineering Cooperative Ltd. in India are briefly discussed, including juice heaters and evaporators; sulphitation plant; pans and crystallizers; syrup feed tanks, molasses dilution tanks and condensate extraction systems, etc.

Inventory control theory and practice in the sugar industry. S. Narain. *Maharashtra Sugar,* 1977, **2,** (10), 27-42.—Maintenance of adequate stocks of sugar factory spares and their re-ordering are discussed.

Progress in the sugar industry. V. R. Rajebhosale. *Maharashtra Sugar,* 1977, **2,** (10), 43-49.—Details are given of steps taken over a 4-year period to increase factory efficiency at Bhogawati.

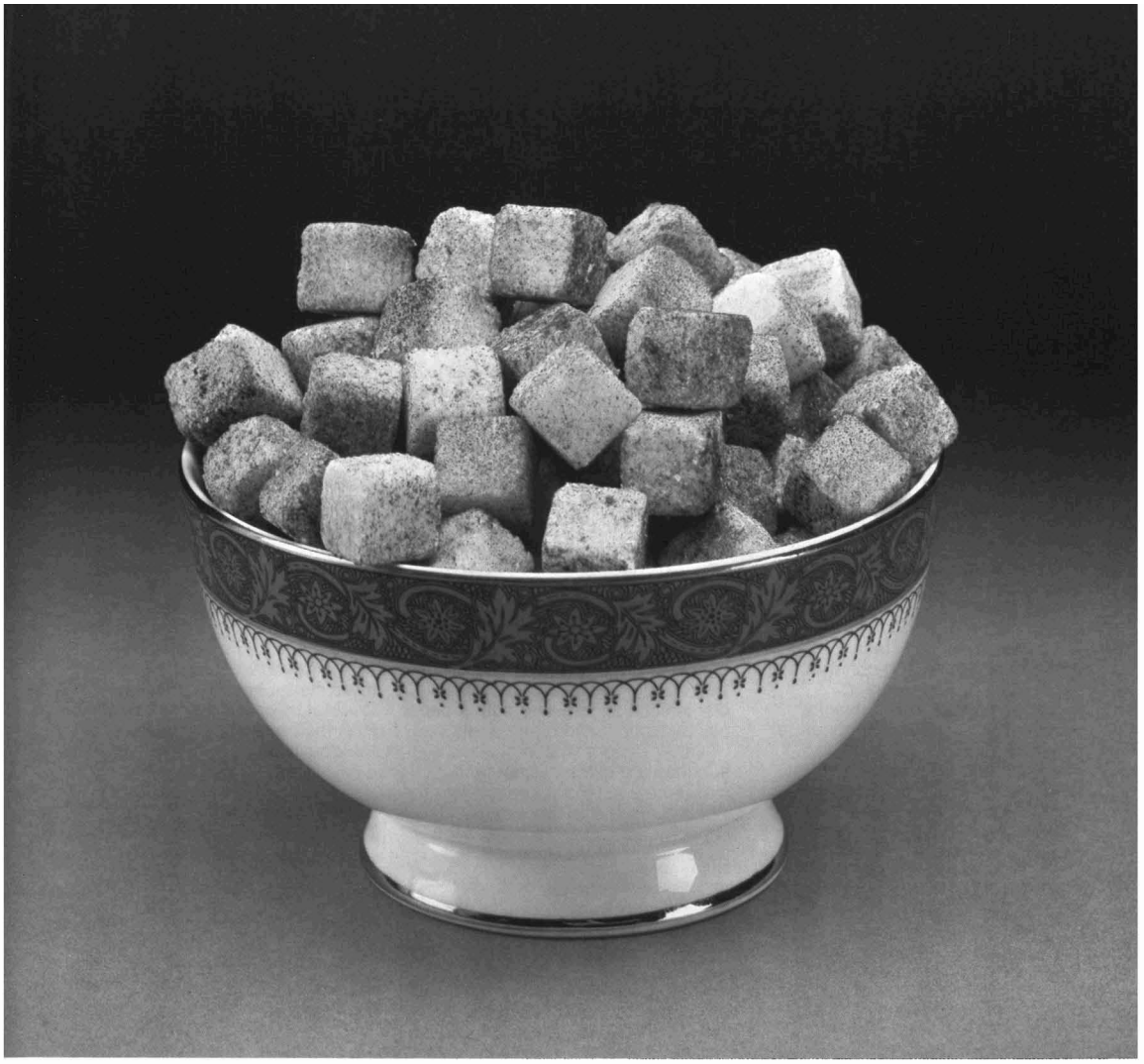
Evaluation of screen modifications on a continuous centrifugal. P. A. Prince and M. R. G. Montocchio. *S. African Sugar J.,* 1977, **61,** 455-464.—See *I.S.J.,* 1978, **80,** 180.

Maintenance of electric machines and installations in the sugar industry. S. S. Bijlani. *Maharashtra Sugar,* 1977, **2,** (12), 23-34.—Safety and technical factors concerning electrical installations in a sugar factory are examined. It is pointed out that all systems should have adequate current capacity for the tasks for which they are intended, be provided with some flexibility in distribution and circuiting, allow ready access to equipment and be reliable. A logical approach should be adopted to designing electrical systems, and suitable conductors selected according to circuit voltage. The reasons for earthing are listed, and causes and control of static electricity discussed. Operation and maintenance of A.C. induction motors are described and various important terms used in connexion with motors are explained. The correct approach to adopt in handling the armature of a D.C. motor is indicated. After discussion of general maintenance requirements, a table is given for help in establishing causes of A.C. motor faults and their remedies.

The effects of heavy metals on the clarification of cane mixed juice. J. C. Fandialan and N. P. Dorado. *Crystallizer,* 1977, **2,** (3), 12.—Instead of liming to pH 7·4-7·6 with heating, a system was developed at Canlubang whereby juice was limed to pH 8·0-8·2 and Mn or Zn salts added in three doses to give concentrations in juice of 150, 200 and 250 ppm, respectively. At 150 ppm, either element improved juice clarity by comparison with the control, while 200 ppm gave better colour than in the control. Mud settled faster as a result of the heavy metal addition. Residual quantities found by atomic absorption spectrophotometry were 12·3-27·8 ppm Mn and 8·3-24·1 ppm Zn. No sucrose or reducing sugar destruction took place at pH 8·0-8·2.

The "Unigrator": a cane knife and shredder for improved cane preparation. J. Bouvet. *Proc. 24th Ann. Conv. Philippines Sugar Tech.,* 1976, 141-149.—At Laupahoehoe sugar factory in Hawaii, following closure of Hamakua mill, the cane supply was increased from 99·6 to 131·9 t.c.h. over two years. In the first year, the mill staff were fully committed to maintaining throughput and coping with engineering work in capital projects,so that milling performance fell from 95·15 to 92·62% extraction; in the second year, however, this was improved to 93·73% despite a 40% cut in imbibition (because of bottle-necks) and a rise in throughput to 139·9 t.c.h. Characteristics of the "Unigrator"[1] are described and installations (including 32 in Brazil, built by M. Dedini S.A. Metalúrgica) are listed.

[1] *I.S.J.,* 1975, **77,** 140-142.



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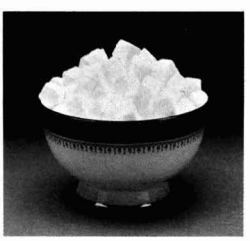

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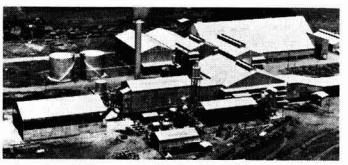

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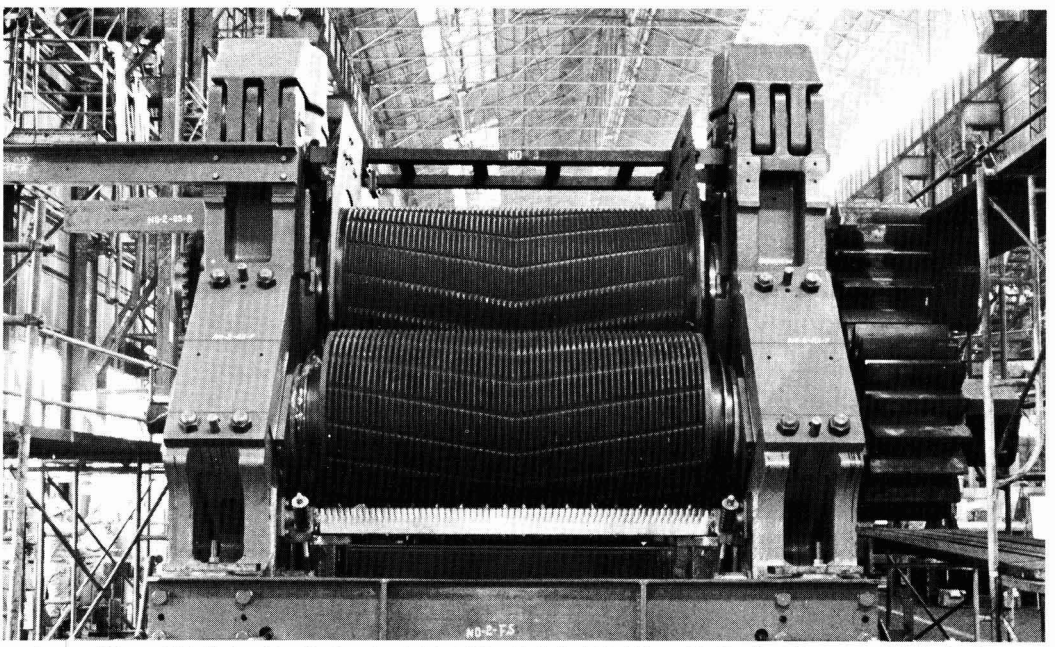

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Bagasse preparation and pneumatic conveying. E. J. Thoma. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 150-153.—In one system, bagasse is sent to the boilers direct from the mill, with surplus being sent to a store from which it is reclaimed when necessary. A newer system has all bagasse sent to store from which that required by the boilers is reclaimed. The second system is being adopted by a number of Hawaiian and Australian mills and maintains a constant supply to the boilers while being simple to automate with reduced operating cost and better utilization of storage buildings. Pneumatic conveyors are a clean and efficient method of bagasse transportation and can be provided with the required screens at their discharge. Drying of bagasse increases its calorific value and can afford appreciable savings, which are discussed.

Improvements in mill feeding. D. J. Wright. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 154-160. See *I.S.J.*, 1977, **79**, 200.

What type of trap should you use? J. B. Pallugna. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 161-169.—Characteristics of a number of types of steam trap are described with applications recommended for each.

Extended milling operation during the peak periods. A. M. Alacal. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 170-176.—Capacity utilization of a factory would be maximum if it were able to operate continuously throughout a campaign, but this is not possible because of the need to clean evaporators and carry out maintenance. Three schemes are compared: (1) with weekly shutdowns for 12 hours on Monday for cleaning, etc.; (2) running continuously for two weeks by use of a high dosage of an antiscalant to maintain evaporator efficiency through 13·5 days; and (3) shutdowns twice in three weeks (i.e. Monday—Thursday—Monday) using a smaller amount of antiscalant. The disadvantages of scheme (2) are that the cost of antiscalant is high, it is uneconomical for the alternate Monday when cane supply after the week-end is often insufficient for full capacity milling, and there is an increased risk of major breakdown owing to the longer continuous running. These are mitigated in scheme (3) so that, although the savings in downtime allow greater milling throughput and so higher income in system (2) than the other systems, there is greater profit per tonne of cane in system (3).

Environmental effects of sugar central effluents. M. Gloria. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 205-208.—Examination of discharges from 12 sugar factories showed that temperature, pH, chloride, total solids and oil exceeded tolerable limits in only a few instances. More than half had BOD levels above the limits, and these were associated with higher than acceptable odour; this indicates fermentation or the presence of organic matter. Although total solids were not a problem, high turbidity occurred in about two-thirds of the cases, usually caused by fines in washings or from bagasse dust. Although all of the twelve cases failed the standards for Class C receiving waters, several almost met the standards, and the pollution problems in most factories could be solved fairly simply without too much expense. Generally, only factories with annexed distilleries and bagasse pulp plants have serious problems which, although not impossible to solve, might be expensive to overcome.

Performance evaluation of a Philippine-formulated cleaning compound. C. M. Madrazo. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 231-236.—A Philippine-formulated material, "Polykleen Vap-200", has shown improved effects in removing evaporator, heater and pan tube scale and has been adopted in 15 of the country's factories.

Environmental implications of different sugar technologies with special reference to India. B. Behari. *Paper presented at Joint UNEP/UNIDO Seminar on Implication of Technology Choice in the African Sugar Industry*, 1977, 36 pp.—After a brief description of the development of the Indian sugar industry and sugar machinery manufacture, the author discusses the effect of sugar manufacture on the local population. The major problems which arise in cane agriculture include the uncertainties amongst farmers resulting from the dependence on the factory owner for purchase of the crop (partially removed by development of inter-cropping to raise farm profits), labour shortages, the need to prolong the crushing season, and the delays between harvesting and processing caused by transport inadequacies. It is stated that 4·26 million tonnes of white sugar was produced in 1975/76, but that more than double this figure (8·61 million tonnes) was manufactured in the form of gur and khandsari. While gur (jaggery) contains only 56-59% sucrose and is produced by crushing of the cane and concentration of the juice in open pans, khandsari is a raw sugar produced by extraction of the juice which is then clarified, boiled in open pans, dropped as a hot massecuite into earthen vessels for cooling over a 2-3 week period or into stirred crystallizers for 2-3 days, and then spun and dried. While attempts to introduce improvements in gur manufacture have met with little response, since the process is popular because of its simplicity and provides a cheap form of energy food where the rural population has little money, khandsari has depended for its popularity on improvements in clarification, and its manufacturing technology has greatly improved over the last two decades. Moreover, while sugar factories are subject to restrictions on the price paid for cane and sugar selling price as well as having to pay certain levies, khandsari units are not subject to price restraints and can claim rebates on levies based on the type of machinery used. Hence, khandsari is more competitive than sugar. The pattern of the cane crop in India is described in an appendix.

Economic viability in African conditions of the large-scale vacuum pan sugar technology. R. Alpine and F. Duguid. *Paper presented at Joint UNEP/UNIDO Seminar on Implication of Technology Choice in the African Sugar Industry*, 1977, 26 pp.—The economic viability of large-scale vacuum pan sugar factory operation under African conditions was analysed. Assumptions were: a long season of 270 days, a short season of 150 days, use or omission of irrigation, and crushing capacities of 100 and 200 t.c.h. Results showed that the long season was better financially than the short season, that irrigation (giving a higher cane yield) was better than reliance on rainfall (which gave a lower cane yield), and the higher crushing rate was better than the lower one.

BEET SUGAR MANUFACTURE

Biological treatment of sugar factory waste waters. K. Čiž and J. Gebler. *Ind. Alim. Agric.*, 1977, **94**, 731-734 (*French*).—See *I.S.J.*, 1977, **79**, 24.

Expansion of sugar production in Yugoslavia. Anon. *Zeitsch. Zuckerind.*, 1977, **102**, 672-673 (*German*). A brief survey is presented of the Yugoslavian sugar industry, with a map showing the location of existing and planned sugar factories. Within the framework of a scheme for the industry, the existing 13 factories are to be reconstructed, expanded and modernized, while 10 new factories are to be built, each of 4000 tonnes.day^{-1} rated slice. Four of the new factories are to be built in the Vojvodina region, which is the major beet-growing area, located in the north-east of the country. Despite progressive expansion in sugar production, whereby consumption is covered and adequate stocks provided, Yugoslavia still has to import refined sugar.

Control of operation of low-grade crystallizers using a mini-computer. W. Lekawski and A. Bober. *Gaz. Cukr.*, 1977, **85**, 198-201 (*Polish*).—A system for low-grade crystallization control is described which is based on use of a mini-computer to monitor dilution of the massecuite with amounts of water calculated in accordance with a number of determined massecuite parameters. Such a system has been installed at Orestias factory in Greece where the average cooling rate is 0·79°C.hr^{-1} over a period of 47 hours.

Use of biological methods for sugar factory effluent treatment. B. Zalicka and B. Poleć. *Gaz. Cukr.*, 1977, **85**, 201-204 (*Polish*).—Activated sludge treatment of factory effluent is discussed, and trials reported in which effluent of 2-3 kg.m^{-3} BOD_5 was first held in an anaerobic tank. Subsequent treatment included preliminary aeration, contact with activated mud in two tanks with a settling tank between them, and further activated mud treatment followed by final settling and extraction of treated water. Preliminary anaerobic treatment reduced the BOD_5 by 60-80%, while the other stages reduced the initial BOD_5 by up to 99·5%. Temperatures and retention times for the various stages are indicated. Total treatment time was 4 days.

Effect of pulp press water recycling on mass transfer in tower diffusers. A. I. Fel'dman, A. A. Lipets, O. V. Stratienko and V. M. Lysyanskii. *Izv. Vuzov, Pishch. Tekh.*, 1977, (3), 102-105 (*Russian*).—Investigations were made into the effect of press water recirculation on diffusion kinetics in a Soviet KDA and a Buckau-Wolf diffuser. Feeding of press water into the diffuser at a point removed from the fresh water intake was found to have considerable effect on the hydrodynamics, as reflected by disruption of the counter-current nature of the process at the press water intake, where no sugar was extracted in a number of tests, and co-current conditions were observed on occasions, particularly when the diffuser throughput was slightly above the rated. Increase in the mass transfer rate in the next zone was attributed to increase in the free surface available for transfer as a consequence of loosening of the cossettes by fresh water extractant fed into the tail part of the diffuser. Hence, it is better (as regards sugar loss minimization) to feed press water and fresh water together at the same point.

The highly advanced KDP 2500 continuous diffuser. M. Sterzinger. *Czechoslovak Heavy Ind.*, 1977, (10), 8-15. Details are given of the Czechoslovakian KDP 2500 beet diffuser, which takes the form of a 4° sloping rotary trough of 24 m effective length which carries fixed paddles some of which also act as heating elements. A conveyor system comprising L-shaped blades fixed to a central shaft rotates within the system of fixed wall paddles with such a small distance between the edges of the two types of blades as to eliminate backward flow of the cossettes. Trials at Šurany sugar factory showed losses of 0·238% on beet at a throughput of 1923 tonnes of beet per day (compared with a rating of 2500 tonnes.day^{-1}) and a juice draft of 112·7%. Steam consumption was lower than in the older KDP 1500 model, while cossette heating was more uniform, the temperature being maintained at an optimum level throughout the trough.

Thermodynamic practice in the sugar factory. –. Poiré. *Sucr. Franç.*, 1977, **118**, 289-297, 321-328 (*French*). The author shows how knowledge of the use of the Mollier diagram and certain ratios relating to energy transformation is all that is needed to calculate optimum conditions of steam fed via a turbine to the evaporator at lowest fuel consumption and minimum pressure loss. Hypothetical cases are described with the intention of indicating the various possible ways in which more effective use can be made of available steam in a sugar factory.

The development of the sugar industry in the USSR. P. P. Borschtschewski. *Die Lebensmittelind.*, 1977, **24**, 437-439 (*German*).—A survey is presented of the development of the Soviet sugar industry with mention of future plans and prospects.

Spray cementing of lime kilns in the sugar industry. Z. Kowalski, Z. Domagalski, H. Król and J. Dyda. *Gaz. Cukr.*, 1977, **85**, 227-230 (*Polish*).—The spray cementing of lime kiln walls is described and details are given of the various commercial preparations available.

The dynamics of "Faltan" residues. I. Residue from practical application to stored sugar beet. V. Černá and V. Beneš. *Listy Cukr.*, 1977, **93**, 229-233 (*Czech*). "Faltan" is a fungicide in which the active ingredient is N-(trichloromethylthio)phthalamide. As a 50% wettable powder, "Orthophaltan 50" has reduced sugar losses in stored beet by inhibiting the metabolic processes, maintaining the beets in a healthy condition up to processing. Details are given of thin-layer and gas-liquid chromatographic investigations to determine residues of the fungicide in beet, cossettes and pulp, flume and wash water, raw juice, molasses and effluent after treatment of beet with 8 g a.i. per m^3 before 40-45 days' storage. Results indicated 0·006-0·051 ppm on beet

surface, 0·05–0·1 ppm in some cases below the surface, 0·013–0·05 ppm in cossettes, and 0·025–0·05 ppm in some effluent samples. No traces could be found in pulp, molasses or raw juice.

The use of process computers for control of the boiling process. P. W. van der Poel, C. C. Bleyenberg and N. H. M. de Visser. *Zucker*, 1977, **30**, 590–594 (*German*).—After a brief survey of automatic boiling systems in use in various factories and countries, the authors describe the automatic system introduced at the Breda factory of Centrale Suiker Mij. in Holland, which is based on massecuite viscosity and permits operation of seven pans simultaneously while requiring only two supervisors (although provision is also made for short-period manual control). The real time system used includes a Siemens 310 computer with "Simat C" software using "Fortran C" language. The system was first used in 1976 to control low-grade boiling and was to be extended to all pans in 1978. Each pan has five control circuits: viscosity, consistency, level, condenser water temperature and vacuum. The programme for the actual boiling process is divided into four parts: the stage from initial syrup feeding to concentration to the required supersaturation, seeding and grain formation, maintenance of crystal growth, and final Brixing-up and discharge. Three "Fortran" programmes are used: for the consistency target value, for reduction of water addition (for intermediate and low-grade products only) and for recording of syrup charging. While low-grade boiling has been satisfactory, control of massecuite consistency by means of the juice or water feed valves has been possible only within very narrow limits, and further investigations of this are considered necessary. Possible sources of difficulty are the point at which the viscosity/consistency indicator is located in the pan, irregularity in massecuite circulation (creating dead spaces), the acceptance of syrup or water drinks by the massecuite, and vacuum fluctuations. The improvements introduced into a computer control system by use of micro-processors are briefly examined, and the advantages for boiling control indicated.

New ion exchange systems for the beet sugar industry. II. Increased extraction through total cation exchange. A. C. Gupta and K. W. R. Schoenrock. *Zucker*, 1977, **30**, 607–611 (*German*).—See *I.S.J.*, 1977, **79**, 83.

Enamel now also used in sugar industry plant. J. Vollmann and R. Neidhart. *Zucker*, 1977, **30**, 620–621 (*German*).—Enamel is one of the hardest surface coatings known; moreover, because of its high oxide content, it cannot be oxidized further, so that it is highly suitable as a coating for steel pipelines and pipeline components such as valves. In a north German sugar factory, tests over two campaigns revealed no measurable abrasion of enamelled pipe walls, whereas un-enamelled pipes used for the same purpose had earlier failed to last even one campaign. Enamel has the further advantage of being hygienic and heat-resistant.

Experience in processing beet of low technological quality. Yu. I. Molotilin. *Sakhar. Prom.*, 1977, (11), 48–50 (*Russian*).—At the author's factory the 1976/77 campaign was prolonged to 154 days and was characterized by sharp fluctuations in beet quality; while beets entering the factory in September-October were of high quality and gave juices and syrups of high purity and low colour content, those received towards the end of the campaign were frosted and practically unsuitable for processing without application of emergency measures. These included addition to prelimed juice of 0·005% on beet of a 1% polyacrylamide flocculant (activated with caustic soda or sodium triphosphate), whereby the settling rate increased by 200–300%. The lime salts content was reduced and juice thermostability maintained by addition of 0·15–0·20% (on juice) CaO as milk-of-lime in the 2nd carbonatation vessel, the clear juice then being treated with 4–5 ppm sodium triphosphate, perlite also being added if there was marked deterioration in check filtration of the juice. Intensive sulphitation to 0·003–0·035% free sulphite before evaporation and subsequent "inter-effect" sulphitation of evaporation juice with remelt liquor to 0·025–0·03% ensured a white sugar colour no greater than 0·8° St even where evaporator syrup had a colour content of 65–80° St. Normal boiling house working was achieved by addition of 0·8–1·0 ppm surfactant to *A*- and *B*-massecuite (where a high lime salts content had raised the viscosity). The yellow sugar of 15–25°St colour content obtained from *B*-massecuite did not require affination.

Features of harvesting, storage and processing of low-quality beet. N. M. Palamar', I. M. Rudenko and V. I. Radalovskii. *Sakhar. Prom.*, 1977, (11), 50–52 (*Russian*).—In 1976, beet drilling in the area of Mironovka sugar factory (in the Ukraine) was late; this fact, coupled with the favourable weather conditions at the end of the beet growth period (with root development being at the rate of 5–7 g per day), led to reluctance to harvest the beet in accordance with the dates laid down in official instructions. As a result, the dirt tare was high at 15·5% and the late-harvested beet became frosted, resulting in poor storage and processing properties. Particular difficulty arose in slicing and as a result of bacterial slime. Emergency measures adopted to solve the problems included use of beet knives having a flat cutting edge, increase in formalin addition in diffusion, increase in the volume of 1st carbonatation juice recycled to preliming, raising of the lime consumption, use of kieselguhr as precoat for 2nd carbonatation juice filtration, addition of lime in 2nd carbonatation, and addition of surfactant to massecuite in boiling.

Increasing the reliability of multi-relay schemes for electric drive control in sugar factories. N. V. Pokrovskii and M. V. Babkov. *Sakhar. Prom.*, 1977, (11), 57–59 (*Russian*).—Conventional control schemes involving contactors and relays, as used in the Soviet Union in beet feeding to process, pulp removal and massecuite curing in centrifugals, are too cumbersome, unreliable and difficult to service. Instead, integral logical micro-systems are considered preferable for electric motor control. A system for pulp removal is described with the aid of block diagrams and the sequence of operations indicated.

The microbiology of beet sugar manufacture. Practical aspects of factory control and measures against micro-organisms. F. Hollaus. *Zeitsch. Zuckerind.*, 1977, **102**, 722–726 (*German*).—See *I.S.J.*, 1978, **80**, 84.

SUGAR REFINING

Problem of colouring matter in refined sugar loaf manufacture. G. K. Shukla. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), G.43-G.50 (+ figs.). Details are given of the loaf sugar manufacturing process used at Ahwaz refinery in Iran. Excessive raw sugar colouring matter (as well as pol loss) was attributed to 10 months' storage of the sugar in bags in the open air at temperatures (in May-August) in the range 46-54°C. Affination of the raw sugar melt is followed by 1st, 2nd and 3rd carbonatation and subsequent active carbon treatment; triple filtration yields a refined melt of 0·4-1·0°St colour. For high-quality loaf production, 3rd carbonatation is best carried out at 87°C to pH 7·0-7·2.

Stainless steel in refineries and sugar factories. E. Hale. *Ind. Alimentari*, 1977, **16**, 122-125 (*Italian*).—See *I.S.J.*, 1978, **80**, 245.

A study on utilization of reverse osmosis in sugar refineries. K. Sasaki, E. Sugita and T. Naito. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1977, **27**, 36-41 (*Japanese*).—Experiments are reported in which a ROGA 4100 reverse osmosis module of 6 m^2 filtering area and a capacity of 100 litres.hr^{-1} was used to concentrate sweet water. A maximum final concentration of approx. 30°Bx was attained, although 10-20°Bx was the most economical range. Sugar rejection was 99·8% in the Brix range 3-20°. For reverse osmosis application in a sugar refinery, a study should be made of membrane thermal stability, sterilization and life.

Some properties of "Synthad". A. Kodaka. *Proc. Research Soc. Japanese Sugar Refineries' Tech.*, 1977, **27**, 42-48 (*Japanese*).—Laboratory tests were conducted with "Synthad" (synthetic adsorbent containing 55-60% calcium phosphate) to see if it could replace bone char in the treatment of refinery liquor. Comparison of the composition and properties of "Synthad" with those of fresh and revivified bone char showed that "Synthad" was of higher density than fresh char but lower than revivified char, that it contained more HCl-insoluble matter than did char, and that it had a hardness lower than that of fresh char but higher than revivified char. The decolorization efficiency of "Synthad" was almost the same as that of bone char in the case of dark coloured liquor, but was inferior to that of char with light coloured liquor such as liquor once treated with char. "Synthad" removed less CaO than did bone char.

On the pneumatic transporting system of bulk sugar. H. Kitamura and Y. Aizawa. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1977, **27**, 53-57 (*Japanese*). The pneumatic conveying of sugar at the authors' refinery is described. Based on trials conducted before 1975, the system covers 45 m and transfers sugar at a speed of 3 $m.sec^{-1}$ and an hourly rate of 2·8 tonnes. No abrasion or breakage of the crystals occurs during conveying, the grain size distribution after conveying being almost the same as before.

Density control of refined liquor for double-effect evaporation. T. Akino and T. Tada. *Proc. Research Japan Sugar Refineries' Tech.*, 1977, **27**, 58-63 (*Japanese*). Ion exchange treated liquor is fed to a supply tank whence it passes to a heater and then to the 1st effect of a double-effect evaporator; a heater is installed between the two effects. Brix control of the fine liquor leaving the 2nd effect is based on a required flow rate of heating steam to give a required Brix at a given input flow rate and concentration. Analogue circuits are used with signals sent by DP transmitters to the steam flow control valve. A recirculation circuit provides for recycling of the liquor should the output Brix be below the desired limit. Accurate and stable maintenance of final liquor Brix is possible within widely fluctuating parameter values.

On the treatment of effluent from a sugar refinery. H. Hashimoto and K. Hara. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1977, **27**, 75-94 (*Japanese*). Details are given of preliminary experiments and of the resultant final scheme for effluent treatment and disposal at the new Osaka refinery of Ensuiko Sugar Refining Co. Ltd. Process effluent is fed to an equalizing tank and thence to an activated sludge tank, aeration tank and settling tank; inorganic effluent is sent via an equalizing tank to a neutralizing tank and thence to the public sewerage system together with the effluent from the settling tank. Flocculation tanks are provided for carbonatated liquor filter effluent as well as a thickener for suspended matter treatment, two screw decanters for surplus sludge dewatering and the necessary control and instrumentation means plus a polyelectrolyte feeding system. The plant has been designed for 4-5 hours' aeration and a reduction of BOD_5 from an average of 0·98 $kg.m^{-3}.day^{-1}$ and of COD from an average of 0·82 $kg.m^{-3}.day^{-1}$ to less than 20 ppm (i.e. a 95% efficiency). When the quantity of effluent is abnormally high, the effluent is stored in an equalizing tank, aerated for 1-7 days and treated with activated sludge once the COD has fallen to 700-800 ppm. Under normal refining conditions, effluent treatment is successful.

On the electrolytic treatment of regeneration waste of ion exchange resin. I. Kensho and T. Tomimatsu. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1977, **27**, 95-101 (*Japanese*).—Tests were conducted on colour and COD removal from ion exchanger regeneration effluent with a titanium cathode and an anode of titanium coated with lead dioxide. Laboratory experiments showed that treatment was unaffected by the initial pH of the waste water in the range 4-10 (the final pH after treatment was 7-8). An NaCl concentration greater than 2% was required; colour removal was maximum (approx. 90%) at 8% NaCl, at which a maximum COD removal of nearly 80% was achieved. Separation efficiency was dependent on effluent dilution. The installation of baffle plates between the electrodes had a positive effect on colour removal, while circulation of the effluent did not. Power consumption at 90% colour removal was 35 $kWh.m^{-3}$. COD removal was 25 g per kWh.

LABORATORY STUDIES

Prediction of molasses sugar. Ö. Krieger. *Zucker*, 1977, **30**, 601-606 (*German*).—See *I.S.J.*, 1978, **80**, 121.

Statistical calculation applied to experimentation. L. Condemarin A. *Sugar y Azúcar*, 1977, **72**, (8), 21-24. The author briefly discusses the advantages of statistical evaluation of test results and demonstrates his theme by means of three case histories: tests on a surfactant added to syrup, molasses and low-grade massecuite, determination of the comparative effects of two mill bactericides, and prediction of limits within which the colour of export sugar from a given factory would be expected to fluctuate under conditions of constant cane and juice factors.

Inhibition of acid and neutral invertases in sugar cane juice. V. Santisopasri and E. J. del Rosario. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 177-187.—Filtered cane juice and a partially purified invertase preparation obtained from cane juice were used to determine the inhibitory power of (*a*) sodium metasilicate, (*b*) sodium lauryl sulphate, and (*c*) the commercial detergent "Tide". Complete inhibition of the purified enzyme was obtained with 4 mM (*a*), 20 mM (*b*) and 0·2% (*c*), while complete inhibition of the enzymes in the filtered juice required 12 mM (*a*), 42 mM (*b*) and only 15% inhibition was given by 0·25% (*c*). The acid invertase, the optimum pH of which is 5·3, was more strongly inhibited by (*b*) than the neutral enzyme, while (*a*) and (*c*) produced greater inhibition of the neutral enzyme.

Critical analysis of the International Sugar Council conversion formula. J. M. Binueza. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 188-199.—The formula adopted by the I.S.C. in 1958 for conversion of the quantity Q of raw sugar of one polarization P to the corresponding quantity Q_{96} of raw sugar of 96 polarization is $\frac{Q_{96}}{Q} = \frac{2P - 100}{2(96) - 100}$. The author has considered the change of quantity for a raw sugar by addition of a quantity of molasses of purity P_m and derives an expression for the ratio of the two quantities expressed as $\frac{Q'}{Q} = \frac{2P - 2P_m}{2P' - 2P_m}$. This is of the same form as the I.S.C. formula which is thus considered valid provided the quantity of pure sucrose crystal in a raw sugar remains the same irrespective of the polarization and the molasses film on the crystal is of uniform polarization and 50 purity. These two conditions are not true, however, but while *A*-molasses purity may vary between 45 and 55, this only gives a variation of $\pm 0{\cdot}96\%$ from the quantity calculated at the 50 purity figure. However, the equivalent weight changes by 2% per unit degree change in sugar polarization, indicating the strong influence of the latter. The Net Sucrose Formula, $N = 2P - 100$, has also been investigated and shown to be valid for estimating the amount of pure sucrose crystals in raw sugar of polarization P when the molasses film is of 50 purity.

Micro methods of determining moisture and ash in molasses. R. A. Cruz and T. C. Puyaoan. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 200-204.—The official ICUMSA method for moisture determination in molasses requires 5¾ hr drying while the "Official Methods of Chemical Control for Philippine Cane Sugar Factories" (OMCC) method requires 8 hr. Sulphated and plain ash determinations also take 8 hr for each standard method. Comparative analyses were made by both official methods and micro methods which employ only 0·2 g of molasses and require 2½ hr each for moisture, sulphated ash and plain ash determination. Using 12 samples, moisture averaged 19·94% (between 18·58 and 23·00%) for the OMCC method, 19·78% (between 18·73 and 21·34%) for the ICUMSA method and 20·86% (between 19·31 and 21·97%) for the micro method. Sulphated ash averaged 10·21% (between 10·13 and 10·32%) for the OMCC method, 11·26% (between 11·03 and 11·65%) for the ICUMSA method and 10·15% (between 10·00 and 10·25%) for the micro method. Plain ash averaged 8·52% (between 8·33 and 8·66%) for the OMCC method, 7·79% (between 7·10 and 8·63%) for the ICUMSA method, and 8·70% (between 8·48 and 9·01%) for the micro method.

Experience gained in the field of enzymatic determination of raffinose by means of galactose-dehydrogenase in the beet sugar factory. F. Hollaus, L. Wieninger and W. Braunsteiner. *Sucr. Belge*, 1977, **96**, 411-419 (*French*).—While the method of Schiweck & Büsching[1] has proved better than paper or thin-layer chromatographic methods for raffinose determination, it suffers from two possible sources of error: (1) while raffinose is measured indirectly as galactose, and allowance can be easily made for any free galactose in the sample, it is not possible to identify the component (e.g. raffinose, stachyose, galactinol, etc.) from which galactose is liberated by the α-galactosidase; (2) lead acetate clarification used to separate galactinol also eliminates some of the raffinose. A series of tests was therefore conducted on raffinose and galactose determination in pressed and raw juice and on raffinose determination in thin and thick juice and molasses. Results showed that clarification had a varying effect according to the test product. In the case of raw juice, the percentage of galactose components separated increased with increase in the amount of lead acetate added until separation reached almost constancy. On the other hand, increase in the quantity of acetate added to molasses caused a fall in the "raffinose content" (sum of the α-galactosidic components of the galactose precipitated) until a value was reached which was identical to that of an unclarified solution. Hence, the method is not considered suitable for determination of the absolute raffinose content, although it is of value for determination of raffinose with the aim of correcting the polarization value.

Linear relationship of saturation coefficient to non-sucrose:water ratio in final molasses. V. M. Jesic. *Rpts.* 1976 *Hawaiian Sugar Tech.*, 99-104.—See *I.S.J.*, 1977, **79**, 274-277.

[1] *I.S.J.*, 1970, **72**, 120; 1976, **78**, 28.

BY-PRODUCTS

Kinetics of biodegradation of distillery slops. R. G. Camarungan and T. T. Bantilan. *Proc. 24th Ann. Conv. Philippines Sugar Tech.*, 1976, 218-230.—Examination of distillery waste from Central Azucarera Don Pedro showed that it had an organic matter content of 72 $mg.cm^{-3}$, a BOD_5 value of 39,750 ppm and a calculated total oxygen demand of 42,000 ppm. Thus, 58% of the organic matter is biodegradable and 95% of this would be degraded in five days if the waste were discharged into a watercourse of sufficient oxygen content. However, it would have a severe deoxygenating effect on such a watercourse which would lead to undesirable characteristics, so that such a means of disposal should be avoided.

uction of kojic acid from molasses. P. K. Ag arwal and L. Viswanathan. *Proc. 5th Joint Conv. Indian Sugar Tech. Assocs.*, 1975, (I), G.115-G.119 (+ figs.).—Kojic acid production by culturing *Aspergillus flavus* on various media was investigated. While maximum yield of 34·3 $mg.cm^{-3}$ was obtained on a sucrose-yeast extract medium after 10 days, this was only 17·15% conversion of the available carbohydrate, whereas 39-64% conversion was obtained after 40 days on a medium of unclarified cane sugar factory molasses or khandsari molasses, although the yields were only 14-22 $mg.cm^{-3}$. Potential uses of kojic acid are briefly discussed.

Values and optimum valorization of beet by-products. A. Deswijsen. *Le Betteravier*, 1977, **11**, (113), 7-8, 14, 16 (*French*).—The energy and protein requirements of dairy cows are indicated, and the mineral constituents in beet pulp discussed. While corn silage is of low Ca content, beet pulp has too much, so that it can bring risks (because of milk fever) when fed to a cow in the two weeks preceding calving, especially if combined with lucerne. Pulp is deficient in P, Mn, Cu and Zn, the quantities of which must be made up—insufficient P and Mn adversely affect cattle fertility. The question of molasses addition to pulp is discussed, particularly the possible reduction in N availability and in the feed value of the pulp when there is a disproportion of molasses or where pulp drying has been carried out at too high a temperature. Where the ration contains sufficient bulk but insufficient readily fermentable carbohydrate, addition of ⩾20% molasses is recommended; 1 kg of molasses is equivalent to 0·80-0·87 kg barley. A higher proportion of molasses causes a change in the rumen fermentation processes. Even a small quantity of molasses has been found to stimulate bacterial synthesis of N, a fact which should be remembered when considering the addition of urea or ammonia to pulp. Possible rations containing molasses are discussed. The factors to consider in making beet leaf silage (with or without crowns) are examined, and possible ways in which pulp of varying dry solids content can be incorporated in rations are described. Evaluation of pulp quality using the swelling test and the lysine test is of significance only when directly linked with the animal's utilization of the fodder.

Ensilage of pulp, leaves and crowns. M. Martens and R. Vanstallen. *Le Betteravier*, 1977, **11**, (113), 10-11 (*French*).—Recommendations are given on ensilage of beet pulp, leaves and crowns for feeding to beef cattle. Pre-pressing of the pulp is recommended so as to increase the dry solids and prevent losses through liquid seepage, although it is stressed that dried pulp will not stack of its own accord but must be piled in silos. The fertilizer value of beet leaves incorporated in the soil is also briefly mentioned. Beet harvested from 1 ha will yield 25 tonnes of leaves containing a total of 115 kg N, 30 kg assimilable P, 220 kg assimilable K and 900 kg assimilable humus plus trace elements.

Hard pressing of carbonatation mud. R. F. Madsen. *Zeitsch. Zuckerind.*, 1977, **102**, 643-645 (*German*).—Details are given of a patented press developed by De Danske Sukkerfabrikker to increase the dry solids content of carbonatation mud to 69-72% for use as a granular fertilizer. The press comprises 8 discs, 60 cm in diameter and covered on each side with filter cloth. The discs rotate intermittently about a central horizontal axis which passes through an angle of 45° at each stroke (which lasts about 15 sec), so that each disc moves to the position previously occupied by the disc in front. The arc described by the three lowest discs passes through a mud trough, so that at any one time mud (of about 45% dry solids) is drawn onto the filter cloth by vacuum. At the two disc positions after the trough, the cake is dewatered under vacuum, and in the top position (at right angles to the horizontal) it is pressed by two hydraulic cylinders; each of these carries at its end a plunger and filter cloth, so that moisture can be extracted from the cake by suction during pressing. In the next position the cake is still subjected to vacuum, while, in the last position before the mud trough, the cake is removed by compressed air. The extracted liquid is used for lime slaking. Before entering the trough, the mud is first subjected to thorough stirring in an agitation vessel, to which any excess from the press is returned. The press reduces mud sugar to 50-60% of that occurring in rotary filter cake. While the power rating is 30 kW, energy consumption is rather low, since the load on the press varies, and maximum applied pressure is not normally used. Mud of 70% dry solids can be stored in 2 m high piles in the open for 5-6 months without changing its consistency. A typical carbonatation mud solids analysis from Nakskov is given; at this factory, a prototype press of 1·6 m^2 total filter area operated in 1976 to give 28 $tonnes.day^{-1}$ of mud of 70-71% dry solids. Six presses were to be installed there for the 1977/78 campaign.

Beet pulp pressing. A. H. Bausier and A. Ö. Utvik. *Sucr. Belge*, 1977, **96**, 371-384 (*French*).—While pulp intended for ensilage need not have a dry solids content greater than 20%, pulp to be dried with high-temperature gas should have a dry solids content of at least 23%. Preliminary tests were conducted with presses primarily designed for fruit juice extraction; three types of pulp were pressed, the initial dry solids contents being 9·4%, 15·4% and 21·8%, while the temperatures were 50°, 38° and 48°C and the pressures applied were in the range 0-30 bar. Results showed that after 8-10 minutes the dry

solids contents were almost the same, indicating the importance of the time factor. Subsequent tests were conducted during three campaigns at Brugelette and Tirlemont, using three different types of Stord presses. The pulp was pressed to a dry solids content generally in the range 23–27%. Results showed that pulp pressability was governed by the characteristics of the cell tissue (and hence by beet variety, climatic conditions during beet growth and beet maturity), by pulp pH and by use in diffusion of additives such as $CaCl_2$ which form pectates having a rigid structure (of benefit in diffusion as well as pulp pressing). The time required to obtain the required dry solids was dependent on type of press and speed of rotation, while the maximum practical temperature (preferably 70–75°C) was dependent on the temperature of the exhausted cossettes leaving the diffuser, the aim being to minimize heat losses between the diffuser and press. The pressure applied to the pulp depended on the method used to feed the press, best results being obtained with a vertical chute at least 3 m high, widened at its base and having a smooth lining; feeding should be continuous, and no water added (not even hot water) where a chute of this type is used, since pressing will be adversely affected. While a press water pH below 6 favours diffusion, it is stressed that the pH used will depend on local conditions, excellent results having been obtained in the tests at pH 6·1–6·4; however, in general, a pH of 5·1–5·2 improves performance, although it may give rise to dangers of diffuser corrosion. Addition of 150 g $CaCl_2$ per tonne of beet is recommended in diffusion. It was found that for each unit % dry solids obtained in the range 22–26%, an extra 70–100 g of sugar was recovered per tonne of beet. Power consumption varied, according to beet pressability, in the range 1–1·7 kWh per tonne of beet; nevertheless, although larger presses are needed where the requirement is for prolonged pressing or greater pressure, this does not necessarily mean that power consumption will be increased.

Ethanol production from sugar cane tops. R. Samaniego and C. S. Abrigo. *Crystallizer,* 1977, **2,** (3), 13, 16. While ethanol production from cane tops is not commercially viable, it could become so were the price of crude oil to become prohibitive. Investigations are reported in which sun-dried cane tops were first treated with various concentrations of sulphuric acid. Optimum was 2·5% H_2SO_4, which hydrolysed 44·64% of the fibre (17·9 g in 20 g cane tops) and yielded a hydrolysate containing 1·7% reducing sugars. Subsequent fermentation and distillation yielded, however, only 7·32 cm^3 (5·78 g) ethanol from 89·5 g fibre (100 g cane tops), which was only about 50% of the theoretical yield.

Indigenous materials for paper packing: sugar cane bagasse (soda pulp). J. V. Zerrudo. *Crystallizer,* 1977, **2,** (3), 13, 16.—Partially depithed bagasse was pulped by treatment with NaOH at a charge in the range 12–20%. Best results were obtained with 16% NaOH at 4:1 liquor:bagasse ratio, 60 minutes impregnation time (gradual rise to maximum temperature) and 30 minutes cooking time at 160°C. All the pulps were bleachable and had strength characteristics comparable to those of commercial bagasse pulp, being suitable for production of packing paper. Screened yield increased and the permanganate number (degree of cooking) fell with increase in the impregnation time. Use of the lower cooking temperature and shorter cooking time permits considerable energy savings by comparison with the method normally used.

Removal of colouring matter from molasses solutions. V. N. Shvets, E. I. Knogotkova and L. N. Pavlyuchenko. *Izv. Vuzov, Pishch. Tekh.,* 1977, (4), 31–35 (*Russian*).—Molasses samples received by various distilleries were subjected, after dilution, to decolorization by different means. The results of the tests showed that neither AGS-4 granular carbon nor D.C. electrocoagulation in a laboratory unit was sufficiently effective at a molasses dry solids content in the range 25–50%, whereas treatment with AV-16 GS anion exchange resin in mixed OH^- and Cl^- form was adequate, approximately halving the concentration of melanoidins and thermal degradation products. Reduction in pH and dry solids of the molasses solutions increased decolorization efficiency. Treatment had no effect on the concentration of invert sugar or K, Na and Ca salts. Regeneration of the resin with HCl had a more positive effect on decolorization (while removing almost all Ca, Mg and Fe hydroxides) than did regeneration with NaOH.

Calculation of pressed pulp, press water and dried pulp yield. I. P. Lepeshkin. *Sakhar. Prom.,* 1977, (11), 60–62 (*Russian*).—Formulae are presented for calculation of the title yields as a percentage of beet and fresh pulp by weight at a fresh pulp dry solids content of 6·5% and a fresh pulp yield of 83% on beet. Tabulated values are given of the yields of pulp and water after pressing to a dry solids content in the range 7·0–25·0% at unit intervals. The formulae allow for the effect of press water recycling to diffusion. Worked examples are presented.

The use of fibrous sugar cane by-products by ruminants. III. Effect of the NaOH level on the *in vitro* total VFA production of bagasse and bagasse pith. P. C. Martín, A. Cabello and A. Elías. *Cuban J. Agric. Sci.,* 1977, **11,** 167–174.—Investigations are reported on the effect of NaOH treatment of bagasse and bagasse pith (to increase its digestibility) on the total *in vitro* volatile fatty acids (VFA) production in samples inoculated with a mixture of rumen liquid and artificial saliva. Results showed that VFA production increased with rise in the NaOH level and that it was greater with bagasse than with bagasse pith.

Torula yeast developed in final molasses and dried for broiler fattening. II. Inclusion levels in fast growing broilers. M. Valdivié, A. Elías, H. Jordán and E. Aragón. *Cuban J. Agric. Sci.,* 1977, **11,** 181–189.—Diets containing 5, 15, 20, 25 or 30% torula yeast obtained from final molasses were fed to 21-day-old chicks. During a 5-week period, feed consumption fell with 20% or more yeast; in the case of the male chicks, live weights and gains also tended to fall with increase in the yeast content, whereas this effect was noticeable only at 30% yeast in the case of the females. Since the diet containing 5% yeast contained also 5% fish meal in contrast to only 3% in the other diets, the higher live weights and gains with the minimum yeast may be attributable to the higher amino-acid content associated with the fish meal.

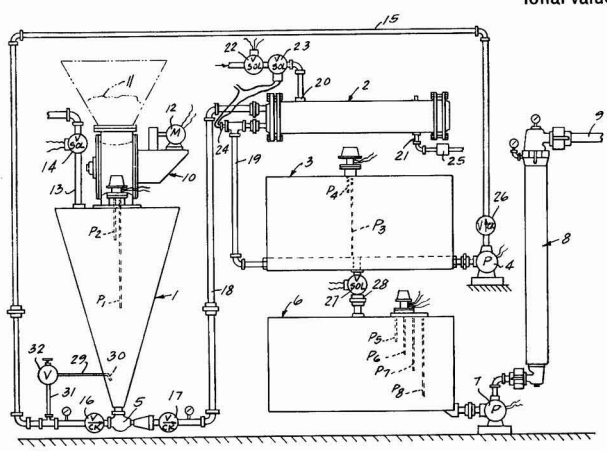
PATENTS

UNITED STATES

Beet seed sowing machine. E. A. H. Ribouleau, of Largeasse, France. **3,901,169.** 22nd January 1974; 26th August 1975.

Sugar syrup production. D. R. White, of Western Springs, IL, USA. **3,901,724.** 8th March 1973; 26th August 1975.

Dry sugar is admitted from a hopper 11 through a rotary valve 10 driven by motor 12 and falls into mixing chamber 1. A precisely corresponding amount of water is supplied to chamber 1 through inlet pipe 13 under the control of a solenoid valve 14. The mixture is withdrawn through eductor 5 under the action of circulating pump



4 and passed through pipe 18 to a heater 2 until all the sugar is dissolved. Syrup required for process is withdrawn from tank 3 by pipe 28 and enters supply tank 6 from which it is delivered by pump 7 to filter 8 and thence through pipe 9 to process. As the level in chamber 1 falls, its minimum level is detected by probe P_1 and sugar and water admitted until the upper limit is detected by probe P_2. Similar probes P_3, P_4, P_5, P_6, P_7 and P_8 control the levels in tanks 3 and 6. The bottom of chamber 1 may be flushed by a supply of syrup from pipe 15 sent through a by-pass 31 and valve 32 to a pressure pipe 29 with a jet end 30. Suitable controls are provided for the steam supply to heater 2 to ensure the required temperature is maintained but that the syrup is not over-heated.

Animal fodder. H. H. Roth, F. L. Saunders and H. Small, *assrs.* Dow Chemical Co., of Midland, MI, U.S.A. **3,901,976.** 2nd April 1973; 26th August 1975.—A thixotropic liquid animal feed supplement comprises water and molasses or a solution of starch, dextrin, pectin, or sugar (an edible sugar solution), containing at least 0·5% of a soluble acid or at least 0·01% of a polyvalent cation (Ca^{++}) and from 0·5 to 5·0% of a dispersant-treated clay such as bentonite, attapulgite or sepiolite, the dispersant (Na, K or NH_4 tripolyphosphate, pyrophosphate or polyphosphate or a Na salt of polymeric carboxylic acids) being used to the extent of 1-20% on weight of clay. Also may be included insoluble minerals, edible water-insoluble fats and oils, and/or a non-protein nitrogen source (urea or biuret).

Animal fodder containing bagasse, protein and yeast. Y. Kimura, of Naha, Okinawa, Japan. **3,903,307.** 23rd August 1972; 2nd September 1975.—Bagasse is mixed and fermented (aerobically, in a multiple-stage system) with a yeast-like micro-organism (*Candida utilis* or *C. utilis* var *major*) and with *Trichoderma viride*, the former adding protein and the latter decomposing the crude fibre cellulose of the bagasse to dextrose. The fermented product is (treated with powdered chlorella and comfrey to increase the vitamin content and nutritional value, nucleotide liquid added to improve its taste; *C. flaveri, C. guilliermondii, Clostridium acetobutylicum, Eremothecium ashbyii* or *Ashbya gossyppii* added to provide vitamin B_2, *Saccharomyces cerevisiae* added to increase protein content and $CaCO_3$ incorporated and) mixed with a starch source (cane tops or cereals), rolled into a desired shape and dried to give a solid feed.

Increasing the protein content of animal fodder. F. J. Hruby, of Ravenna, OH, U.S.A. **3,904,768.** 8th May 1974; 9th September 1975. Bagasse, beet pulp or citrus pulp is comminuted, sufficient urea, ammonium sulphate, sulphamide or ammonium nitrate (3% on bagasse or pulp) added to increase the protein content after processing, and a batch of the product cooked at above 212°F and above atmospheric pressure for long enough to sterilize the batch. After cooling to 150°F, it is treated with a fermenting agent and fermented until evolution of CO_2 substantially stops, and the batch then dried. Oxygen under pressure may be added during the fermentation or the entire batch may be dried.

Solidified product from high fructose corn syrup. E. F. Glabe, P. W. Anderson, and S. Laftsidis, *assrs.* Food Technology Inc., of Chicago, IL, U.S.A. **3,906,114.** 28th March 1974; 16th September 1975.—High fructose corn syrup is mixed with (honey in a solids ratio of 15:85-85:15 and with) at least partially defatted soya protein (having a protein content of 20-90% w/w and a protein:fat ratio of 1·5-90:1) (to give a soya protein-HFCS ratio of 30:70 w/w).

Copies of specifications of United Kingdom patents can be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price 95p each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).

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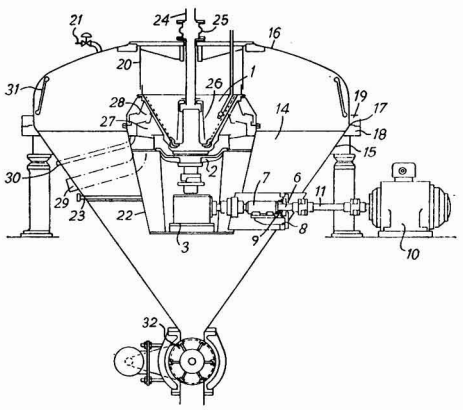
Bagasse board production. B. Simunic, of Dietikon, Switzerland. **1,414,310.** 24th November 1972; 19th November 1975.—Wood or like (bagasse) chips are mixed with water and cement and a moulding is subsequently form formed which is pressed and dried to a finished board. Before moulding, an aqueous copolymer dispersion is embodied in the board by adding it to the mixture in the proportion of 2·5–15%; alternatively the dispersion may be applied (by spraying) to at least one side of the moulding before pressing (at 100–300 $g.m^{-2}$ of copolymer). The dispersion contains a vinyl chloride copolymer containing 5–50% (5–40%) of vinyl chloride, (and 40–80% of a vinyl ester of a C_1–C_{18} carboxylic acid or) (25–40% of) a vinyl ester of a C_1–C_3 carboxylic acid, (25–50% of) an ethylenically unsaturated carboxylic acid ($R_1CH=CR_3COOR_2$, where R_1=H, alkyl or $COOR_2$, R_2 = C_4 — C_8 alkyl and R_3 = H or CH_3) and/or (5–25% of) an alkylene (ethylene).

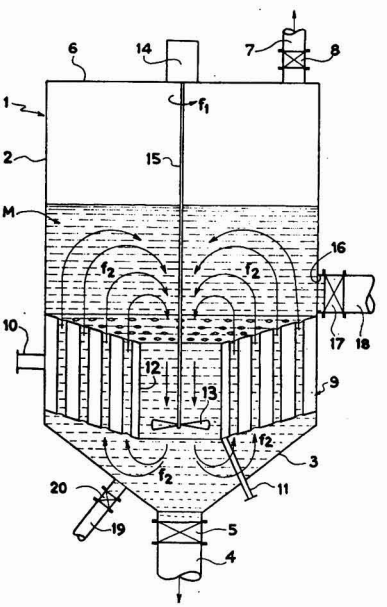
Continuous centrifugal. Fives Lille-Cail, of Paris, France. **1,416,093.** 2nd May 1973; 3rd December 1975. Sugar crystals discharged over the lip of a cone-type continuous centrifugal are slowed during passage through the air before striking the casing and this deceleration helps to reduce crystal damage. The decelerating effect depends on the distance and on the resistance to movement which depends on the mass density of the air. In order to increase the effect, the centrifugal described is closed and provided with air under pressure which thus is of higher mass density.



The motor 10 rotates the basket 1 through the shaft 11 and drive train 6, 7, 3. The basket Is mounted on a mechanism 2 supported by container 22 which is connected by radial ribs 14 to a conical vessel 15 which acts as a hopper and is closed by a cover 16. The vessel 15 and cover 16 have flanges 18, 19 which are closed on a sealing element 17. The interior of container 22 and vessel 15 are connected only through the narrow gap between the top of the container and the basket 1, while a sleeve 20 hangs from cover 16 with a flexible skirt a short distance from the edge of the basket. The small gaps provided ensure that air turbulence caused by rotation of the basket does not affect uniformity of pressure within the system. Massecuite enters the centrifugal through pipe 24 and sleeve 25, passing over distributor 26 to the interior of the basket. Mother liquor and washings collect in annular chambers 27 and 28 and are withdrawn through pipes 29, 30, while sugar crystals are discharged over the lip of basket 1 nto vessel 15 and are deflected by a flexible annular sleeve 31 to collect in the bottom of the vessel from which they are removed through the rotary air-lock 32.

Boiling. Union Nationale des Cooperatives Agricoles de Transformation de la Betterave, of Paris, France. **1,418,816.** 29th October 1973; 24th December 1975.

Boiling is carried out in the vacuum pan 1 comprising a lateral wall 2 with a conical bottom 3, central discharge 4 and valve 5, cover 6 and conduit 7 and valve 8 leading to a source of vacuum. Steam is admitted through pipe 10 to the calandria 9 with condensate discharge through pipe 11. In the downtake 12 is a mechanical stirrer 13 driven by motor 14 through shaft 15 to aid circulation of massecuite. A lateral conduit 18 and valve 17 are located at an orifice 16 above the calandria for partial discharge of the contents, while feed to the pan is admitted through pipe 19 and valve 20.



A relatively pure liquor is admitted to the pan and the massecuite M subsequently built up on a medium purity liquor. When the pan is full the steam is shut off, the vacuum broken and the stirrer operation continued while valve 17 is opened and the upper contents of the pan discharged to a reserve vessel or mixer or to a cooling unit, etc. A lower purity liquor may now be added through pipe 19 and boiling continued with enlargement of the crystals in the massecuite. After the required consecutive boilings at decreasing purity the pan is emptied through pipe 4 by opening valve 5. Use of the pan and circulator permits development of larger crystals and a higher crystal yield than in a conventional boiling system and the time for two batches in the same pan is scarcely longer than for the second in separate pans.

TRADE NOTICES

PUBLICATIONS RECEIVED

Weighers. Richard Simon & Sons, Weigher Division, Park Lane, Basford, Nottingham, England NG6 0DT.

New leaflets available from Richard Simon & Sons describe a belt weigher specially designed to provide a reliable and accurate measurement of the totalized quantity of material which has passed over a conveyor belt, and the Model 5780 digital weight display.

Material handling and vibrating equipment. Rexnord Inc., Material Handling Division, Lebanon Rd., Danville, KY 40422, USA.

A new 24-page brochure is available from Rexnord Inc. which describes their complete material handling and vibrating equipment capabilities; 100 colour photographs survey 54 key applications in a wide range of industries, while descriptions are given of all types of Mathews unit conveyors and Carrier vibrating equipment. The brochure also lists Rexnord's other divisions and products.

Solids handling. Simon-Solitec, Bristol Rd., Gloucester, England GL2 6BY.

A gatefold brochure from Simon-Solitec, a member of the Simon Engineering Group, outlines machinery, plant systems and components for bulk handling and processing of particulate solids, covering bin discharge means, intermediate bulk containers, screw conveyors, bucket elevators, metering feeders, bag opening equipment, fluidized bed dryers, centrifugal dryers, mixers and screens.

Positive-displacement rotary pumps. Challenge Manufacturing Co. Inc., 1308 67th St., Oakland CA 94608, USA.

An 8-page brochure describes the "Granco" positive-displacement rotary pump series which operates on the principle of the universal joint, whereby a rotor, pivoted in a spherical housing, provides positive expulsion of fluid from the pump chamber directly into the line of flow. There are no gears, blades, scoops, valves, springs and wheels to cause trouble, and the pump gives a gentle squeezing action, thus minimizing fluid shear or agitation. Displacement per input shaft revolution is determined by the angle of the stub shaft at the rear of the pump and is maximum at 300 gal.min^{-1} (with a 30° angle). Among products which the pump can handle are molasses and syrups.

Škoda cane mills. Technoexport Czechoslovakia, Praha 2, 56 Václavské nám., Czechoslovakia.

Featured on pp. 39–47 of Issue No. 2, 1978, of *Skoda Review* is an illustrated article by Černy & Heis which describes Škoda cane mills, available in capacities ranging from 100 to 8000 t.c.d. Gearing and intermediate conveyors are also described. It is stated that Škoda have been manufacturing sugar factory equipment for over 100 years.

Bagging weigher and a feed system for continuous mixing. Howe Richardson Scale Co. Ltd., Arnside Rd., Bestwood Estate, Nottingham, England NG5 5HD.

Two new leaflets from Howe Richardson Scale Co. Ltd. describe the ECB 51 load cell nett bagging weigher (specifically designed to provide fast, accurate nett weighing for high-speed bagging lines) and the loss-in-weight feed system for continuous mixing. The accuracies of both of these electronically-controlled systems are very high.

Cleaning in place. The A.P.V. Co. Ltd., P.O. Box 4, Manor Royal, Crawley, Sussex, England RH10 2QB.

Cleaning in place (CIP) is a technique whereby process equipment can be cleaned by water and chemical solutions fed through a fixed system of piping under control from a central location. Tanks, heat exchangers, valves, filters, pumps, probes and dosing units as well as special spray devices are available for APV "Paraclean" systems, which are either available as standard packages or can be designed to customer specifications. APV are able to provide "Parachem" chemicals for use in their CIP systems. Full details of the modular systems are given in Publication A483, available from the above address.

Centralized lubrication.—Denco Farval have obtained an order for the supply of centralized lubrication equipment to a sugar factory in the Caribbean. Worth £500,000, the order covers more than 100 central pumping units complete with time clock control, 2500 grease dispensing valves and 40 miles of steel and copper piping.

RT4 beet diffuser order from Rumania.—Soc. Fives-Cail Babcock have obtained an order from the Rumanian organization, Uzinexport Import, for the supply of a RT4 diffuser having a daily capacity of 4–5000 tonnes of beet. Soc. Sucrière d'Etudes et de Conseils of Tirlemont have granted the Rumanians a licence for construction, sale and operation of RT4 diffusers of the same dimensions, while Soc. Fives-Cail Babcock have sold Uzinexport Import the set of plans necessary for construction of the equipment. The total value of the three contracts is of the order of 100 million Belgian francs.

Surfactant licence for Peru.—Talres Development B.V., of Amsterdam, has granted a licence to Surfactantes Peruanos S.A., of Lima, for the manufacture of sucrose surfactants using a process patented by Talres Development Ltd., a Tate & Lyle subsidiary. Talres Development will also offer a technical assistance agreement covering the provision of formulations designed especially for the Peruvian market, the training of Peruvian personnel and marketing assistance. The Peruvians will also be allowed to use the "Tal" trade mark, and have appointed Chemical Engineering Development Ltd., of Windsor, England, to design and construct the plant for "Tal" surfactant production in Lima. Until the plant is in operation at an initial capacity of 2000 tonnes a year, the Peruvian market will be served by imported surfactant from Talres Development Ltd. in England. This is the second overseas licence granted by Talres this year, the first being to Mitsui Toatsu Chemical Co., of Tokyo.

Sugar handling orders for UK company.—British Ropeway Engineering Co. Ltd. have received an order worth about £310,000 from Tate & Lyle Engineering Ltd. for the design and supply of plant to handle raw and refined sugar at the refinery under construction alongside an existing raw sugar factory at Bukidnon in the Philippines. For raw sugar handling, British Ropeway will supply a truck intake hopper, feeder and conveyors, all rated at 80 tonnes.hr^{-1}, to feed existing store conveyors which are to be modified to cater for an increased capacity of 100 tonnes.hr^{-1}; the sugar will be from the existing sugar factory plus that brought in by truck from other factories in the area. A pneumatically-operated plough will be installed on the existing store conveyor to divert the raw sugar at a rate of 30 tonnes.hr^{-1} to the conveyors and elevator feeding the raw sugar hopper in the refinery, the balance of the sugar passing to store for reclaiming via an existing system when required during the inter-season period. In the refinery, conveyors and elevators will transfer refined sugar from the dryer, at 30 tonnes.hr^{-1}, to four 50-tonne blending bins and the weigher supply hopper, which, together with the support structures, are included in the British Ropeway contract. A flat belt conveyor with hand-propelled tripper and side discharge will convey 50-kg bags of sugar from the bagging machines to store. British Ropeways have recently also won contracts to supply sugar and bagasse handling systems for factories built by Tate & Lyle in Zambia, Trinidad and Venezuela.

Cube sugar system agreement.—An agreement has recently been signed between Svenska Sockerfabriks AB (SSA, the Swedish Sugar Corporation) and Sandvik Conveyor Division for the manufacture, sale and after-sales service of the cube sugar system developed by SSA. Sandvik Conveyor produce a steel belt dryer, and drying is an important part of the SSA cube sugar system.

Brazil sugar statistics[1]

	1977	1976	1975
	tonnes, raw value		
Initial stocks	2,683,343	1,790,493	2,211,375
Production	8,758,970	7,236,245	6,298,594
	11,442,313	9,026,738	8,509,969
Exports	2,486,587	1,252,389	1,729,598
Consumption	5,060,280	5,091,006	4,989,878
Final stocks	3,895,446	2,683,343	1,790,493
Exports			
Afghanistan	—	—	13,439
Algeria	200,742	225,817	172,786
Belgium/Luxembourg	—	—	11,243
Chile	10,826	—	38,874
China	163,967	—	71,942
Egypt	130,793	125,477	2,131
Finland	35,742	46,133	11,735
France	62,925	89,443	73,075
Germany, West	—	—	5,361
Ghana	21,652	9,562	5,314
Indonesia	145,311	—	—
Iran	64,307	9,724	38,602
Iraq	352,294	153,204	277,225
Israel	—	—	36,328
Italy	—	—	30,815
Ivory Coast	—	—	7,177
Japan	79,085	210,087	346,594
Jordan	10,284	23,818	—
Kenya	6,344	—	—
Kuwait	—	2,923	18,216
Lebanon	—	—	9,548
Malaysia	13,407	—	—
Morocco	22,826	13,650	12,802
Nigeria	15,969	—	—
Pakistan	—	—	11,181
Paraguay	—	8,406	—
Portugal	120,815	13,200	40,066
Qatar	5,684	—	—
Rumania	59,160	—	—
Saudi Arabia	—	—	11,774
Senegal	11,150	6,300	7,789
Somalia	11,777	—	—
Spain	—	—	23,384
Sri Lanka	22,711	—	—
Sudan	41,324	—	—
Sweden	11,000	—	—
Syria	23,276	36,249	61,048
Tunisia	28,886	21,428	11,952
United Kingdom	54,259	101,000	100,475
USA	679,841	—	154,673
USSR	24,359	—	95,494
Venezuela	41,065	60,088	—
Yemen, North	11,909	—	—
Yemen, South	—	5,954	5,867
Yugoslavia	—	75,782	15,677
Zaire	—	10,904	—
Other countries	2,897	3,240	7,011
	2,486,587	1,252,389	1,729,598

Cane smut in Florida[2].—It has been reported that on 29th June 1978 the first outbreak of smut, a fungal disease affecting sugar cane, was discovered in Florida. Severe damage is not expected in the current crop year but growers are concerned for the next year because they have no chemical or physical means of curbing the disease. It is estimated that about 60% of Florida's total cane area is planted with smut-resistant varieties. However, precise statistics are not available on the 15,000 acres of seed cane cultivated for next year's crop. The smut fungus originated in Africa and reached the Caribbean in the mid-1970's with a major outbreak in Jamaica in November 1976. It appears that the wind-borne spores have now been carried across to the continental USA.

Italian sugar factory closures.—Difficulties of the Avezzano sugar factory in Italy have led to its closure[3]. Beets from growers formerly supplying the factory will be delivered to the Celano factory in the same Fucino district. The Piacenza factory, of 4500 tonnes. day^{-1} slice, was closed in December 1977[4].

Barbados sugar exports, 1977[5]

	1977	1976	1975
	tonnes, raw value		
Canada	4,718	6,076	4,863
Germany, West	0	206	0
Ireland	41,866	0	0
Leeward & Windward Is.	0	1,837	1,169
New Zealand	0	0	634
UK	22,571	0	52,910
USA	40,279	36,279	24,403
Other countries	149	0	0
Total	109,583	93,233	83,979

European beet area, 1978[6].—The International Association for Sugar Statistics has recently published the results of its inquiry into the beet areas of its member countries in Western Europe, while F. O. Licht GmbH have also presented their latest estimates for the non-member countries of both Western and Eastern Europe. The overall picture is of only a slight change from the previous estimates[7] with a total of 7,876,195 hectares, against 7,798,138 hectares in 1978, an increase of 1%. With such a small difference, the sugar outturn, compared with last campaign, will depend on the weather and crop prospects are average or perhaps slightly below average, so that 1978/79 sugar production can be expected to show a decline on last year.

Fiji sugar production, 1977[8].—A total of 2,674,162 tonnes of cane was crushed at the four Fiji sugar factories during the 1977 season. Because of an excellent cane:sugar ratio (7·38 overall) the amount of sugar produced was 362,375 tonnes, the second highest ever. In the 1976 season, 2,282,877 tonnes of cane had been crushed to yield 295,852 tonnes of sugar. The cane crop, although the third largest ever, fell short of the target of 3,195,320 tonnes but was a great improvement over the levels of 1972–75. Cane and sugar production in the 1978 season are not expected to exceed those of 1977 but the target of 3 million tonnes of cane and 400,000 tonnes of sugar could be a reality in 1980 provided that the weather next year is favourable and allows the planting of sufficient seed cane.

Thailand bulk terminal[9].—According to press reports, Thailand's first bulk sugar terminal, located at Phra Pradaeng, is scheduled to begin operations soon. At present the 160-million Baht (about £4,000,000) terminal is carrying out test runs. It includes a warehouse of 50,000 tonnes storage capacity and can load ships by a conveyor system with a capacity of 400 tons.hr^{-1}. The terminal, owned by the Mitr Phol group, is expected to handle 150,000 tonnes of sugar this year, increasing to 200–300,000 tonnes annually in the next few years.

Réunion sugar factory closure[10].—The smallest sugar factory on the island of Réunion, Sucrerie Stella Matutina in Saint-Leu on the west coast, is to be closed after 106 years of operation.

Indian sugar industry plans.—According to a statement by the Deputy Chairman of the Indian Planning Commission[11], no new sugar factories are to be set up during the Sixth Five-Year Plan period (1978–1982). Increase in demand will be largely left to khandsari units "which employ four times the labour with half the capital per unit of production".

Austrian sugar factory closure[12].—The Dürnkrut sugar factory of Marchfelder Zuckerfabriken Ges.m.b.H was closed after the last campaign.

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[1] *I.S.O. Stat. Bull.*, 1978, **37**, (5), 24.
[2] *World Sugar J.*, 1978, **1**, (2), 27.
[3] *Zuckerind.*, 1978, **103**, 440.
[4] *ibid.*, 610.
[5] *Lamborn*, 1978, **56**, 79.
[6] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (23), 4–5.
[7] *I.S.J.*, 1978, **80**, 226.
[8] *Ann. Rpt. Fiji Sugar Ind. Independent Chmn.*, 1977.
[9] F. O. Licht, *International Sugar Rpt.*, 1978, **110**, (20), 15.
[10] *Zuckerind.*, 1978, **103**, 439.
[11] *Indian Sugar*, 1978, **27**, 795.
[12] *Zuckerind.*, 1978, **103**, 611.

Sudan sugar statistics[1]

	1977	1976	1975
	——tonnes, raw value——		
Initial stocks	59,192	60,792	61,159
Production	150,770	140,000*	139,434
Imports	177,827	143,400	143,766
	387,789	344,192	344,359
Consumption	339,154	285,000*	283,567
Final stocks	48,635	59,192	60,792
Imports	—— tonnes, refined sugar ——		
Argentina	0	9,421	0
Brazil	73,377	0	0
China	10,328	0	10,000
Cuba	0	0	24,140
EEC	5,000	17,413	0
Egypt	3,195	0	0
Greece	2,500	0	0
India	32,050	105,092	65,630
Korea	32,400	0	20,000
Pakistan	0	0	12,495
Portugal	4,750	0	0
Other countries	0	2	0
Total	163,600	131,928	132,265
Total, raw value	177,827	143,400	143,766

* Estimated

Bagasse newsprint plant in Mexico[2].—A newsprint plant using bagasse as raw material is under construction by Mexicana de Papel Periódico, a state-controlled company. It is expected that production will begin later this year at a rate of 100,000 tonnes per year; a further 100,000 tonnes of annual capacity will be installed by 1980. The new plant will cover a large proportion of Mexico's existing newsprint import requirements.

Thailand sugar production 1977/78[3].—The Sugar Institute has reported that sugar factories throughout the country processed 18·61 million tonnes of cane during the 1977/78 season as compared with 26·09 million tonnes for the previous season. The yield was 1,560,000 tonnes of sugar against 2,210,000 tonnes in 1976/77.

Venezuela sugar deficit[4].—According to the Association of Sugar Producers, Venezuela will have to import 300,000 tonnes of sugar this year compared with 200,000 tonnes in both 1976 and 1977. Production in 1977/78 is expected to reach 394,000 tonnes, tel quel, whereas consumption will be nearly 600,000 tonnes. Cane production has been affected adversely in recent years by unfavourable weather conditions while other constraints on sugar manufacture have been lack of adequate labour supply, lack of production incentives and lack of credit for the purchase of new machinery. Under an agreement with the Dominican Republic, signed in 1976 by the Presidents of both countries, the Dominican Republic agreed to cover Venezuela's sugar deficit.

USSR sugar industry expansion.—Further information has been released[5] on the Soviet sugar industry expansion plans under the 10th 5-year plan, for the 1976–80 period. While, as stated earlier[6], it is planned to expand the total beet slicing capacity by 140,000 tonnes.day^{-1} (54,000 tonnes by building new factories and the remaining 86,000 tonnes by expansion and reconstruction of existing ones), already there have been considerable discrepancies between the actual and planned work as a result of shortfalls in capital investment and poor organization of the constructional work. In 1976 alone it was planned to increase the total slice by 21,480 tonnes whereas the actual increase achieved was 14,740 tonnes. It is stated, however, that in the last two years the slice has been raised by 27,650 tonnes at existing factories while another 9000 tonnes.day^{-1} is accounted for by the start-up of two new factories, Chortkovskii factory (of 6000 tonnes daily beet slice) in the Ternopol' region of the Ukraine and Glodyanskii factory (of 3000 tonnes daily slice) in Moldavia. However, work on the three new factories, each of 6000 tonnes daily beet slice, being built this year at Dobrinskii, in the Lipetsk region of the Russian Federation, and at L'vov and Poltava in the Ukraine, has already fallen behind schedule because of a shortage of labour and materials. Similar problems have beset the reconstruction work at a number of factories. One example cited is the reconstruction of Pal'mirskii factory; in 1977 it was planned to allot 3,200,000 roubles for this work, but only 2,300,000 roubles was spent; the position had not improved in 1978. At Gorodeiskii sugar factory in Belorussiya the inefficient use of available funds for re-equipping has resulted in a daily slice of 1800 tonnes of beet (compared with 1500 tonnes when it was first built in 1959), whereas the capacities of individual process stations are very much higher, e.g. a diffuser throughput of 3000 tonnes.day^{-1}.

Trinidad sugar company difficulties[7].—Caroni Ltd., the state-owned sugar company which is responsible for almost the whole of Trinidad sugar production, has lost $TT131 million over the past three years with a loss of $TT51 last year alone. Presenting the Company's annual report for 1977, the Chairman, Mr. Frank Barsotti, made it plain that Caroni would have closed down long ago if it had not been state-owned. The 1978 outlook seems equally gloomy with final production not expected to exceed 155,000 tons, a fall of 41,000 tons below target, against 156,000 tons in 1977 and 206,000 tons in 1976. With present production trends it is likely that a similar situation exists in some of the other sugar producers in the area.

US refinery improvements[8].—Refined Syrups & Sugars Inc. have announced the completion of their new $3,000,000 bulk granulated sugar storage and conditioning silo complex which increases three-fold their granulated storage capacity. Additional major refinery and expansion projects continue under way at an estimated cost of $13,500,000 and are scheduled for completion by the last quarter of 1979.

Brazil sugar development programme results[9].—The $2000 million sugar development programme, initiated by the Instituto do Açúcar e do Alcool (IAA) in 1971, has produced the following results: sugar yield has been raised from 4·3 tonnes.ha^{-1} in the early 1970's to 6·8 tonnes.ha^{-1} in the 1977/78 crop; two marine terminals have been installed, one in Recife, completed in 1972 with a storage capacity of 200,000 tonnes and a loading capacity of 1000 tonnes.hr^{-1}, and the other in Maceió which was due to be opened in April last with similar capacities; about 30 obsolete sugar factories have been closed, with the north-northeast region processing 41·3% of the 1975/76 national crop in 88 factories (against only 29·6% of the 1973/74 crop in 90 factories) and the remainder being processed in the centre-south in about 125 factories. Production of raw sugar has been raised from 5·4 million tonnes in 1970/71 to 7·6 million tonnes in 1976/77 and 8·8 million tonnes in 1977/78.

Hungary sugar imports, 1977[10].—Imports of sugar by Hungary totalled 90,818 tonnes, raw value, against 150,804 tonnes in 1976 and 198,384 tonnes in 1975. Suppliers included Cuba (62,115 tonnes), West Germany (28,164 tonnes) and Poland (539 tonnes). In 1976 the major supplier was Austria (83,400 tonnes) while Cuba provided 55,993 tonnes and Poland 11,411 tonnes.

New Egyptian sugar factory[11].—In April, President Sadat inaugurated a new sugar factory and refinery at the town of Deshna, in Kenya governorate. Egypt's sugar production will be raised further with the completion of the Marga sugar plant, expected to produce 150,000 tonnes annually, the beet sugar plant in the north of the Delta due to turn out 100,000 tonnes yearly and the development of the Hawamdieh sugar plants during the 1978/82 five-year plan.

Malaysia sugar project.—Malaysia's largest sugar complex, Gula Padang Terap Berhad, located at Kuala Nerang, about 30 miles from Alor Setar, Kedah, was officially opened in February 1978. The $103 million project is a joint venture between the Kedah State Economic Development Corporation (56%), Fima (27%) and Perlis Plantations (17%). The company will produce 23,000 tons of refined sugar from its cane this year. By 1982 it expects to produce 52,000 tons or roughly 10% of the country's estimated sugar needs for that year, saving about $38 million in foreign exchange.

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