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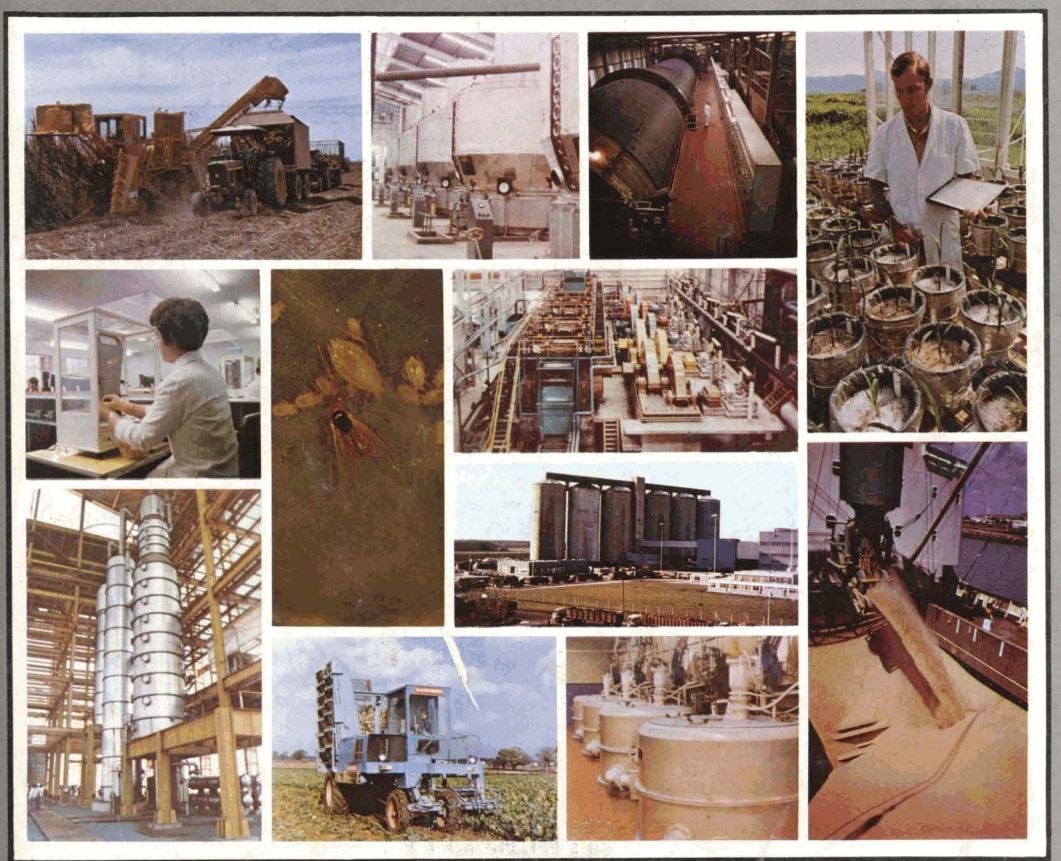

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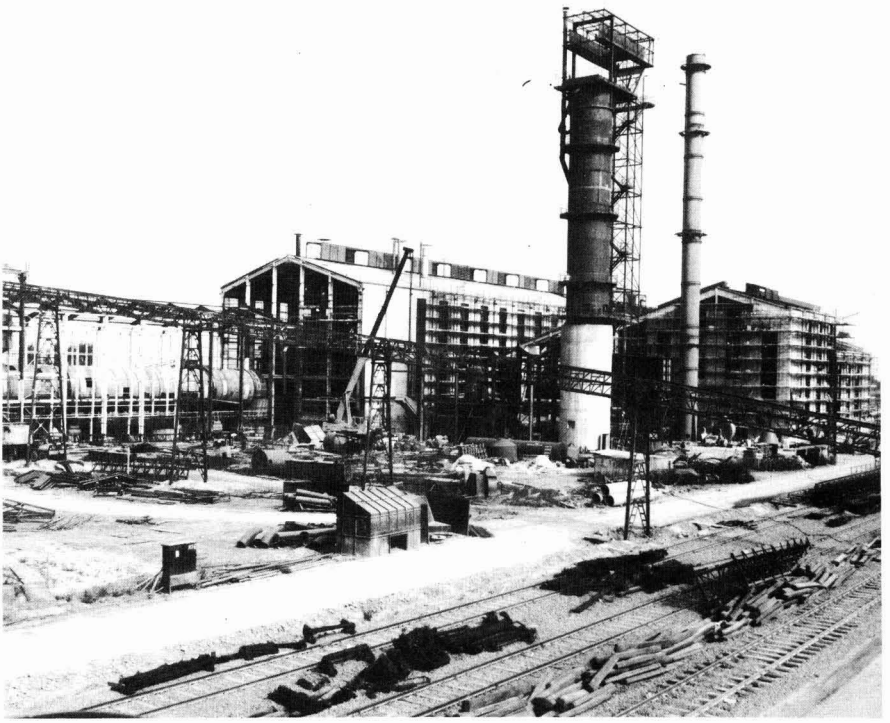

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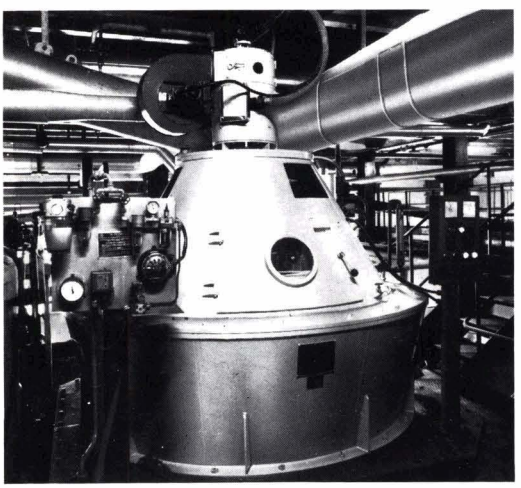

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ISSCT MANILA 1980 Stand 53-55

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In 1972 FS completed a turnkey cane sugar factory located at Davao on the island of Mindanao. The factory which has a design capacity of 4,000 tonnes of cane per day also incorporates a refinery capable of processing 250 tons of refined sugar per day. In its short life Davao has withstood severe typhoons and earthquakes which have devastated

adjoining areas of the island, and despite the hazards has emerged with a first class record of operating efficiency.

Closely following the Davao factory FS was awarded a contract by the Bicolandia Sugar Development Corporation to build a 4,000 tonnes of cane per day raw sugar factory close to Naga City on the island of Luzon.

FS has recently completed a third turnkey project, the Northern Cotabato sugar factory sited on Mindanao island. Like the previous two factories Cotabato has a design capacity of 4,000 t.c.p.d. with provision for expansion to 5,500 t.c.p.d. at a later date.

This project, which is under the guidance of the Philippine Sugar Commission (Philsucom), is part of an extensive programme of rationalisation which is geared to increasing the efficiency of its existing plant and equipment in order to benefit both its home and export markets. Most recently FS has been awarded a contract to build a refinery at Batangas on the island of Luzon to produce 550 tons of high quality refined sugar per day. The Batangas refinery will play an important role in the strategy for improving the quality of sugar in the Philippines so as to promote the further development of local industries such as fruit canning and soft drinks without the need for importing the special grades required by these users.

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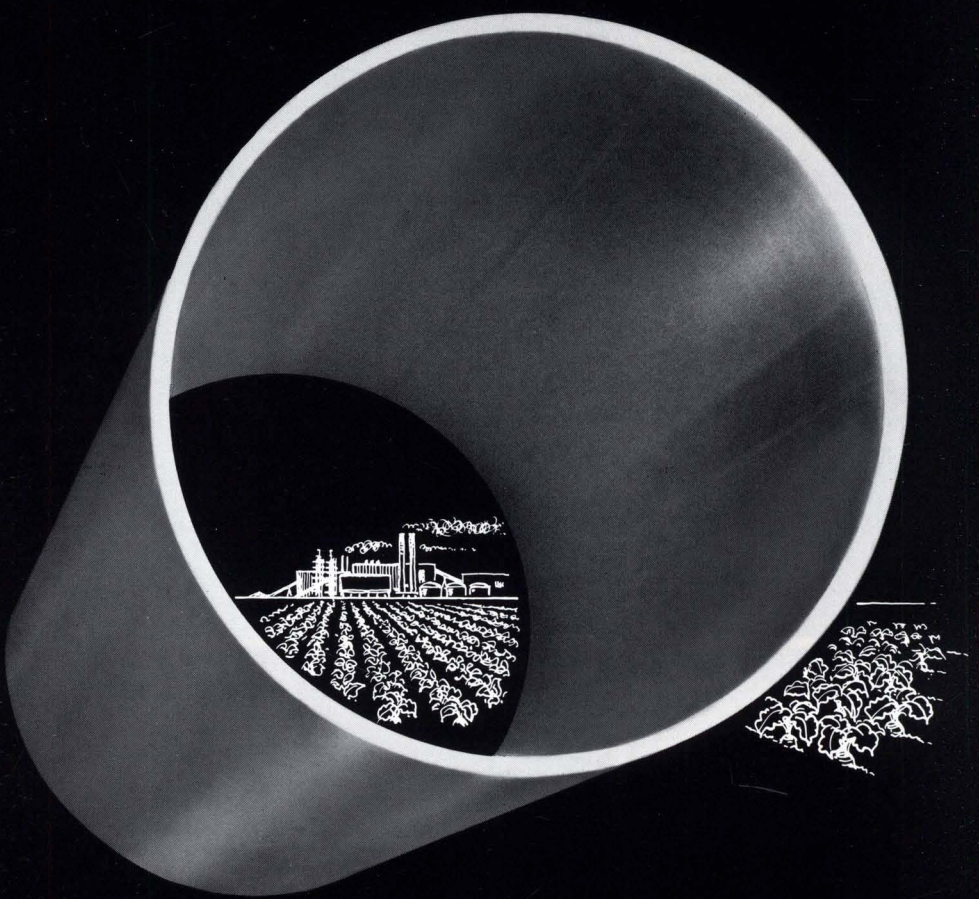

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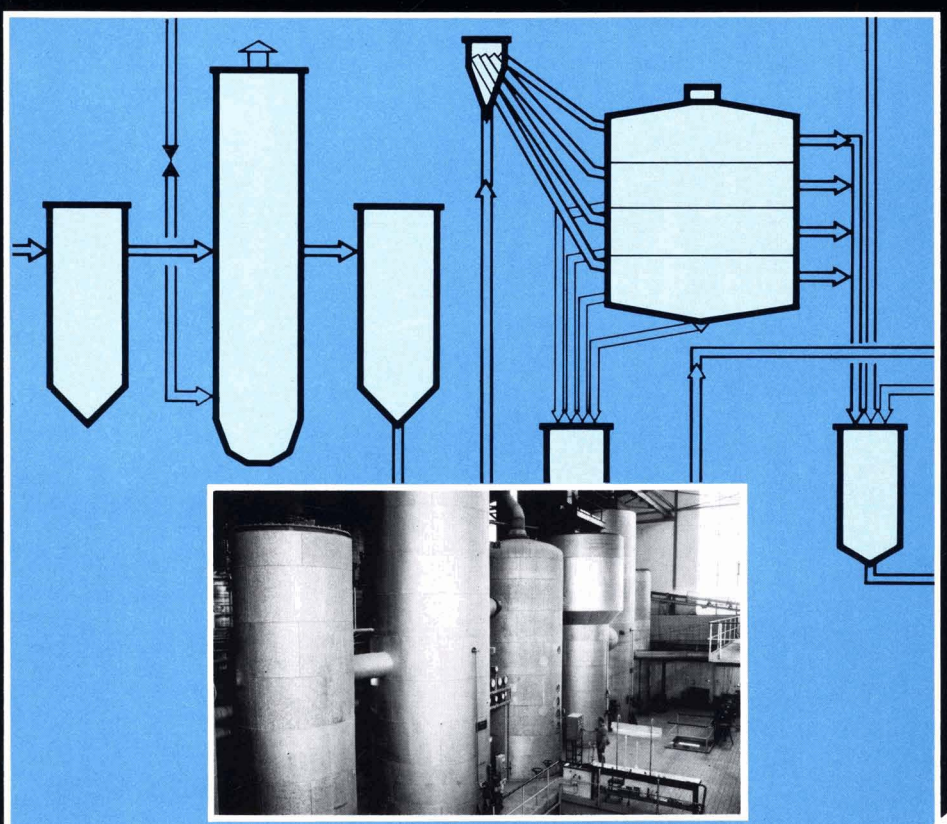

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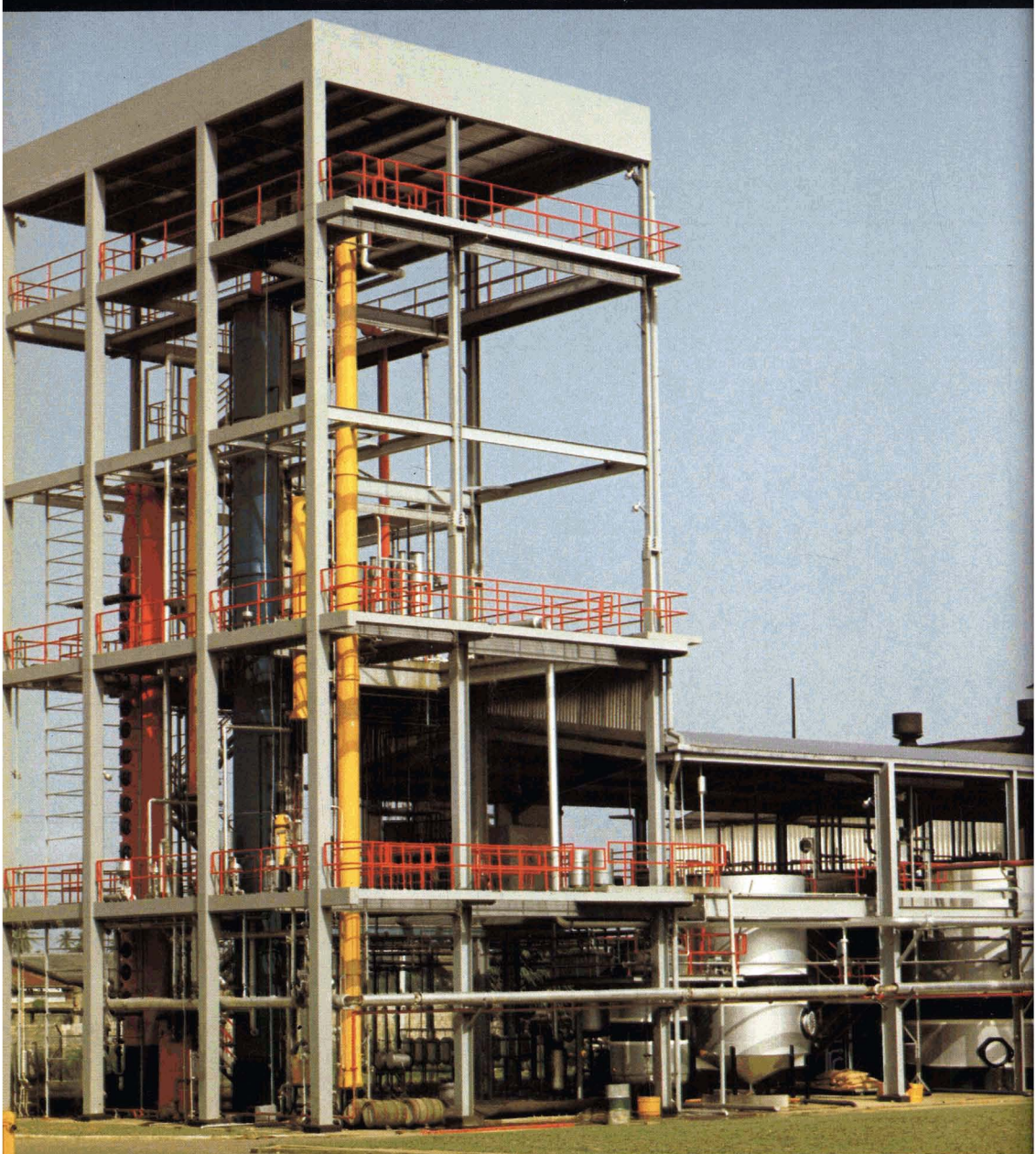

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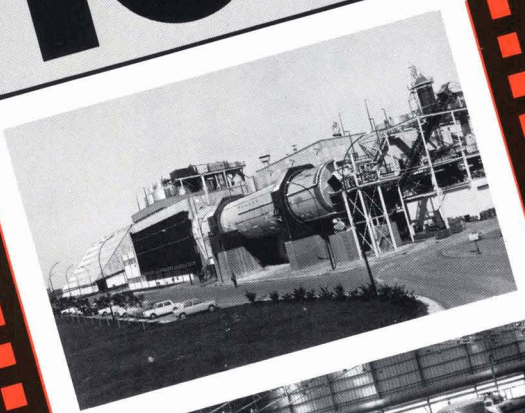
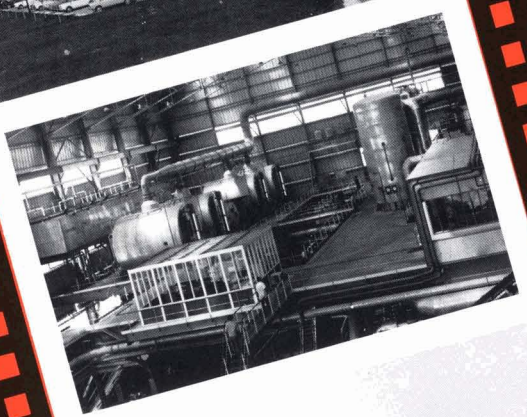
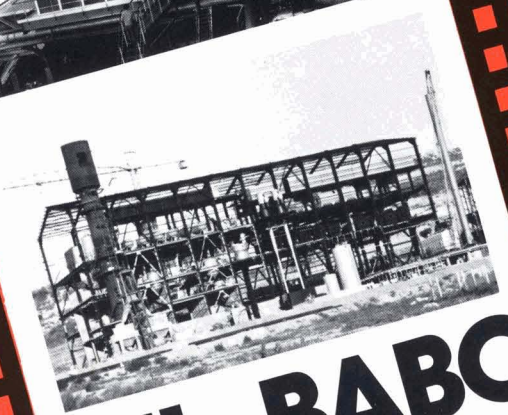


Beet sugar factories.



Cane sugar factories.



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- Minimum retention time required to obtain a certain exhaustion
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- Effective agitation
- High cooling surface/volume ratio
- Rapid cooling without risk of fine grain formation
- The system is easy to extend
- Can be placed outdoors
- Simple and reliable automation

Standard Design

The equipment consists of

- DDS crystallizer type A and B
- Cooling water pump
- Hydraulically operated reciprocating agitator

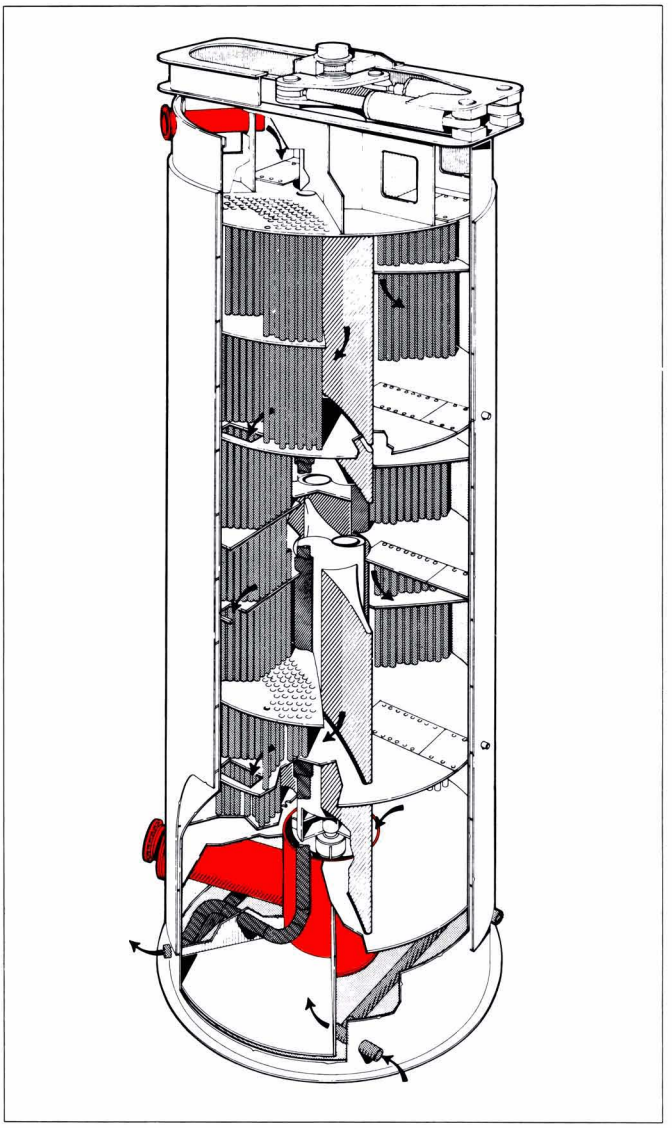
Specifications

	Type A	Type B
Diameter – m	4.0	4.0
Height – m	12.9	13.4
Weight – tons	60	55
Massecuite vol. m^3	100	100
Cooling surface m^2	480	250

Installation Examples

Afterproduct Massecuite (tons/24 hours)	**400**	**600**
Inlet temperature (°C)	80	80
Outlet temperature (°C)	35	35
Total number of crystallizers	**2**	**3**
Corresponding retention time (hours)*	18	18
Total number of crystallizers	**3**	**4**
Corresponding retention time (hours)**	27	24

*) For usual exhaustion requirements, corresponding to raffinose corrected molasses purity of 59–60 in Danish factories.
**) For obtaining molasses purities 0,5–1,5 below usual exhaustion requirements as mentioned above.



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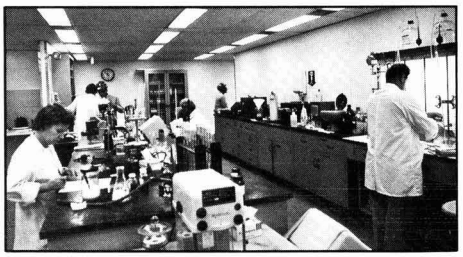
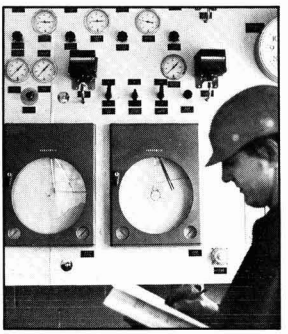
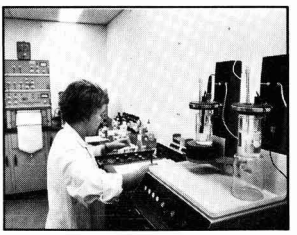
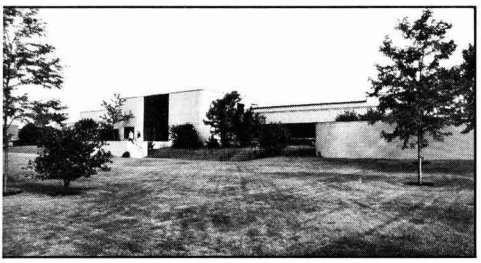
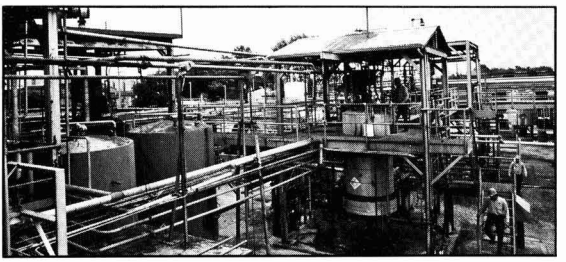

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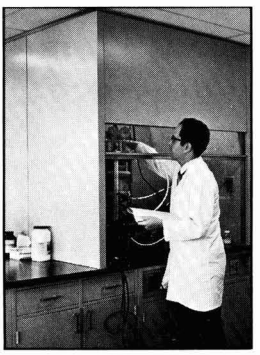


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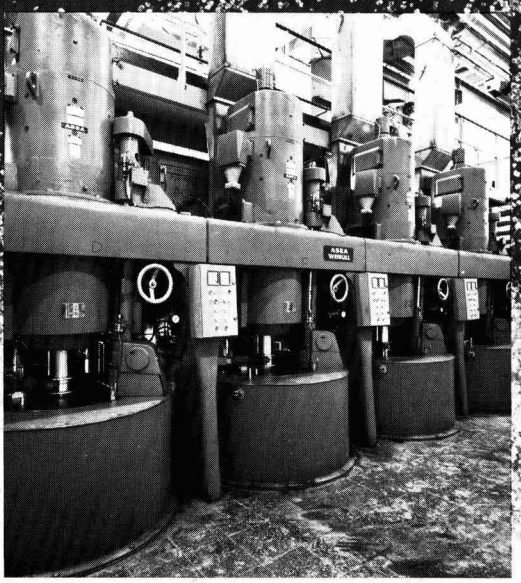

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NOTES AND COMMENTS

International Sugar Agreement

The Executive Committee of the ISO met in London in early October and, among other things, decided to resume use of the New York spot price as one of the bases for calculation of its Daily Price the level of which acts as a trigger for a number of actions under the Agreement. Since it is possible for the LDP and New York spot price to differ by more than 0.10 cents/lb, especially in a fluctuating market, it was decided that when this occurs the ISO Daily Price would be the lower of the two plus 0.05 cents, instead of the mean of the two. The Price Review Committee was to meet in November to consider price developments and, in particular, the effects of inflation and the fall in the value of the US dollar on the various prices mentioned in the Agreement.

The "prevailing price" – the 15-day average of the ISA Daily Price – exceeded 11 cents/lb on October 22 and the amount of sugar which members are authorized to import from non-members was consequently raised from 390,753 to 551,188 tonnes, but C. Czarnikow Ltd. consider that in fact little extra non-member sugar would be shipped in 1979. The next "trigger point" is a prevailing price of 12 cents/lb, when shortfalls could be reallocated, at the discretion of the Executive Committee. Such shortfalls currently total 126,671 tonnes, made up of 7,846 tonnes for Argentina, 15,000 tonnes for Austria, 50,000 tonnes for Guatemala, 5,227 tonnes for Peru and 48,598 tonnes for Trinidad.

The next stage would be if the prevailing price exceeded 13 cents/lb, when the global quota would be increased by 5%; however, this is not permitted if it occurs within 45 days of the end of the quota year, however, so that it seems at the time of writing to be unlikely for 1979. E.D. & F. Man consider[1] that "forward prices have passed through and beyond the levels which the fundamental background would seem to warrant. World stocks are still high, after allowing for a 3.5 million tonne reduction in 1980. Thus, even assuming substantial ISA shortfalls and increased import demand for 1980, it is unlikely that the market will have need of ISA quota releases in excess of 100% of B.E.T.'s and shortfall reallocations."

World sugar prices

The strengthening of sugar prices continued during October and from £120 per tonne on October 1, the LDP rose to £155 by October 26 before falling to £150 on October 30. Recovery was almost immediate and the rise in price resumed to £154 by November 1. The white sugar price rose in parallel for most of the month but the premium over raw sugar increased later in the month of October so that from £130 per tonne, the LDP(W) rose to no less than £172 by November 1. There has been steady demand and reports of poor crops in India and Cuba. The supposition that the rise might be more a reflection of the declining value of money has been shown to be incorrect as a parallel initial rise in the prices of other commodities has been reversed while that for sugar has continued.

EEC production quotas

The EEC sugar régime expires on June 30, 1980, and recommendations should have been made in the spring of 1979 for consideration by the Council of Ministers so that they can decide before January 1, 1980, on the arrangements to take effect six months later. In fact, representations have been made to the Commission by a number of interested parties and proposals to be put forward were to be discussed by the full Commission in early November.

The Farm Commissioner, Mr. Finn Olav Gundelach, is reported[2] to be strongly opposed to the quota system. This system of national quotas was initially introduced as a transitional measure but any move to remove them would almost certainly meet with resistance from some of the Ministers, especially those representing the higher cost producers whose industries have now been established to function up to and, in some cases, in excess of current levels of quota and would therefore be faced with the problems of over-capacity if they had to entertain open competition.

Critics of the quota system say that the fundamental reason for introducing production quotas was to protect those areas of high cost production within the Community which could be expected to reduce or cease sugar production if regional specialization was allowed to operate unhindered. It is also argued that quotas were set too high to prevent the build-up of substantial sugar surpluses within the Community. This, however, is rooted not in the system itself but in the manner in which it is practised. In any case it is apparent that only the quota system provides a basis for agreement in the Council of Ministers on the regulation of the market from 1980 on. This was apparently recognized also by Gundelach who now aims at reducing the level of quotas. Gundelach wants to cut the production quotas by up to 1 million tonnes which, however, is certain to meet stiff opposition from major sugar producing countries, such as France. Gundelach may also be considering limiting exports of *C*-quota sugar, which may not be sold for human consumption within the EEC and for which no export subsidies are paid, in order to be able to comply more closely with ISA requirements, thus opening the way for EEC affiliation. This proposal is also likely to be rejected by the Council of Ministers.

US sugar legislation

The House of Representatives discussed the Sugar Bill and was defeated on October 23 by the appreciable margin of 249 to 158. The rejection of a bill which permitted ratification of the International Sugar Agreement by the US came as a disappointment but did not hinder the steady rise in sugar prices. The substantial opposition to the bill seems to have been a combination of the influence of consumers' lobbies who objected to what they consider to be the inflationary provision for raising the sugar price objective from 15 to 15.8 cents/lb, and of anti-Cuban sentiment whereby the fact that Cuba benefits from the Agreement was sufficient grounds to be against it, irrespective of the benefit provided by the ISA to 25 other exporting countries to which the US presumably remains friendly.

Under the circumstances, the Administration is prudently not acting hastily to try to obtain Congress-

[1] *The Sugar Situation*, 1979, (341).

[2] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 604.

ional approval of ratification untied to US domestic measures, but USDA officials and Congressional leaders have met to discuss the prospects and timetable for possible approval of enabling legislation.

While under the present strengthening conditions of the sugar market, membership of the Agreement by the USA, the major importer from the free market, and the EEC, its major supplier, is not essential, failure to ratify by the US raises problems for the International Sugar Council which was to meet on November 19. The future of the Stock Financing Fund will have to be decided and, as C. Czarnikow Ltd.[1] comment: "Whether it will be possible to operate the whole procedure of Special Stocks and Fees in the absence of the USA must be doubtful but, on the other hand, countries which have already invested money in the establishment of new storage facilities will hardly be enthusiastic about these provisions of the Agreement being dismantled".

New London raw sugar contract

Rules and Administration Procedures for the proposed new raw sugar contract[2] were submitted to members of the UTSMA at the beginning of October and, in the absence of objections the contract, UTSMA Raw Sugar Contract No. 4, became effective with trading commencing on November 12. Transfers from the old No. 2 contract to No. 4 are permitted free of commission. The No. 2 contract will expire after October 1980.

EEC sugar exports, 1978[3]

At the beginning of 1978 most observers were of the opinion that world prices would not rise to the minimum price level written into the International Sugar Agreement and that therefore the EEC could have difficulties in disposing of its sugar surplus. This was not the case, however, and no difficulties are anticipated for 1979. On the contrary, export statistics for 1978 shows that the EEC was able to increase its deliveries substantially. Total sales increased from 1.9 million tons, raw value, in 1976 to 2.7 million tonnes in 1977 and 3.6 million tonnes in 1978. Despite the general upward tendency there were significant differences from one export market to the other.

Exports to Africa rose from 609,146 tonnes, (32.27% of the total) in 1976 to 1,410,885 tonnes (39.56%) in 1978. The second largest outlet were the countries of the Near and Middle East, who took 1,232,914 tonnes in 1978 (34.57%) from 482,206 tonnes (25.55%) in 1976. Exports to non-EEC member countries of Western Europe were slightly higher in 1978 than 1976 at 429,404 tonnes *vs.* 405,519 tonnes, while this represented a considerable fall as a proportion of the total (12.04% *vs.* 48%).

Sugar exports to Asia rose from 6,620 tonnes in 1976 (0.35%) to 204,689 tonnes in 1978 (5.74%), the bulk of 1978 exports being to China. Eastern Europe imports from the EEC declined from 317,145 tonnes in 1976 (16.8%) to only 53,329 tonnes (1.50%) in 1978, performance depending largely on the sugar crops of these countries. Exports to North America increased from 19,992 tonnes in 1976 (1.06%) to 78,910 tonnes in 1978 (2.21%) but may be expected to fall because of countervailing duties imposed by the US.

Central and South American countries took 130,671 tonnes in 1976 (3.66%) against only 35,785 tonnes in 1976 (1.90%), mainly because of production shortfalls in Chile and Venezuela; recovery of these presently depressed industries could result in a decline in future exports. Exports to Oceania were negligible, amounting to only 5137 tonnes (0.27%) in 1976 and 13,589 tonnes in 1978 (0.38%).

The EEC enjoys a freight advantage over India and South American competitors as regards markets in the Middle East, Europe, and Africa, but the future of its exports will depend on which countries decide to join the ISA and the trend to achievement of self-sufficiency among importers, especially in Africa.

US loan sugar sales[4]

After two unsuccessful tenders, when all bids were rejected by the Commodity Credit Corporation[5], a sale was achieved on October 25 of 3540 short tons of raw sugar at prices ranging from 14.31 to 14.85 cents per pound, f.o.b. As at October 30, outstanding loans under the CCC sugar loan programme totalled 1,170,828 short tons, raw value, of which 453,022 tons was beet sugar and 717,806 tons was cane sugar. Because a final decision on an overall loan extension programme is still pending, the US Department of Agriculture authorized a second one-month extension of loans on 1978 crop sugar that would normally have matured on October 1 so that the maturity date became November 30.

Indian sugar situation[6]

A feature of the past year or so has been the remarkable expansion in sugar consumption in India. This has led to some whittling away of the substantial tonnage of sugar held in store, which at one time promised to be such a burden on the Indian industry. There has now been a new development which may entirely change the statistical situation in India, so that where once heavy stocks were in prospect there is now the possibility of shortages.

Severe droughts have occurred in many areas and the 1979/80 crop is currently expected to amount to around 5.0 million tonnes, white value, which compares with 6.4 million tonnes in 1977/78 and a probable output in 1978/79 of the order of 5.9 million tonnes. The key to the Indian statistical position is, of course, the future direction of consumption. In the crop year October 1976/September 1977 it amounted to no more than 3,746,000 tonnes but, the following year, during the course of which it was freed from control, it rose to 4,476,000 tonnes. Current indications are that it will have been of the order of 6.1 million tonnes in 1978/79 and it was expected that further growth would occur in 1979/80.

The outlook has now been put in some doubt, however, by the announcement that ex-factory and retail prices for sugar are once again to be controlled. Producers are said to be disappointed at the level at which the prices have been set, which they claim are below the cost of production. While at first sight the establishment of maximum prices might be thought to be an encouragement to consumption, it might also discourage production. One way or another, it seems likely to lead to a further diminution of the Indian stock position. Indeed, it could even affect India's ability to fulfil its export entitlements to the EEC and under the ISA.

[1] *Sugar Review*, 1979, (1463), 211.
[2] *I.S.J.*, 1979, **81**, 289.
[3] F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 443-449.
[4] *Lamborn*, 1979, **57**, 173, 176.
[5] See also *I.S.J.*, 1979, **81**, 322.
[6] C. Czarnikow Ltd., *Sugar Review*, 1979, (1457), 179.

The Kenana Sugar Project

Sugar has become an increasingly important part of the diet of the Sudanese people and meeting the demand has added significantly to the country's import bill, of which it is by far the most costly food component. From 1974 to 1976 the country spent over U.S. $250 million on imports of sugar. As a consequence the Sudan Government has given major emphasis to development of increased sugar production.

The 1972 IDCAS/UNIDO conference particularly confirmed the Sudan's suitability for sugar cane growing. All the necessary conditions are present for growers to anticipate excellent cane growth and yields. Compared with other producing countries the Sudan has many important natural advantages.

participation in its development. Detailed survey work, including aerial photography over an extended land area, topographical surveys and a detailed soil survey, was commenced in 1972 and a market report was also produced.

A detailed feasibility study was produced in April 1973 which projected a capital cost of $145 million. Since its inception, however, the project has been affected by unprecedented inflation and economic instability in the industrialized countries that are providing the equipment and major contractors. A thorough revision of the forecast total cost of the project was undertaken recently and the capital cost is now forecast to be $524 million, plus pre-production

Kenana factory under construction, April 1979

Photo: Courtesy Richard Roxburgh

The Government's Sugar and Beverage Corporation has three sugar factories operating at Guneid, Khasm-el-Girba and Sennar. The policy of expanding sugar production is demonstrated in the development of estates and new factories presently being undertaken and planned for Kenana, Haggar Assalaya, Melut, Mongalla and Setit. The successful realization of these projects will establish the Sudan as an exporter of sugar and should transform the country into a major producer of sugar with a surplus available for export, most probably to neighbouring Arab markets.

The Kenana project

Under an agreement with the Sudan Government, signed on June 9, 1972, Lonrho Ltd. was to investigate and report on the viability of establishing a sugar estate with a view, in the event of favourable findings, to joint

expenses of some $47 million. Maximum cash requirements will be approximately $600 million. This total cost includes the high expenditure on infrastructure as well as the complete irrigation system. At present, apart from export credit facilities from France and Japan, the developments undertaken have been funded by equity and loans from shareholders.

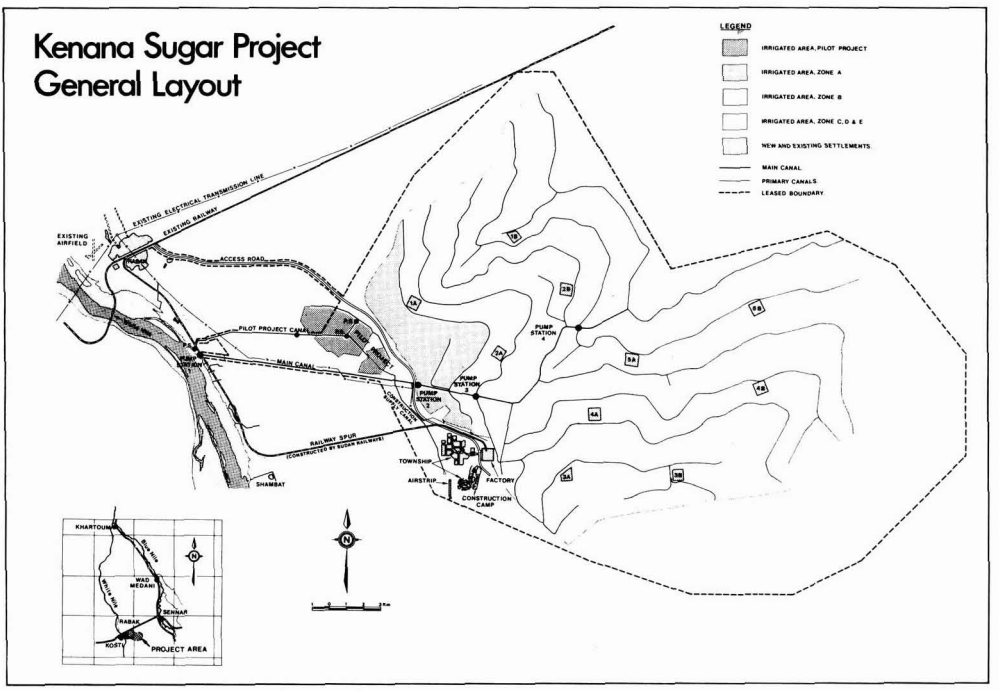
Kenana Sugar Company Limited was incorporated on March 11, 1975, with the purpose of developing and operating an integrated cane estate and sugar factory with an annexed refinery. The estate, on a site 250 kilometres south of Khartoum, comprises 81,000 feddans (34,000 ha) of sugar cane, all irrigated by water pumped from the White Nile, and will produce 330,000 tonnes of refined sugar. It is anticipated that production of sugar will begin during 1979 and to this end substantial progress has been achieved.

The site

The site selected has many favourable features required for sugar cane growing:

(1) *Soils.* – The uniform clay soils formed from Blue Nile deposits, rich in nutrients and ideal for surface irrigation, are available and are assessed to be ideal for growing cane.

(2) *Climate.* – With a rainy season averaging three months, a high number of sunshine hours and high solar radiation, and with three months of low temperatures at night during the harvesting season, the local climate proves favourable for high rates of photosynthesis, high crop yields and excellent juice quality.



(3) *Water.* – Good quality water is abundantly available throughout from the White Nile. The water will be lifted 40 metres by pumping and will be distributed across the estate by contour canals, and from these by gravity to the cane fields.

(4) *Land.* – Sufficient land is available for the estate in an area which is well-drained, non-saline and relatively easy to prepare for cultivation.

(5) *Power.* – Bagasse will provide fuel for steam-generated power to meet irrigation pumping requirements, factory and domestic demands during the crop season. The 33 kV power supply to the estate will provide power required prior to start-up of the factory. It will also provide an auxiliary source of power thereafter.

The estate is close to Rabak, with the factory itself abut 30 km from the town. Khartoum, approximately 250 km to the north, and Port Sudan, approximately 1200 km to the north-east, are connected by railway lines to Rabak. Telephone and postal services are available across the Nile at Kosti. The estate contains a gravel area of good load-bearing capacity, suitable for the siting of the factory, while deposits of sand and gravel for concrete works, foundations and road surfacing are available within the confines of the estate.

Communications and access

The Company, as a matter of priority, established communications and easy access to the project site. These include:

(i) a radio telex linking the site, Port Sudan and Khartoum,

(ii) a 30 km rail spur from Rabak to the factory, completed in 1976 by Sudan Railways, which has been used extensively for transporting equipment and supplies directly to the factory site,

(iii) a 27 km all-weather gravel road from Rabak to the factory which was completed in mid-Summer 1976, enabling access to the site to continue during the rainy season, and

(iv) an all-weather 1500-metre gravel air-strip which was completed by mid-1976 and allows daily flights for personnel by DC 3 or other light aircraft direct to the project site.

Irrigation

Howard Humphreys & Sons, civil engineering consultants of Reading, England, were engaged to advise on the infrastructure and civil works, including the irrigation canals, pumping works and structures, and housing and site development. In June 1974 they undertook the task of designing the canals and irrigation

works for the estate area. By the end of 1977, 19 km of the main canal and 100 km of primary distribution canal were completed while three of the four pumping stations were in operation. This had made 25,000 feddans (10,500 ha) available for planting, all of which is now under cane. Work is in progress on the final 10 km of main canal, the fourth pumping station and the remaining 170 km of primary canals. The bulk of this work will be completed by 1980.

The main canal transports the water to the fields through an irrigation network comprising:

(a) primary canals, which follow the topographical contours and utilize field outlet structures located in the primary canal banks; these in turn feed

(b) field channels, from which water is siphoned at approximately 1.5 metre intervals into

(c) long-line furrows, which form the actual field irrigation system.

The whole system is controlled by structures, regulators, gates and distributors of a type to ensure distribution of the right amount of water under the required head.

Pumping

By contract dated July 10, 1975, Maschinenfabrik Andritz AG, of Graz, Austria, agreed to provide the design, construction and installation of the pumps at the four pumping stations. The tender value of the contract is approximately 216 million Austrian Schillings, or $14.0 million.

The first and second pumping stations each have eight pumps with an aggregate capacity of 42 $m^3.sec^{-1}$ per station, against a maximum calculated requirement of 36 $m^3.sec^{-1}$ (or about 700 million gallons of water per day). The pumping station design allows for an additional pump to be added which would bring the total capacity to over 47 $m^3.sec^{-1}$ each.

Power

Initially, electricity for the pumps is taken from the National Grid; bagasse from the factory will eventually become the main source of fuel for generating power. The Public Electricity and Water Corporation of Sudan has been awarded the contract for the provision of the necessary 33 kV and 11 kV power lines. The National Grid will be used as a back-up source of power.

Agricultural development

The land was largely free of trees and bushes so that clearing costs have been minimal. Moreover, its uniform topography has ensured that little levelling has been required and land preparation consists mainly of ploughing, harrowing and furrowing to obtain sufficient tilth for planting.

Land prepared for seed cane has been planted and fertilized, and subsequent irrigation carefully controlled, with more water being applied during the extremely dry and hot summer months. The planting rate will reach a maximum of 3000 to 3500 feddans (1260 – 1470 ha) per month during the most active planting months. It is anticipated that yields of over 56 tonnes of cane per feddan (133 tonnes. ha^{-1}) will be produced in the plant crop. Cane will be harvested during the dry months of November to May.

The equipment to be used throughout the agricultural operations will be modern and specialized. The main repair facility will be established centrally, and preventive maintenance, spares stores and refuelling facilities will be provided in each agricultural area.

Cane has been grown at the project site since 1973. The first cane grown for ultimate estate use was planted on the 2000-feddan (840 ha) Pilot Project Extension in early 1975, following completion of the 9 km pilot canal. It is from this area that the main estate first derived its seed cane.

Advantage was taken of the close co-operation with the existing sugar estates in the Sudan in the Company's early experiments to determine those cane varieties best suited for planting. Three were chosen (N:Co 310, Co 527 and N:Co 376) for use as crop cane. The Company will not limit itself to these three varieties but is intensifying its research into new varieties. At the same time it is increasing its research into many aspects of ensuring healthy cane growth, including fertilizer control, weed control, differing irrigation frequencies and control measures against insects, pests and disease.

There is sufficient area presently under cane and at different stages of growth for experts to agree that the cane growth is outstanding by world standards, with 64 tonnes of cane per feddan in 14-months old cane.

Factory and refinery

The President of the Democratic Republic of the Sudan, General Gaafar Mohamed Numeri, laid the foundation stone for the factory at a ceremony held on November 25, 1976. The factory, due to be commissioned in December 1979, is designed to produce in excess of 330,000 tonnes of white sugar per annum. It will have an initial daily crushing capacity of 8500 tonnes of cane, rising to 17,000 tonnes in 1980. In spite of the unusually large size of the factory, in order to keep equipment within reasonable unit sizes and to minimize the possibility of down-time, each production line incorporates several units.

"Out-of-gauge" equipment being brought 1200 km across the desert from Port Sudan to site on heavy-duty articulated trailers. 1500 tonnes of such equipment was brought to site in this way.

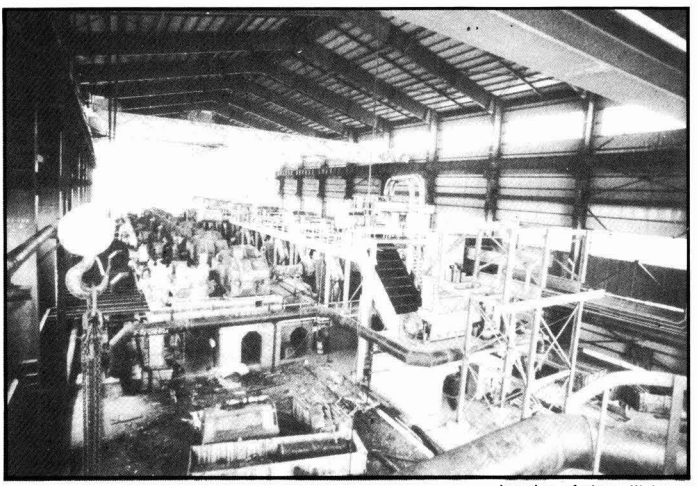
Photo: Courtesy Richard Roxburgh

Chopped cane is brought to the factory in 12-tonne containers, hauled in pairs by road tractors. These containers are tipped onto feed tables, each of which passes the cane by way of two cane knife sets and a shredder to one of the two turbine-driven Fives-Cail Babcock milling tandems of seven mills each. The raw juice is limed and settled in a total of seven continuous clarifiers, with five vacuum filters for the mud. The evaporator station includes two quadruple-effects of

120,000 ft^2 h.s. each and employing vapour bleeding.

Within the raw sugar house there are nine 85 m^3 vacuum pans while the massecuites are cured in 15 54 in x 42 in batch-type *A*- and *B*-centrifugals and 12 continuous *C*-machines.

The refinery, built as an integral part of the plant, uses a remelt carbonatation process utilizing flue gases from the boilers. It incorporates four vacuum pans and a further 11 centrifugals. The crystal size produced may be varied to suit the market is is destined for. From the refinery, sugar passes by overhead conveyor into the bagging and weighing station where it is loaded into 50-kg sacks. Warehouse capacity exists for 60,000 tonnes (just over one month's production).



Interior of the mill house
Photo: Courtesy Richard Roxburgh

One of the fundamental concepts was that the factory would incorporate a power house capable of generating sufficient electric power for both the factory operation and the irrigation pumps and township. Steam to drive the turbo-generators is produced by burning bagasse and one of the main reasons why the factory is built as a single large complex, rather than as two smaller separate factories, is to obtain maximum economy of steam utilization and maximum power generation from the quantity of bagasse available. All the bagasse is taken by overhead conveyor to a storage area from which it is reclaimed and taken to the boilers by rubber belt conveyors.

The steam plant itself consists of six high-pressure boilers, each generating 112 tonnes of steam per hour at a pressure of 31 $kg.cm^{-2}$ (450 psig). About 35% of the steam produced is piped direct to the mill turbines to drive the tandems while the major proportion is piped to the power house where it drives four turbo-generators of 10 MW capacity each. Two of these generators are back-pressure sets and two full condensing units, so that, when the factory is closed down between June and October, steam can continue to be produced and electricity generated for irrigation and the township, using furnace fuel or stored bagasse. In the event of any shortfall, additional power is available from Sudan's Blue Nile grid, but the estate should normally be self-sufficient throughout the year.

The design and construction of the factory reflect the international nature of the project, with Arkel International Inc. of the United States acting as consulting engineers in connexion with the plant, responsible for commissioning, but French and Japanese companies supplying equipment. Compagnie Française d'Etudes et de Construction Technip was awarded the contract for detailed engineering, supply of the majority of the sugar processing plant and on-site supervisory services, while Nissho-Iwai Co. Ltd. was responsible for provision of equipment mainly related to the power house and power generation. Capper Neill International Ltd. of the UK was awarded the contract for erection of the factory.

Experience gained in transporting equipment to site will make a major contribution to the successful export of 150,000 tonnes of sugar per year through Port Sudan, together with surplus molasses which could total a further 100,000 tonnes each season. Sugar for local consumption will be transported by rail wagons and road lorries, together with river barges which will be especially useful for moving sugar to Southern Sudan along the White Nile.

Outlook

Kenana forms part of the Government's overall national development plan to turn the Sudan into a major sugar exporting country and this is reflected in the co-operation which has been extended by all sectors of central and local Government. Apart from generating foreign exchange, the project will have a significant impact on the lives of the people in the Rabak/Kosti area, with the creation of 10,000 permanent jobs, which in turn will provide secondary employment for a similar number of people in the surrounding area.

Summary

An account is given of the history and development of the Kenana sugar estate and factory/refinery which indicates the importance of the project to the Sudan.

Le projet sucrier de Kenana

On donne un exposé sur l'histoire et développement du domaine sucrier et de la sucrerie/raffinerie de Kenana, qui indique l'importance du projet pour le Soudan.

Das Zuckerprojekt Kenana

Man berichtet über die Geschichte und Entwicklung der Zuckerplantage und der Zuckerfabrik/Raffinerie von Kenana, was auf die Bedeutung des Projekts für die Sudan hinweist.

El proyecto azucarero de Kenana

Se presenta un examen de la historia y desarrollo de la finca azucarera y fábrica/refinería de Kenana que indica la importancia del proyecto para el Sudán.

Physiological and biochemical changes in sugar cane as influenced by soil moisture during low temperature stress

By ONKAR SINGH AND R.S. KANWAR

Sugarcane Research Station, Punjab Agricultural University, Jullundur, India)

Introduction

The sugar cane crop during its maturity phase from November to February, quite often experiences low temperature stress in most parts of Northern India, causing deterioration in juice quality[1,2] and, during certain years, shortage of seed cane for the next planting [3,4]. Similar results have also been reported from other countries by various workers[5,6,7,8]. Qualitative studies[9] have suggested that keeping the soil wet (near field capacity) during frost protects the sugar cane crop from injurious effects of low temperature at early growth stage. Frequent irrigations when frost occurs during the maturation of sugar cane have also been advocated[10,11, 12]. The physiological basis for such an effect of irrigation is not well established, and the present studies have been made to elucidate this.

Materials and methods

An experiment was conducted for two years during 1976–78 at the PAU Sugarcane Research Station, Jullundur. Sugarcane variety CoJ 46, a moderately frost-resistant variety, was planted in a randomized block design with four replications, in the second week of March. The soil was a sandy loam with wilting point of 4.5% and field capacity of 13.5%. Normal crop husbandry practices were used. After common irrigations were given on December 1, 1976 and December 7, 1977, sections of the crop were irrigated at intervals of 10, 20, 30 and 40 days until the 3rd week of February. The crop experienced the following rainfall (Table I) and frosty spells (Table II) during the course of the studies.

Table I. Rainfall, mm

Year	December	Date	January	Date	February	Date	Total
1976–77	2.6	3	47.4	11,24, 25,26	–	–	50.0
1977–78	18.7	26,27 29	8.0	28,29	29.3	9,13, 16,17, 18	56.0

Table II. Occurences of frost in 1976/77 and 1977/78

	Light	Moderately intense	Severe
1976-77	19	5	26
1977-78	13	3	8

The maximum and minimum temperatures were recorded daily at 7.30 a.m. inside the crop at heights of 30 cm (bottom portion), 120 cm (middle portion) and 240 cm (top portion), and soil temperatures at depths of 7.5, 15 and 30 cm. Similar observations were also recorded under open-field conditions. Only monthly averages of the data from different crop heights and soil depths have been presented in Table III. However, the detailed observations showed that the maximum temperature under open-field conditions always remained higher than inside the cane crop.

Frequent irrigations at 10-day intervals were found to lower the maximum temperature by comparison with 20, 30 and 40-day intervals. The minimum temperature was always higher inside the crop than the open-field conditions. However, inside the crop it remained higher with 10 and 20-day irrigation intervals by comparison with 30 and 40-day intervals. The top portions of the crop experienced lower minimum temperatures than the middle and bottom portions throughout the period of observation while the reverse was true under open-field conditions. On the whole, irrigation, depending on the intervals, increased the soil temperature inside the crop, the relative increase being highest with 10-day intervals followed by that with 20-day intervals. The lowest minimum temperature was recorded at a soil depth of 7.5 cm, followed by 15 cm and 30 cm, irrespective of the site of observations and irrigation treatments.

Cane samples were taken from the plots at fortnightly intervals. The juice was extracted with a laboratory cane crusher and samples analysed for electrical conductance (mmho.cm^{-1}) by means of a conductivity bridge, pH and titratable acidity (cm^3 of 0.1N NaOH required to bring 50 cm^3 juice to pH 8.3), gum content (ppm) by the method of Friloux *et al.*[5], reducing sugars by Fehling's method, pol and apparent purity. The leaf and sheath moisture and relative turgidity were determined by the method of Weatherly[13]. The measurements are recorded in Tables IV and V.

Results and discussion

Soil moisture at 10-day irrigation intervals was significantly higher than with the other treatments. However, only frequent irrigations, i.e. at 10 and 20-day intervals,

1 Kanwar *et al: I.S.J.*, 1977, **79**, 340-346.
2 Singh & Singh: *ibid.*, 1975, **77**, 131-132.
3 Gill: *Ann. Rpt. Sugar Res. Sta. Jullundur* (India), 1964.
4 Gill & Singh: *Indian Sugar*, 1972, **22**, 627-632.
5 Friloux *et al: Sugar y Azúcar*, 1965, **60**, (1), 43-46.
6 Irvine: *Proc. 14th Congr. ISSCT*, 1971, 1-8.
7 Irvine & Friloux: *Sugar y Azúcar*, 1965, **60**, (11), 58-59.
8 Sund: *Proc. 12th Congr. ISSCT*, 1965, 561-568.
9 Singh & Singh: *Indian Sugar*, 1974, **24**, 751-754.
10 Kanwar: *Sugar News* (India), 1978, **10**, 11-15.
11 Kanwar & Sharma. *Prog.Fmg.* (PAU), 1971, **7**, 14.
12 Singh: *Indian Fmr.Digest* (PAU), 1972, **5**, 15-16.
13 *New Phytol.*, 1950, **49**, 81-83.

Table III. Mean maximum and minimum temperatures of air and soil, °C

Date	*Irrigation intervals, days*												*Open-field conditions*		
	10			20			30			40					
	Max.	Min.	Soil	Max.	Min.	Soil	Max.	Min.	Soil	Max.	Min.	Soil	Max.	Min.	Soil
Dec.1976	20.6	4.1	9.1	20.7	4.0	9.1	20.8	3.9	9.8	20.6	4.0	8.4	–	–	–
Jan.1977	19.1	3.8	8.0	19.0	4.0	7.4	18.9	3.6	7.2	19.0	3.9	7.5	–	–	–
Feb.1977	21.7	4.4	7.0	21.8	4.2	6.8	21.2	4.3	6.7	21.4	4.2	6.7	–	–	–
Dec.1977	19.7	7.0	11.4	20.6	6.6	11.5	–	–	–	21.9	4.8	11.6	22.4	4.9	11.6
Jan.1978	16.3	5.2	9.6	16.9	4.0	9.0	–	–	–	18.3	3.0	8.7	18.4	3.1	11.1
Feb.1978	16.6	8.4	9.5	18.3	5.7	9.5	–	–	–	18.5	5.9	9.4	19.4	5.0	10.3

Table IV. Moisture content % leaves (L) and leaf sheaths (LS)

	Irrigation interval, days							
	10		20		30		40	
Date	L	LS	L	LS	L	LS	L	LS
Dec.1976	74.1	74.94	71.3	75.4	68.35	72.79	68.1	72.4
Jan.1977	62.05	71.98	59.8	67.8	58.1	66.31	56.6	64.8
Feb.1977	62.51	67.22	61.2	66.0	60.07	64.51	59.3	62.9
Dec. 1977	65.93	72.16	65.0	70.9	64.6	70.2	64.7	70.1
Jan.1978	64.12	70.41	62.9	69.6	60.8	66.4	60.6	65.2
Feb.1978	65.45	67.3	64.9	68.1	63.2	63.9	62.2	61.7

Table V. Electrical conductivity of cane juice, mmho.cm^{-1}

	Irrigation interval, days			
	10	20	30	40
Date				
Dec.1976	5.0	5.23	5.23	5.29
Jan.1977	4.39	4.42	4.63	4.78
Feb.1977	4.33	4.44	4.63	4.77
Dec.1977	5.19	5.34	5.19	5.49
Jan.1978	4.82	4.73	5.24	5.49
Feb.1978	5.03	5.22	5.73	5.81

resulted in significantly higher moisture content and relative turgidity in the leaf and sheath tissues as compared with the restricted irrigations, i.e. 30 and 40-day intervals throughout the period.

Electrical conductivity of the juice decreased significantly during severe low temperature stress and increased during the post-frost period. However, such changes in electrical conductivity were minimal at irrigation intervals of 10 days followed by those at 20 days and were maximal at a 40-day interval followed by a 30-day interval. It appears from this that the low temperature stress, specifically under restricted soil moisture conditions, rapidly increases the soluble salts in the cane juice, and juice quality deteriorates accordingly. The gum content in the juice during frost increased gradually between 10- and 20-day irrigation intervals but abruptly for 30- and 40-day intervals. It decreased significantly during the post-frost period. This suggests that the rhythm in the levels of gum content under low temperature stress is better controlled by the higher soil moisture, than under restricted soil moisture.

A significant decrease in pH with a corresponding increase in titratable acidity of cane juice began with the onset of low temperature stress and continued to the end of February. Such changes were higher with 40-day irrigation intervals and lower with 10-day intervals followed by 20-day intervals. These results indicate that the frequent irrigations during low temperature stress also control the increase in titratable acidity in the juice.

Data on the changes in gum content, pH, titratable acidity, reducing sugars, sucrose and purity coefficient of cane juice were recorded and are summarized in Table VI. In general, the level of reducing sugars increased significantly with corresponding decrease in sucrose and purity during severe low temperature stress. The trend reversed during the post-freeze period. However, when these changes were compared between the irrigation treatments, it was noticed that the frequency of the rhythm was substantially reduced by irrigation at shorter

Trapiches Zanini-Farrel 42" x 84" - Usina São Martinho - trapiches con 4 molinos - 8000 TCD - 12% FIBRA

Solamente quien fabrica el mejor trapiche del mundo puede transformar su ingenio en un moderno central azucarero.

En el ramo azucarero, así como en cualquier otro, un buen equipo es de vital importancia para la obtención de un mejor resultado final. Cada pieza, cada equipo influye en el funcionamiento, pero sucede muy a menudo que un buen equipo no puede alcanzar los resultados deseados, debido a una falta de armonía del conjunto en general.

Es por eso que Zanini no solamente fabrica el mejor trapiche del mundo, como también ejecuta proyectos completos para centrales azucareros. La calidad Zanini está siempre presente, para mejor seguridad del central azucarero y mayor tranquilidad del cliente, desde la fabricación del equipo hasta la indispensable asistencia técnica después de la instalación.

Y esta eficiencia es garantizada por el alto nivel tecnológico conseguido a través de una asociación que reunió en una única fuente, la experiencia, la tradición y el "know-how" de Zanini y Farrel.

Por lo tanto, cuando Ud. piense en trapiches o en un gran proyecto de producción de azúcar, diríjase a aquel que tenga condiciones de suministrar no sólo el mejor equipo como también la mejor solución para la coordinación global de su proyecto. Diríjase a Zanini.

TRAPICHES ZANINI-FARREL:

Zanini fabrica trapiches en las siguientes dimensiones (en pulgadas):

30" x 54"	36" x 72"	43" x 90"
30" x 60"	37" x 78"	44" x 96"
34" x 66"	42" x 84"	

pero también puede suministrarlos en tamaños especiales.

GARANTÍA:

Los trapiches Zanini - Farrel ofrecen una garantía total valedera por dos (2) años, contra cualquier defecto de fabricación.

zanini s/a
equipamentos pesados

Fábrica: Km 4 da Rodovia Armando de Salles Oliveira
Caixa Postal, 139 - 14160 Sertãozinho - SP - Brasil
Teléfono: (0166) 42.2255
Telex: 0166.315 - ZANI BR
Oficina Central: Avenida Paulista, 460 - 18º andar
01310 São Paulo - SP - Brasil
Teléfono: (011) 285.5122
Telex: 011.22901 - ZANI BR - 011.21550 - ZANI BR

intervals, i.e. 10 and 20-days, as compared with restricted irrigations, i.e. at 30- and 40-day intervals. Interestingly, the yield of cane (Table VII) was significantly higher with more frequent irrigation (10- and 20- day intervals) as compared with restricted irrigation (30 and 40 days) during 1976-77. However, during 1977-78, only irrigation at 10-day intervals significantly outyielded the remaining treatments.

stress. Reducing sugars increased, with a corresponding decrease in sucrose and purity of juice, during frost, but the condition was reversed afterwards. These physiological changes due to low temperature were minimized by application of irrigation at intervals of 10 days. Interestingly, the highest yield of millable canes was obtained with 10-day irrigation intervals during the winter.

Table VI. Mean composition of juice during the winters of (A) Dec. 1, 1976 – Feb. 23, 1977 and (B) Dec. 7, 1977 – Feb. 20, 1978

		Irrigation interval, days			
		10	20	30	40
Gum content, ppm	A	17.34	18.96	22.29	25.64
	B	15.84	16.87	18.43	18.87
pH	A	5.22	5.12	5.05	5.01
	B	5.38	5.36	5.28	5.24
Titratable acidity, cm^3 of O.1N NaOH	A	10.27	10.91	11.64	12.11
	B	10.39	10.88	11.82	12.13
Reducing sugars % juice	A	1.22	1.23	1.30	1.33
	B	0.83	0.87	1.01	1.09
Pol	A	14.72	14.39	14.43	14.29
	B	16.45	16.23	15.92	15.37
Apparent purity	A	80.27	78.63	78.30	77.66
	B	82.85	82.62	81.47	80.63

Table VII. Millable cane yield, tonnes.ha^{-1}

	Irrigation interval, days			
	10	20	30	40
1976/77	61.6	58.9	53.5	49.8
1977/78	58.4	55.3	54.7	54.6
Mean	60.0	57.1	54.1	52.2

From the foregoing it may be safely concluded that irrigation at intervals of 10 days in periods of low temperature stress during the ripening-maturity phase of CoJ 46 is the best means of minimizing the detrimental effects of frost on juice quality. The higher turgidity in the leaf as well as in the sheath tissues was probably more conducive to optimal physiological functions of the sugar cane plant.

Summary

The maximum temperature was always higher under open-field conditions than in the interior of the crop and the reverse was true in the case of minimum temperature. The top portion of the crop experienced the lowest minimum temperature followed by the middle and bottom portions, while the reverse was true under open-field conditions. The soil temperature was lowest at a depth of 7.5 cm and increased with the depth of soil both inside and outside the crop. Irrigation intervals of 10 and 20 days induced significantly higher moisture content in soil than intervals of 30 and 40 days as well as higher moisture content and relative turgidity in leaf and sheath tissues, throughout the low temperature stress.

The gum content and electrical conductance of juice increased significantly during frost and thaw, while the juice pH decreased, with a corresponding increase in titratable acidity, with the onset of low temperature

Modifications physiologiques et biochimiques de la canne à sucre sous l'influence de l'humidité du sol au cours de la sollicitation par le froid

La température maximum était toujours supérieure dans les conditions de plein champ qu'à l'intérieur de la récolte et l'inverse était vrai pour le cas de la température minimum. La partie supérieure de la récolte a subi la température minimum la plus basse, suivie par les parties du milieu et du pied, tandis que l'inverse était vrai sous les conditions de plein champ. La température du sol était la plus basse à une profondeur de 7,5 cm et augmentait avec la profondeur à la fois à l'intérieur et à l'extérieur de la récolte. Des intervalles d'irrigation de 10 et 20 jours ont induit une teneur en humidité du sol nettement plus élevée que des intervalles de 30 et 40 jours, ainsi qu'une teneur plus élevée en humidité et une turgescence relative plus élevée dans les tissus de feuilles et gaines, tout au long de la sollicitation par le froid.

La teneur en gommes et la conductivité électrique du jus augmentèrent de façon significative pendant la période des gelées et rosées, tandis que le pH du jus baissait, avec un accroissement correspondant en acidité titrable dès la sollicitation par basse température. Durant les gelées on constata un accroissement en sucres réducteurs, avec une baisse correspondante en saccharose et en pureté du jus, mais les conditions s'inversèrent par après. Ces modifications physiologiques dues aux basses températures étaient minimalisées par l'application de l'irrigation à des intervalles de 10 jours. Il est intéressant de noter que la production la plus élevée en canne broyable a été obtenue par irrigation à 10 jours d'intervalle au cours de l'hiver.

Physiologische und biochemische Veränderungen im Zuckerrohr unter dem Einfluß von Bodenfeuchtigkeit bei extrem niedriger Temperatur

Das Temperaturmaximum war unter den Bedingungen des freien Feldes immer höher als im Inneren der Kultur, und entgegengesetzt war es der Fall beim Temperaturminimum. Die höheren Lagen der Kultur hatten die niedrigsten Temperaturminima gefolgt von den in den mittleren und unteren Lagen, während es unter offenen Feldbedingungen entgegengesetzt war. Die Bodentemperatur war am niedrigsten in 7,5 cm Tiefe und nahm mit der Bodentiefe zu, sowohl innerhalb als auch außerhalb der Kultur. Bewässerungspausen von 10 und 20 Tagen induzierten einen bedeutend höheren Feuchtigkeitsgehalt im Boden als Intervalle von 30 bis 40 Tagen sowie höheren Feuchtigkeitsgehalt und relative Turgeszenz in Blatt und Blattscheidengewebe während extrem niedriger Temperaturen.

Der Gehalt an Gums und die elektrische Leitfähigkeit des Saftes nahmen bei Frost und Tau signifikant zu, während der pH-Wert des Saftes abnahm mit einer entsprechenden Zunahme an titrierbarer Säure bei einem Schock durch extrem niedrige Temperaturen. Reduzierende Zucker nahmen bei Frost zu mit einem entsprechenden Rückgang an Saccharose und Saftreinheit, jedoch wandelten sich diese Bedingungen später ins Gegenteil um. Diese physiologischen Veränderungen infolge niedriger Temperaturen wurden gemindert durch Bewässerung in zehntägigen Intervallen. Interessanter Weise wurde der höhchste Ertrag an zu verarbeitendem Rohr bei einem 10tägigen Bewässerungsintervall im Winter erzielt.

Cambios fisiológicos y bioquímicos en caña de azúcar como influenciado por agua en el suelo durante esfuerzo a causa de temperatura baja

La temperatura máxima estuvo siempre más alta en condiciones de campo abierto que en el interior de la cosecha y el contrario estuvo verdad en el caso de la temperatura mínima. La porción más alta de la cosecha sufrió la temperatura mínima la más baja con, en sequencia, temperaturas mínimas menos baja para las porciones medias y en el fondo; estuvo verdad el contrario en condiciones de campo abierto. La temperatura del suelo estuvo la más baja en una profundidad de 7.5 cm y creció con profundidad de suelo dentro y por fuera de la cosecha. Regadío en intervales de 10 y 20 dias inducio contenidos significamente más altos de agua en el suelo que intervales de 30 y 40 días, tanto como más alto contenido de agua y turgencia relativa en tejidos de la hoja y la vaina durante el esfuerzo a causa de temperatura baja. El contenido de goma y conductancia eléctrica de jugo creció significamente durante helada y deshielo, mientras que el pH del jugo se disminuió, con un aumento correspondiente en acidez por titración, del comienzo del esfuerzo a causa de temperatura baja. Había durante helada aumento de azúcares reductores, con una disminución en sacarosa y pureza del jugo, pero esta condición se invertió después. Estos cambios fisiológicos como función de temperatura baja se redujeron al mínimo por aplicación de regadío en intervales de 10 dias. Es interesante que el rendimiento más alto de caña para molienda se obtuvo con intervales de regadío de 10 días durante el invierno.

Sugar beet phenols

Investigation of phenolic compounds from sugar beet in relation to the formation of colour

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PART II

IDENTIFICATION OF THE COMPOUNDS IN THE CHROMATOGRAMS

In the previous sections we have used the chromatograms from the HPLC analyses to characterize juice from various sources. We shall now discuss the nature of the compounds using identified peaks to quantify the amount of compounds concerned. We had three methods at our disposal:

(a) investigations of elution volume,
(b) recovery of substance when purifying a standard compound, and
(c) investigations of the absorption spectra of standard compounds and peaks in the chromatograms.

Elution volumes

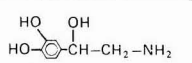
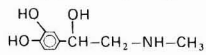
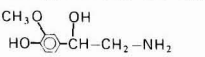
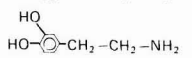
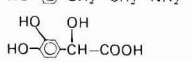
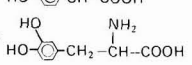
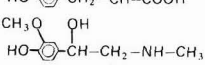
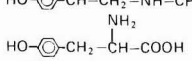
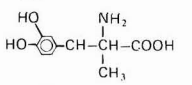
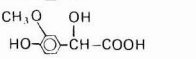
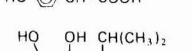
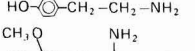
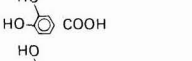
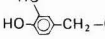
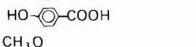
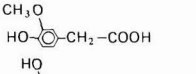
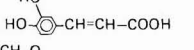
A large number of standard compounds (from Sigma Chemical Company) have been studied. A number are listed in Table I according to their elution volume (V_e). The elution volumes found for the compounds in the last part of the table may show some variation and depend, to a certain extent, on the time the data were obtained. The relative volume of eluate for two compounds was constant. It may be seen that compounds with low polarity leave the column late. Substituting $-CH_3$ for a -H leads to a substantial increase of elution volume. Compounds containing nitrogen have a low elution volume.

Recovery of substances

To evaluate the features of the substances which are purified during the procedure with alumina, a solution of each of the standard substances was purified like raw juice. The juice after purification was run on HPLC, and the area of the peak (if any) was compared with the area of a chromatogram of a solution of the standard compound. The ratio between the two areas is called the recovery (R). Theoretically, the highest value of R is 1.00. Losses during the purification procedure mean that the value found in practice is considerably below 1.00. A list of values for R is given in Table I. It will be seen that a condition of purifying a substance is that the compound contains OH-groups in the 1,2-positions. This fact places important restrictions on the kind of substance found in the HPLC chromatograms of raw juice. With a recovery of 0.45, the concentration of the

Table I: Phenolic compounds

The compounds are eluted from a "μBondapak" C_{18}-column with 0.2 (v/v)% acetic acid at a flow rate of 1.0 $cm^3.min^{-1}$ after adsorption of a 25 μl sample containing 0.005% of the compound in 0.2% acetic acid.

Compound	Formula	MW*	$\lambda(E_{max})$†, nm	V_e‡, cm^3	R§
L-Norepinephrine = L-Noradrenaline = L-Arterenol		169.2	280	3.1	0.48
L-Epinephrine = Adrenaline		183.2	280	3.7	0.45
DL-Normethanephrine		183.2	280	4.4	0.00
Dopamine = 3-Hydroxy-tyramine		153.1	280	5.0	0.45
DL-3,4-Dihydroxymandelic acid		184.1	280	5.4	0.05
L-Dopa = L-β-(3,4-Dihydroxyphenyl)-alanine		197.2	280	6.0	0.43
DL-Methanephrine = DL-*m*-O-Methyl-epinephrine		197.2	280	6.6	0.00
L-Tyrosine		181.2	280	7.8	0.00
Pyrogallol		126.1	265	8.6	0.30
DL-α-Methyl-Dopa = DL-2-Methyl-3(3,4-dihydroxyphenyl)-alanine		211.2	280	9.5	0.48
Hydroquinone		110.1	290	10	0.005
DL-4-Hydroxy-3-methoxy-mandelic acid = Vanillylmandelic acid = Vanilmandelic acid		198.2	280	11	0.00
DL-Isoproterenol = 1-(3',4'-Dihydroxy-phenyl)-2-isopropylaminoethanol = Isopropylarterenol		211.2	280	12	0.49
3-Methoxytyramine = 3-Methoxy-4-hydroxy-phenethylamine		167.1	280	14	0.00
L-3-Methoxy-tyrosine = L-3-0-Methyl-dopa		211.2	280	15	0.00
Resorcinol		110.1	280	18	0.00
Catechol		110.1	280	19	0.49
Protocatechuic acid = 3,4-Dihydroxybenzoic acid		154.1	290	28	0.24
3,4-Dihydroxyphenylacetic acid = Homoprotocatechuic acid		168.0	280	35	0.32
p-Hydroxy-benzoic acid		138.1	250	57	–
4-Hydroxy-3-methoxy-phenylacetic acid = Homovanillic acid		182.0	280	126	0.00
Caffeic acid		180.2	300	154	0.29
Ferulic acid		194.2	300	>154	–

* *Molecular weight.*
† Wavelength at maximum absorbance.
‡ Elution volume.
§ Recovery of the compounds by purification on alumina.

compounds in the sample for HPLC is about ten times the concentration in the juice.

Absorption spectra

All the standards examined contain an aromatic unit and have a maximum absorbance within the range 260-300 nm. The maximum values for $\lambda(E_{max})$ found are given in Table II. They were determined with a Pye Unicam SP8-100 spectrophotometer and the UV detector of the HPLC equipment, and are in agreement with values found in the literature[19]. Most of the compounds have a maximum at 280 nm. Compounds like caffeic acid with 4 conjugated double bonds have a maximum at 300 nm.

Table II. Maxima of peaks from HPLC chromatograms

Compound No.	Approx. retention vol., cm^3	Figure	$\lambda(E_{max})$, nm
I	2.8		280
II	2.9 - 3.1	8	280
III	3.7 - 3.8		290
IV	4.6 - 5.0		peaks at 280 and 290
V	5.2 - 5.4		280
VI	5.7 - 6.1	9	280
VII	∿6.5		290 or above
VIII	7.3 - 7.4		290
IX	17 - 21	10	260 and 290-300

The compounds purified from the factory juice were analysed at several wavelengths. On the basis of a large number of chromatograms, the absorption spectra of the peaks in the chromatograms from juice were recorded. Three of these are given as Figures 8, 9, and 10.

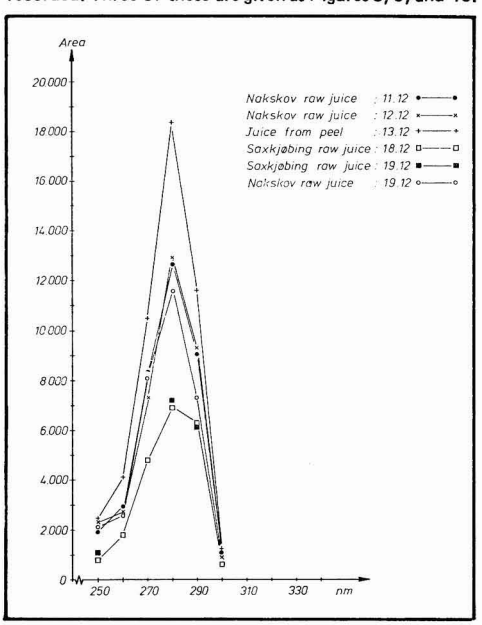


Fig. 8. Absorption spectra of peaks from purified juice found at an elution volume of 2.9 - 3.1 cm^3 in HPLC chromatograms

A summary of the results obtained is given in Table II for the high peaks. Most of the compounds represented by a peak in the chromatograms have a maximum in the range 260-300 nm. However, compound IX (Fig. 10) and possibly some of the small peaks have another shape.

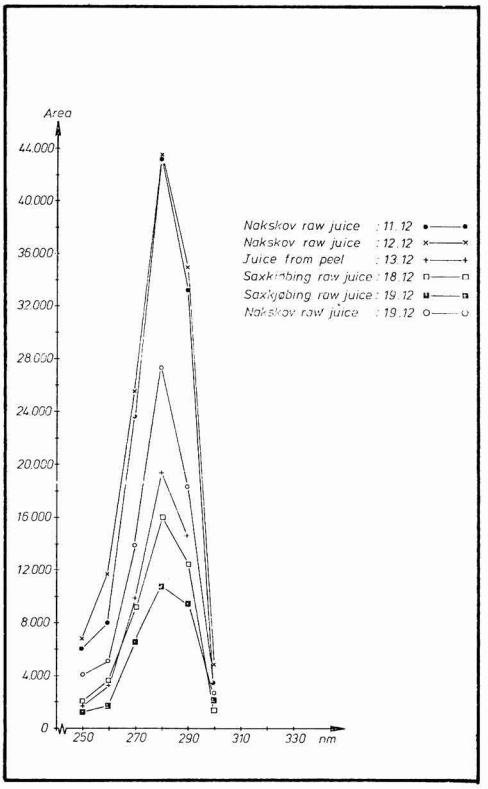
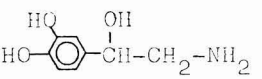


Fig. 9. Absorption spectra of peaks from purified juice found at an elution volume of 5.75 - 6.06 cm^3 in HPLC chromatograms

On the basis of the information achieved we have reached the following conclusions:

Compound I is norepinephrine:



[19] "Handbook of Chemistry and Physics", 50th edn., (Chemical Rubber Co., Cleveland), 1969.

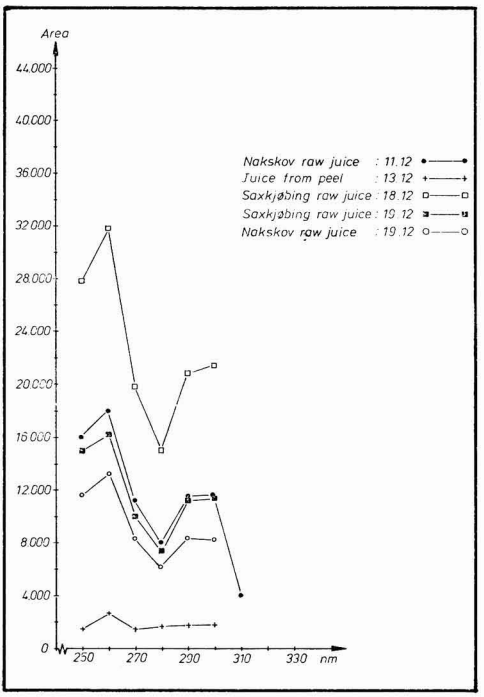
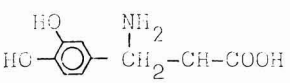
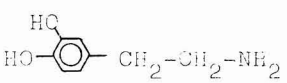


Fig. 10 Absorption spectra of peaks from purified juice found at an elution volume of 17 - 21 cm^3 in HPLC chromatograms

Compound VI is dopa:



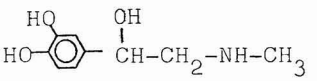
One of the compounds IV is dopamine:



This compound is represented by the peak at 4.95 cm^3 in Fig.2.

A number of observations may be made concerning the other peaks. The main part of the quantitatively predominant peaks is eluted between 3 and 9 cm^3 and includes most of the phenolic compounds containing nitrogen (see Table I). A generic term for these compounds, including those identified, is catecholamines. This term will be used from now on.

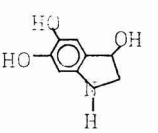
The shoulder after the 3.74 cm^3 peak in Fig. 2 could possibly be epinephrine:



The pathways of syntheses and metabolisms of the catecholamines are known from the physiological studies[20].

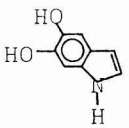
Dopa
↓ L-Aromatic amino acid decarboxylase
Dopamine
↓ Dopamine — ß — hydroxylase
Norepinephrine
↓ Phenylethanolamine-N-methyl transferase
Epinephrine

The 3.74 cm^3 peak (Fig. 2) represents a compound which, structurally, must be closely related to epinephrine and possibly also to norepinephrine according to our observations. In general, addition of an -NH-group to an aromatic ring will result in a shifting of the absorbance maximum towards a higher wavelength. For compound III the following formula may be suggested:



[20] Crout: "Catecholamine metabolism". Chapter in "Hormones and hypertension". Ed. Manager (C. C. Thomas, Springfield, IL.), 1966.

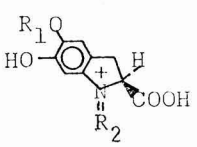
Theoretically, by dehydration this compound is transformed to:



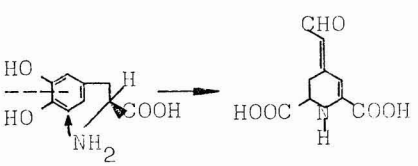
This compound has two aromatic rings, an indole ring system known from tryptophan and, like compound IX, may possibly be found in the later part of the chromatogram (see Table II).

A double ring structure formed by dopa and dopamine could explain some of the other compounds which have a maximum absorption at 290 nm.

It should be borne in mind that one of the natural pigments in beetroot is betanine. A unit in this compound is:



A biosynthetic pathway for another important unit in betalains is formulated on the basis of L-dopa, undergoing an oxidative cleavage and subsequent cyclization to become betalamic acid[2]:



A peak in the chromatograms might be an intermediate for this transformation.

The degradative metabolism of the catecholamines has been studied among higher animals, fungi, and bacteria[21] and should be the subject of investigations on the metabolism of sugar beet.

Analyses of the chromatograms can be used to exclude some phenolic compounds. We have concluded that catechol and pyrogallol are not of any importance in relation to the phenolic compounds in juice from sugar beet.

Quantitative analyses

For separated, identified peaks in a chromatogram from purified juice, for which the compound in question is available as a product of a known content, it is possible to estimate the amount of the compound in the juice. Data for norepinephrine and dopa are given in Table III. The day-by-day variations of the content are considerable and in agreement with variations in the size of the peaks in Figs. 8 and 9. The content of norepinephrine is about 1-2 ppm in raw juice and of dopa about 1-5 ppm with an average of 2.4 in ten determinations.

To estimate the approximate total concentration of catecholamines in raw juice we have added the areas in the chromatograms, and we have placed this sum in relation to the areas and concentrations of norepinephrine and dopa. In all cases the total content is below 20 ppm catecholamines in raw juice. The content in digestion juice of the green material is much higher, especially in relation to the content of RDS.

Summary

A method for analysing polyphenol compounds in raw juice has been developed. After addition to the raw juice of EDTA and ascorbic acid as a reducing agent, and filtration of the sample with "Celite" filter aid, the phenolic compounds are reversibly adsorbed on alumina at pH 8.4. After washing the alumina, the compounds in question are desorbed with acetic acid, and then separated and characterized by reverse phase HPLC.

In raw juice there are about a dozen compounds with OH-groups in the 1, 2-positions of aromatic rings. Of these some 6-8 are predominant. It is demonstrated that they are compounds called catecholamines and possibly some closely related compounds. Norepinephrine, dopa, and probably dopamine have been identified.

In raw juice the concentration of norepinephrine is 1-2 ppm and that of dopa 1-5 ppm. Together they amount to about 20-50% of the content of catecholamines in raw juice. The structures of the other compounds are discussed.

Altogether the compounds studied are believed to be of major importance with regard to colour formation within the sphere of beet sugar production, not only as colour-forming substances on their own but also as precursors of intermediates for known betalains from beetroot.

Catechol and pyrogallol are phenolic compounds of little importance in raw juice.

Les phénols de la betterave sucrière. Etude des composés phénoliques des betteraves en relation avec la coloration

On a mis au point une méthode d'analyse des composés polyphénoliques dans le jus brut. Après

[21] Towers & Subba Rao: *Recent Adv. in Phytochem.*, 1972, 4, 1-41.

Table III. Catecholamines in juice

"N" and "Sx" represent raw juice from the Nakskov and Saxkjøbing factories, respectively.

Juice	RDS	Norepinephrine	Dopa	Catecholamine (*)	Total (†)
		ppm	ppm	ppm	ppm
N 11/12	13.4	1.9	4.2	17	11
N 12/12	16.4	1.9	4.5	20	13
N 14/12	15.2	0.9	2.2	18	12
N 15/12	15.2	0.8	1.0	9	6
Sx 18/12	14.0	1.1	1.6	19	13
Sx 19/12	13.1	1.2	1.2	16	10
N 19/12	14.4	1.8	2.5	11	7
N 20/12	13.6	1.3	1.4	12	8
N 21/12	14.6	1.9	2.9	9	7
N 22/12	13.0	1.5	2.6	16	11
Green material	3.0	1.2	46 (‡)	50	52
Beetroot	8.4	1.3	50 (‡)	60	57

(*) Estimated from the content of norepinephrine
(†) Estimated from the content of dopa
(‡) Calculated as dopamine

addition au jus brut d'EDTA et d'acide ascorbique comme agent réducteur et filtration de l'échantillon avec du "Celite" comme adjuvant, les composés phénoliques sont adsorbés, de façon réversible, sur de l'alumine à pH 8,4. Après lavage de l'alumine, les composés en question sont désorbés avec de l'acide acétique puis séparés et caractérisés par chromatographie liquide à haute performance en phase inversée. Dans le jus brut, il y a environ une douzaine de composés avec des groupes OH sur les positions 1,2 des anneaux aromatiques. Parmi ceux-ci, quelques 6-8 sont prédominants. On démontre que ce sont des composés appelés catecholamines et, peut-être, quelques composés fortement apparentés. On a identifié la norépinéphrine, la dopa et, probablement, la dopamine. Dans le jus brut, la concentration de la norépinéphrine est de 1-2 ppm et celle de la dopa 1-5 ppm. Ensembles, elles représentent environ 20-50 % des catécholamines du jus brut. On discute de la structure des autres composés. On pense que l'ensemble des composés étudiées joue un rôle important dans la coloration en sucrerie de betteraves non seulement en tant que substances générant de la coloration par elles-mêmes mais aussi en tant que précurseurs d'intermédiaires pour les bétalaïnes de betteraves bien connues. Le catéchol et le pyrogallol sont des composés phénoliques de peu d'importance dans le jus brut.

Zuckerrüben-Phenole. Untersuchung der phenolischen Inhaltstoffe von Zuckerrüben im Hinblick auf die Farbbildung

Eine Methode zur Analyse von Polyphenolen im Rohsaft ist entwickelt worden. Nach Zugabe von EDTA und Ascorbinsäure als Reduktionsmittel zum Rohsaft und nach dessen Filtration durch "Celite"-Filtrationshilfsmittel, werden die phenolischen Verbindungen reversibel auf Aluminiumoxid bei pH 8,4 adsorbiert. Nach Waschen des Al_2O_3 wurden die untersuchten Verbindungen mit Essigsäure desorbiert und dann durch Rückphasenhochdruckflüssigkeitschromatographie trennt und charakterisiert. Im Rohsaft wurden ca. ein Dutzend Verbindungen mit OH-Gruppen in der 1,2 Stellungen an aromatischen Ringen gefunden. Von diesen machen ungefähr 6 bis 8 den Hauptteil der Masse aus. Es wird gezeigt, daß diese Verbindungen entweder Catecholamine oder eng mit diesen verwandt sind. Norepinephrin, Dopa und wahrscheinlich Dopamin wurden identifiziert. Im Rohsaft beträgt die Konzentration an Norepinephrin 1-2 ppm und diejenige von Dopa 1-5 ppm. Beide zusammen machen ungefähr 20-50% des Gehaltes an Catecholaminen im Rohsaft aus. Auch die molekulare Struktur der anderen Bestandteile wird diskutiert. Insgesamt ist man der Meinung, daß die untersuchten Verbindungen von größter Bedeutung für die Farbbildung bei der Rübenzuckergewinnung sind, und zwar nicht nur was die farbbildenden Stoffe allein anbelangt, sonder auch als Vorläufer von Zwischenprodukten für bekannte Betalaine aus der Rübenwurzel. Catechol und Pyrogallol sind phenolische Inhaltstoffe von geringer Bedeutung im Rohsaft.

Fenoles de remolacha azucarera. Investigación de compuestos fenólicos de remolacha azucarera respecto de la formación de color

Se ha desarrollado un método para analizar compuestos polifenólicos en jugo crudo. Después de adición al jugo crudo de EDTA (ácido tetra-acético de etilenadiamina) y ácido ascórbico como agente reductor, y filtración de la muestra con "Celite" filtro-ayudo, los compuestos fenólicos se adsorben reversiblemente sobre alumina a pH 8,4. Después de lavado de la alumina, los compuestos en cuestión se desorben con ácido acético y entonces se separan y se caracterizan por reversa-fase cromatografia liquida de alta presión. En jugo crudo hay una docena de compuestos con grupos OH en las posiciones 1,2 de anillos aromáticos. De éstos, unos 6-8 predominan. Se demuestra que son compuestos nombrado catecolaminas y posiblemente algunos compuestos intimamente relatados. Norepinefrina, dopa y probablemente dopamina se han identificado. En jugo crudo, la concentración de norepinefrina alcanza 1-2 ppm y de dopa 1-5 ppm. Combinado, estos compuestos representan 20-50% del contenido de catecolaminas en jugo crudo. Las estructuras de otros compuestos se discuten. En conjunto, los autores creen que los compuestos estudiados son de mayor importancia respecto de formación de color dentro el esfero de producción de azúcar de remolacha, no sólo como materias colorigénicas por su propia cuenta sino como precursores de materias intermedias para betalainas conocidas de remolacha, también. Catecola y pirogalola son compuestos fenólicos de menor importancia en jugo crudo.

Chinese sugar production, 1978/79[1]. – Production of cane sugar in China in 1978/79 amounted to 2,038,400 tonnes, raw value, while beet sugar production amounted to 535,900 tonnes.

[1] *World Sugar J.*, 1979, **2**, (1), 4.

SUGAR CANE AGRONOMY

A preliminary study of the energy inputs in the production of sugar cane. P. A. Donovan. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 188-192.—The expenditure on labour, herbicides, fertilizers, fuels and lubricants, machinery maintenance, chemicals other than herbicides, electricity and contracting work has been converted from monetary terms to input energy expressed as megajoules per tonne of cane produced. Comparison of farm sizes and factory area characteristics show statistically significant differences; this also applies to rain-fed and irrigated areas—in the former, 88% of the energy inputs is represented by fertilizers, fuel and machinery maintenance, whereas in the latter case the same three factors plus electricity account for 94% of the inputs. Considerable scope for energy saving is indicated by comparison of farms with high and low energy inputs, and by comparison of five methods of weed control, ranging from use of tractors for spraying and cultivation to hand hoeing.

Water duties for sugar cane grown during spring and autumn cycles at Pongola. D. B. Hellmann. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 200-205. When the South African sugar industry expanded into new areas where irrigation was required, no data were available on the amount of water to apply. Continued experimentation has been carried out at Pongola Experiment Substation, covering up to 10 ratoon crops. Results, discussed with the aid of tables and graphs, show that 51 mm of effective water applied on a 21-day cycle can be recommended for both spring and autumn cycle crops; this represents 2844 $ha.cumec^{-1}$ where sprinkler irrigation is used (giving 80% efficiency) 168 hours per week, or 1525 $ha.cumec^{-1}$ with surface irrigation used at 60% efficiency 120 hours per week. This recommendation could be applied to a considerable proportion of the cane grown in the irrigated cane areas of South Africa.

Long-term rainfall trends in the South African sugar industry. T. G. J. Dyer and J. M. Gosnell. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 206-213. Records from 18 rainfall stations were subjected to spectral analysis, which showed significant long-term oscillations with a mean wavelength of 19·2 years, varying from 17·7 years in the northern rain-fed areas to 22·5 years in the southern part of the cane belt. Shorter oscillations were also found. From this analysis, subjective projections and predictions based on sunspot behaviour, it is probable that most of the South African cane area will experience below-average rainfall in a number of years centred on the mid-1980's.

Wide planting furrows. C. Richard. *Sugar Bull.*, 1978, **56**, (19), 16-18.—While planting in wide furrows has not given significantly higher cane yields with all varieties, tests with specific varieties have shown significant increases with 18- or 14-inch furrows by comparison with furrows only 12 inches wide. However, it is stressed that, where the new practice is adopted, there is need to have the proper equipment to cover the wide furrows; otherwise there is risk of insufficient space between cane stalks lying in the furrow—the space should be almost numerically equal to the furrow width.

Drip irrigation. Fundamental principles, experience and application in the cultivation of sugar cane. E. Paz-Vergara P. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.* (Peru), 1976, **5**, (3/4), 1-38 (*Spanish*).—A general description is given of Latin American irrigation practices and characteristics of sprinkler and furrow irrigation described by contrast with drip irrigation. The principles of drip irrigation and the response of crops and their yields are indicated. The possibility of its use for desalinization is mentioned and information is presented on equipment, materials and costs, specifically in relation to cane cultivation. A bibliography available in the ICIA and related communications are listed.

Texture and salinity of soils in the Agrarian Cooperative "El Ingenio Ltda. No. 42". J. C. Sevilla G. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.* (Peru), 1976, **5**, (3/4), 39-58 (*Spanish*).—Analysis of soil samples taken in the area of CAP "El Ingenio" showed that the salinity values were not limiting for the achievement of good cane yields. Moreover, the analyses also indicated the presence of a shallow loamy soil above a stony layer very near the surface in most of the fields sampled.

Summary of investigations on fertilization with N, P and K carried out in the Casa Grande Agricultural Experiment Station during the decade 1960-1970. S. Valdivia V. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.* (Peru), 1976, **5**, (3/4), 59-77 (*Spanish*).—A summary is made of the results of fertilization experiments conducted at the Station, some of which have been published previously. Different nitrogen sources showed no significant differences in cane quality or yield. No yield response was found to different rates of K, nor was there a N × K interaction. No response to N occurred at rates between 160 and 240 $kg.ha^{-1}$, but significant responses were obtained to higher rates.

Effect of salinity on the germination of sugar cane. S. Valdivia V. and J. Pinna C. *Saccharum* (Publ. Cient. Inst. Central Invest. Azuc., Peru), 1977, **5**, (1), 51-59 (*Spanish*).—Evaluation of the effects of various levels of salinity on the germination of cane setts was studied in field experiments using variety H 32-8560. A highly significant correlation ($r = 0{\cdot}80$) was found betwen the two. To obtain good germination, better than 85%, the salinity, measured in terms of the conductivity of extract, should be less than 55 $mmho.cm^{-1}$, while a 50% reduction was observed when salinity corresponded to a conductivity of 9.7 $mmho.cm^{-1}$.

Application of vinasse by aspersion. J. M. Lorenzetti and P. G. R. Freitas. *Saccharum* (STAB, Brazil), 1978, **1**, (2), 16-22 (*Portuguese*).—Between 1970 and 1975 vinasse was distributed to cane fields at Usina São José by way of irrigation canals in which it was diluted 1:3 with water. This method gave rise to a number of problems, and in 1975 studies began on the distribution of vinasse in canals to pumping stations from which it was fed to spray points 60 m apart, each covering an area of 2800 m^2. The rates of application are quoted and the benefits

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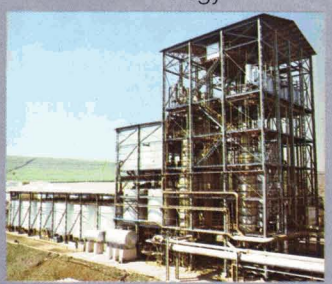

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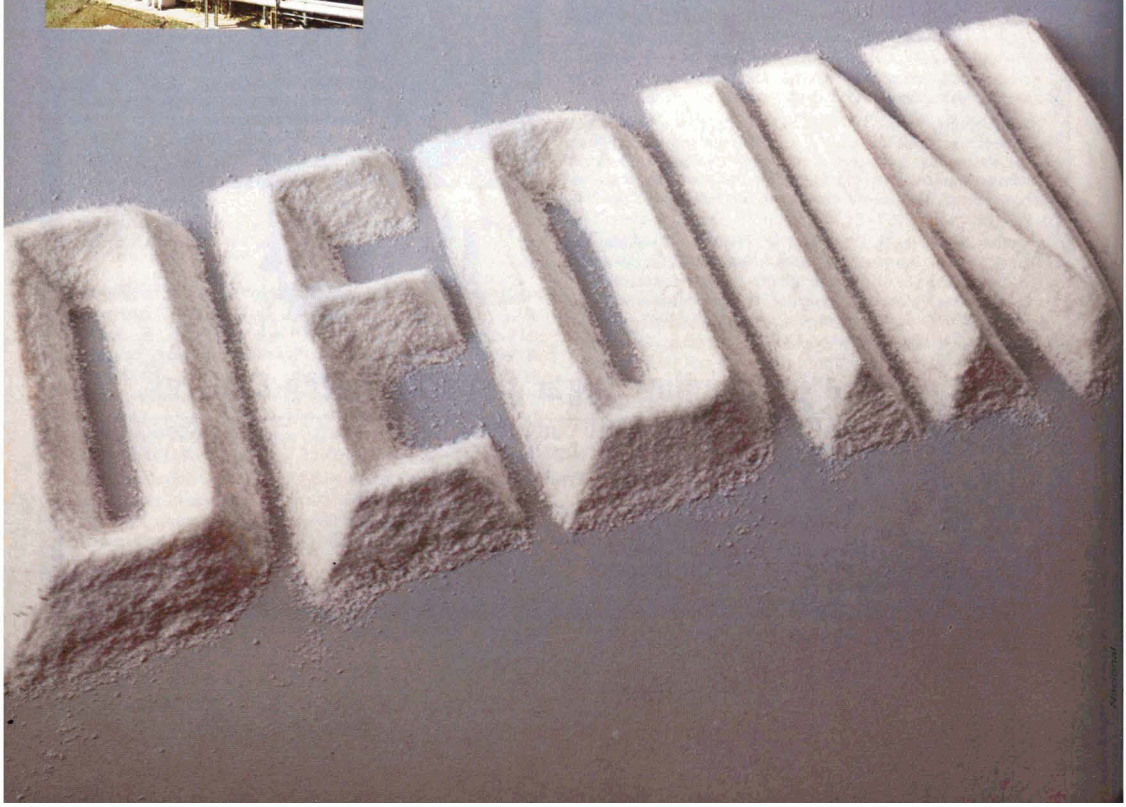

derived are discussed. The cost of vinasse application is lower than that of conventional fertilizer application and the response is better. Other advantages of the system are described.

Use of the Class A pan in determination of true evapotranspiration in the cultivation of sugar cane. N. A. V. Nova, O. O. S. Bacchi and R. Scardua. *Brasil Açuc.*, 1978, **91**, 164-173 (*Portuguese*).—A method described in a doctorate thesis by Souza in 1976 provided a measure of true evapotranspiration of cane based on rainfall and soil tensiometric measurements. By comparison of such measurements with Class A pan evaporation data, a crop coefficient varying between 0·62 and 1·05 with time during the year, and a pan coefficient of 0·75 or 0·85, could be obtained which, when applied to pan data, gave a simple and adequate value to evapotranspiration suitable to govern the supply of irrigation water to a cane crop.

Good results from minimum tillage. Anon. *S. African Sugar J.*, 1978, **62**, 349.—After difficulties in crop re-establishment on a farm where the heavy clay soil forms a crust during the winter months and poses problems in seedbed preparation, the grower investigated minimum tillage methods. The cane was cut, and further growth permitted until the majority of tillers appeared. Spraying with "Roundup" at 8 litres.ha^{-1} was followed, 1-2 weeks later (when the cane started dying), by seedbed preparation and furrow formation (in one operation) by means of a rotary cultivator. Seed cane was then planted and covered by hand; planting was not subject to any delays, even after heavy rain, and there was virtually no erosion (by contrast with the previous system). Germination and growth of the crop were very good.

A preliminary study on the effect of soil oxygen concentration on sugar cane growth. Y. S. Sheu, T. C. Yang and S. J. Yang. *Rpt. Taiwan Sugar Research Inst.*, 1978, (80), 1-11 (*Chinese*).—Investigations of the effect of soil oxygen concentration on cane growth showed that a low concentration induced by poor drainage reduced root development and cane growth, as well as leaf N, P and K in the initial weeks of the growing season. All factors studied correlated closely with soil oxygen concentration in the period from June to October. As a result of the poor drainage, yield fell by 17-50% according to soil condition and planting date.

Cultural practices in relation to the low-temperature effect on sugar cane in north India. R. S. Kanwar. *Sugar News* (India), 1978, **10**, (2), 11-15.—The adverse effects of frost on cane are examined, and possible means of protecting cane from frost are described.

Exploring "no man's land" of sugar cane research. G. Arceneaux. *Sugar J.*, 1978, **41**, (3), 35-36.—The value of small-scale milling to give estimates of sugar recovery from cane, particularly where different varieties are involved, is discussed[1]; references are made to the use of high-extraction milling to supplement results of field experiments at Central Romana in the Dominican Republic, where the varietal correction factor is routinely determined for all promising seedlings in variety trials and for parent canes used in the breeding programmes. Mention is made of inconsistency in estimations of sugar loss caused by the stalk borer, *Diatraea saccharalis*; the error was attributed to wide variation in the weight of internodes, which affected the validity of the practice of denoting borer damage levels as percentages of affected internodes. While expression of the damage in terms of rind punctures per weight of cane would be more universally applicable, the term "percentage of bored joints" is so well established that it would be unpractical to replace it; hence, both methods are used.

N-P-K fertilization of sugar cane in the Mata zone of Minas Gerais. M. S. Manhães, D. F. Azeredo and A. A. Peixoto. *Brasil Açuc.*, 1978, **91**, 314-320 *(Portuguese).* Trials were made, with one replication, using two levels of N, two of P and two of K on plant cane of variety CB 45-3 in a red-yellow latosol, harvested at 16 months. Nitrogen had no consistent positive effect but phosphorus increased yield. Potassium reduced the recoverable sugar in one experiment, but in another increased the production of cane. The best doses were 90 kg.ha^{-1} P_2O_5 and 50 kg.ha^{-1} of K_2O.

A new sugar cane herbicide. J. Everitt and J. Louw. *S. African Sugar J.*, 1978, **62**, 403.—"Bladex Plus SC" (containing "Cyanazine" and "Atrazine" as active ingredients) at 9 litres.ha^{-1} has given good control of guinea grass (*Panicum maximum*) and yellow nutgrass (*Cyperus esculentus*) as well as other grasses and broad-leafed weeds in cane fields. It has been registered for use as a post-emergence herbicide in cane in South Africa.

Irrigation research in Hawaii. *Ann. Rpt. HSPA Expt. Sta.*, 1977, 11-16.—Peak effort in drip irrigation research was made during 1973/74. During the subsequent six years, over 30,000 acres in Hawaii has been provided with the system and efforts have been directed to perfecting the use of accumulated hydraulic data, testing of equipment, development of controllers, fighting ant damage to tubes, study of the use of dirty water and sewage effluent for irrigation and evaluating subsurface (deep) irrigation as an alternative to drip (shallow) irrigation. Drip tubes were subject to testing and water distribution profiles developed to aid designing of irrigation system layouts. The use of rubber tubes for subsurface irrigation would be cheap and it was found that blocked orifices could be cleared when the rubber expanded under application of 20 psi pressure for reactivation of the system for a second year's use. An irrigation controller employing a microprocessor has been developed to a prototype and the software is essentially complete for testing. Microscopic examination of tubes and tube orifices in a drip system has shown that plugging is due to many mechanisms; the present system of irrigation water filtration and chlorination appears satisfactory to prevent plugging but should be tested for any new source of water to be used.

Fertilization, soils and nutrition research in Hawaii. *Ann. Rpt. HSPA Expt. Sta.*, 1977, 17-20.—Preliminary work indicates that phosphate may be applied to cane soils through drip irrigation tubing and will provide adequate nutrient levels. Phosphate application in irrigation water is inferior to placement below the seedpiece in a plant crop, especially during early growth, but should give as good results as side-dressing of a ratoon crop and eliminate a special fertilization operation. A urea/ammonium nitrate nitrogen source for irrigation water application is under study; it contains 32% N, is compatible with hard water and is cheaper to store and transport, while the N is not volatile and the solution is odourless.

[1] Arceneaux: *I.S.J.*, 1976, **78**, 86.

Cane growth and metabolism research in Hawaii. *Ann. Rpt. HSPA Expt. Sta.,* 1977, 21-30.—In the 2½ years after Federal registration of "Polaris" the cane area treated in Hawaii rose to about 60% of that harvested. New ripeners are under study; MON-8000, a formulation of the sodium salt of "Glyphosate", has shown promise in offering a greatly increased ripening effect with less variability in the results and at lower application rates. High leaf nitrogen (over 1.45%) appears to protect the cane from ripener effect while low leaf nitrogen (below 1.26%) indicates that the cane is already ripe; the ripener produces a good response at intermediate levels of N (between 1·26 and 1·45%). Trials at different locations showed that variable results were obtained and depended on the ripener and the time of application. An elevated spray boom has been developed for application of ripeners to mature cane, and tests have shown that some chemicals showed activity when applied to cane through drip irrigation tubing. Application of gibberellic acid is better at regular intervals of 30 days than 15; the response depends on the variety of cane. It acts by increasing the length, weight and pol content of lengthening joints but does not increase leaf area. A study on flowering and climatological data for 1973-77 and for ten varieties has been made and a number of conclusions drawn. Transport through the cell plasma membrane has been studied and its linkage with electrolyte balance established, which may be useful in agronomic practice. The presence of an invertase active at pH 2·5 in leaf tissue has been confirmed, and it was also located in sheath tissue. There are several invertases in cane, and work is continuing on their regulation by chemical means. About 13% of carbon fixed by cane is metabolized via starch in cane leaves, and storage during daylight is greater than the rate of starch metabolism, resulting in accumulation. The activity of starch-synthesizing and -degrading enzymes is under study, but has been shown to differ with cane variety. A number of characters have been studied as criteria for assessment of drought resistance, and this work is to continue.

Weed control research in Hawaii. *Ann. Rpt. HSPA Expt. Sta.,* 1977, 31-33.—Trials have continued with "Roundup" for perennial grass treatment and application to irrigation water ditchbanks, while studies are being made on the persistence of soil residues. "Velpar" has shown promise in treatment of tougher weeds, including guinea grass, para grass and other grass and broad-leafed species. Perennial Johnson grass is not controlled, and dallis grass only responds to treatment in higher rainfall areas. Small plot trials showed good pre- and post-emergence activity against most weeds by "Ravage", but this has not yet been cleared for field testing. Laboratory studies have been completed on its degradation. Restrictive Federal regulations have also prevented receipt of any new herbicide for testing. Application of a number of herbicides in a single shock dose through drip irrigation tubing was tested; further work will use injection of herbicide into a water flow through the tubing, which may correct the non-uniformity of distribution observed. "Eptam" gave the best results on grasses, but broad-leafed weeds appeared after two weeks and were not controlled. "Evik" ("Ametryne") showed no effect initially but gave partial (but inadequate) control after several weeks.

Studies on intercropping of maize in sugar cane. J. P. Patil, V. D. Patil, S. S. Patil and B. K. Nikam. *Maharashtra Sugar,* 1978, **3,** (9), 35-40.—The sucrose content of cane was not appreciably affected by growing maize as an intercrop, but the yield was reduced by up to 32%. The net return was greatest from maize grown in alternate rows at 45 cm plant spacing, with addition of 50 $kg.ha^{-1}$ of N fertilizer.

Improving cane quality. G. K. Zende. *Maharashtra Sugar,* 1978, **3,** (9), 43-46.—Factors affecting cane quality are listed and the need for attention to a number of points in order to raise quality is indicated. Suitability of a number of cane varieties for different areas of Maharashtra is mentioned and the use of particular agronomic practices discussed, including the application of ripeners and micronutrients. The importance of correct water management is briefly mentioned, as is the need to ensure optimum yield response by finding the best methods and intervals of fertilizer application. Other important topics include the use of good quality seed cane, timely disease and pest control measures, harvesting of cane on a maturity basis and payment of cane on a quality basis.

Anhydrous ammonia as a source of fertilizer for sugar cane. M. V. Dahiphale. *Sugar News* (India), 1978, **10,** (3), 6-13.—Anhydrous ammonia was compared with other forms of nitrogen fertilizer in trials at three locations over three seasons. Yield differences were not significant, but it is concluded that larger-scale trials are warranted, since it is a cheaper form of N than other compound and solid fertilizers.

The role of nutrients in sugar cane and signs of their hunger. U. S. Singh. *Indian Sugar,* 1978, **28,** 19-25. The role of major and minor elements in the sugar cane and symptoms of deficiency are described; they include nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, zinc, copper, boron and molybdenum.

Effect of intercropping on the yield of spring-planted sugar cane. S. S. Narwal and K. L. Behl. *Indian Sugar,* 1978, **28,** 27-29.—Studies were made of the effects of three intercrops grown in cane fields in Haryana, the yields and income from the combined crops being calculated and other effects noted. A good additional income may be obtained by growing moong between rows of cane at 75 and 90 cm spacing. It matured quickly and interfered least with cane growth, whereas cowpeas and bhindi reduced cane yields by 11% and 15%, respectively.

Nitrogen and sugar cane. XV. Nitrogen metabolism in relation to growth. U. S. Singh. *Indian Sugar,* 1978, **28,** 81-85, 105.—In investigations on nitrogen metabolism in cane stalks and leaves it was found that the stalk accumulated 21·6% total N during the tillering phase, 51·4% during the elongation growth period and 63·4% during the sugar accumulation phase; corresponding accumulation of total dry matter was 21·9%, 64·9% and 76·2%. The leaves accumulated 78·4%, 48·6% and 36·6% N and 78·1%, 35·1% and 23·8% dry matter in the three phases. N requirement per tonne of dry matter in the stalk was 11·03, 1·90 and 2·21 kg in the three growth periods, while for the leaves the requirement was 26·17, 14·91 and 13·07 $kg.tonne^{-1}$. The patterns of N and dry matter accumulation with growth as shown by these values are discussed.

CANE PESTS AND DISEASES

Brown spot of sugar cane in Taiwan. W. H. Hsieh and D. S. Tseng. *Rpt. Taiwan Sugar Research Inst.*, 1978, (79), 29-36.—A cane leaf disease occurring on a wide scale in a region of eastern Taiwan gave symptoms similar to brown spot and was in fact found to be caused by a new strain of the brown spot pathogen, *Cercospora longipes.* The disease is characterized by 0·3-2·0 × 1·0-5·0 mm reddish-brown lesions on the leaf and leaf sheath. The reactions of 41 cane varieties and of *Saccharum spontaneum* to the disease are recorded.

"Heptachlor" resistance in sugar cane white grub, *Alissonotum impressicolle*, and wireworm, *Melanotus tamsuyensis.* S. A. Hsieh. *Rpt. Taiwan Sugar Research Inst.*, 1978, (79), 37-42 (*Chinese*).—Populations of both title pests have been found in Taiwan which are highly resistant to "Heptachlor", evidently a result of application of the pesticide in a localized area over a number of consecutive years.

Non-volatile nematicides: an initial assessment in north Queensland sugar cane fields. K. J. Chandler. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 85-91. Trials with "Aldicarb" ("Temik") at 5.6 and 2.8 kg.ha^{-1} and "Oxamyl" ("Vydate") at 8.4 kg.ha^{-1} are reported. Tabulated data indicate that both nematicides increased sugar yield from plant and ratoon crops as a result of reduction in nematode numbers and associated cane growth improvements. "Aldicarb" at the higher dosage rate generally gave the best results. The question of suitable time of application is briefly discussed.

Evaluation of new rodenticides in Queensland cane fields. B. E. Hitchcock and R. E. Kerkwyk. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 93-95. In trials on control of *Rattus conatus* in cane fields, two new anti-coagulants, "Diphenacoum" at 0.01% and "Diphacinone" at 0.025%, were similar in effect to thallium sulphate at 0·3%. The results are expressed in terms of the number of damaged cane stalks counted after preharvest burning. The machine-packeted, wholewheat baits used were dropped from an aircraft. The effectiveness of the chemicals against the climbing rat, *Melomys littoralis,* could not be determined because of its absence from the cane fields.

Eye spot disease in far north Queensland. T. G. Willcox and C. M. McAleese. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 103-106.—The development of eye spot in the title area from 1970 to 1976 is traced and the effect of the disease on cane sugar content indicated. Its spread was attributed to weather conditions and to planting of the variety Q 101, which was removed from the lists of approved varieties in 1976. While, under conditions favouring spread of the fungus, a number of current commercial varieties are susceptible to varying degrees of infection, it is thought unlikely that the scale would be that of the Q 101 infection.

Diagnosis of RSD using sugar cane uprights. D. S. Teakle, R. G. Birch and J. M. Appleton. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 107-110. Tests, in which uprights of bana grass *(Pennisetum purpurem x P. americanum)* and of Q 28 cane were inoculated with ratoon stunting disease pathogen, showed that the cane can be used as an alternative to uprights of elephant grass or bana grass for the rapid diagnosis of the disease, symptoms of which developed within 2-3 weeks when inoculation was carried out directly through the cut end of the spindle. While bana grass grows more vigorously and uniformly than Q 28 cane and develops more vascular discoloration, the cane produces more specific symptoms of the disease as well as of bacterial mottle, red stripe and leaf scald (the bacteria of which possibly interfere in RSD development). Sensitivity of both plants to diluted RSD inoculum appeared to be similar.

Land management and the creation of habitat for *Eldana saccharina* Walker (Lepidoptera: Pyralididae). P. R. Atkinson. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 137-138.—Investigations have shown that damage to or clearing of riverside woodland creates opportunities for the growth of reeds, grasses and sedges along the banks and on the river beds, and that *Cyperus immensus,* a host of *E. saccharina* borer, constitutes a high proportion of the sedges in one cane-growing region of South Africa. In addition, disturbance and drainage of beds of *Cyperus papyrus* also lead to heavy infestations of the pest. Planting of fast-growing trees such as *Schinus terebenthifolius* is recommended where the woodland has been cleared; otherwise, the woodland should be left as a safeguard against erosion and borer infestation.

Mill yard surveys of the lepidopterous cane borers *Eldana saccharina* Walker and *Sesamia calamistis* Hampson. R. J. Smaill. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 139-142.—results of surveys conducted in the mill yards of seven South African sugar factories are reported, and 1977/78 curves showing the incidence rates by months are compared with those for 1976/77. Amatikulu is shown to be the most seriously affected factory, as regards *E. saccharina* incidence, and monthly mean maximum temperatures are given for it. *S. calamistis* is more widely distributed than *E. saccharina* but is less harmful.

Mass rearing and artificial infestation methods for *Eldana saccharina* Walker (Lepidoptera:Pyralididae). P. R. Atkinson. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 143-145.—Details are given of the standard method used at the South African Sugar Association Experiment Station for mass rearing of the borer and artificial infestation of cane with it so as to ensure uniform distribution and give infestation rates which are sufficient *e.g.* to permit evaluation of insecticides. Cane tends to be an unsuitable host for *E. saccharina* because of the difficulty which young larvae apparently experience in penetrating the stalk.

Morphology of the lesser sugar cane borer *Elasmopalpus lignosellus* Zeller (Lepidoptera: Physitidae). E. E. Carbonell T. *Saccharum* (Publ. Cient. Inst. Central Invest. Azuc., Peru), 1977, **5**, (1), 18-50 (*Spanish*).—A complete morphological study is presented of the title borer, considered a minor pest of sugar cane which it attacks during its first three months of growth.

CANE BREEDING AND VARIETIES

Cane varieties in Jamaica. *Ann. Rpt. Sugar Ind. Research Inst.,* 1974, 36-66.—Details are given of the distribution of cane varieties and trends in Jamaica, while tabulated details are given of varietal trials in 1974. Outstanding in terms of sugar yield was HJ 5741, which occupied 27% of the total estate area harvested, thus displacing B 4362 which had been the dominant variety for the previous 12 years.

Release of new variety: N 11. Anon. *S. African Sugar J.,* 1978, **62,** 267.—Information is given on N 11, newly released for general cultivation in South Africa. A progeny of the Brazilian variety, CB 40/35, and N:Co 293, it has shown high resistance to smut, leaf scald and mosaic and has consistently outyielded N:Co 376 in terms of sugar under irrigation conditions on well-watered, fertile sites. While its sugar yield is lower than that of N:Co 376 under rain-fed conditions, its higher sugar content (some 1·2 units greater than that of N:Co 376) and disease resistance could warrant its use in areas where such conditions are typical. It performs poorly on recently formed sands, however.

Sugar cane improvement in São Paulo state. F. Brieger. *Saccharum* (STAB, Brazil), 1978, **1,** (2), 13-16 *(Portuguese).*—A graph shows the changes in varieties grown in São Paulo between 1972 and 1977. The most common variety remains CB 41-76 but new ones have been introduced and are increasing in popularity (IAC 52-150, CB 47-355, CB 40-13 and, especially, NA 56-79) while others have disappeared (CB 36-24, CB 40-77, IAC 50-134 and Co 419). Other varieties have continued in use, some with increased areas and others reduced (IAC 51-205, IAC 48-65, CB 46-47, CB 49-260, etc.). Susceptibility to disease is one cause of elimination of varieties and examples of these in Brazil are given. Parameters governing the selection of varieties are listed and discussed, including yield and sucrose in both plant cane and ratoons; adaptation to the soils, climate, etc.; response to fertilizers; resistance to pests and diseases; adaptability to cultivation practices; and good industrial characteristics.

Study of the behaviour of some sugar cane varieties (*Saccharum* spp.) at low temperatures. Experiment II. O. Brinholi, E. C. Ferraz, D. A. S. Marcondes and J. R. Machado. *Brasil Açuc.,* 1978, **91,** 258-265 *(Portuguese).* Eleven cane varieties were grown in an area subject to low temperature and their resistance to frost determined. The most resistant was N:Co 310 and the least resistant CB 41-76 and CB 56-155.

Loss of genotypes of sugar cane in group transplanting. T. G. Pimenta, R. Ruschel and T. G. Pereira. *Brasil Açuc.,* 1978, **91,** 302-304 *(Portuguese).*—It has been found that, when seedlings from sugar cane crosses are planted in groups to permit the testing of large numbers in a restricted area, many of them do not develop and are lost, only the stronger survivors continuing to the next stage of selection.

Cane breeding and selection in Hawaii. *Ann. Rpt. HSPA Expt. Sta.,* 1977, 4-10.—A rapid increase in preliminary testing of new varieties made possible replacement of smut-susceptible varieties in Hawaii, and several promising smut-resistant ones occupy more than 100 acres each. Two derivatives of Thailand *Saccharum spontaneum* seedlings have shown themselves adapted to the Hilo and Ka'u climates and have high yield potential, so being of interest as a source of breeding material. The area under variety H 59-3775 increased to 44·2% in 1977, far ahead of H 50-7209 (19·6%), H 54-775 (13·0%) and H 57-5174 (11·4%). The second is losing ground because of its smut susceptibility. A total of 4269 crosses were made in the 1976/77 crossing season, including 1987 "melting pot" crosses and 314 biparental crosses. Lower than normal temperatures and rainfall during the crossing season reduced pollen production, but seed set and germination were excellent. Field testing continued, a new strain of smut being a factor for selection. A number of triploid clones have been derived from crosses of known tetraploid clones (obtained using callus tissue and cell suspension techniques) with diploid Hawaiian commercial hybrids; these are to be used to determine their performance as parents in crosses and to find if a relationship exists between ploidy level and cane performance. A rapid enzyme technique has been developed to allow production of healthy protoplasts within 3-4 hours. After callus tissue has differentiated into shoots on a conventional medium it is transferred to a 1% agar, 7% sucrose medium in which the tissue develops a vigorous root system and the plants can be moved into vermiculite. Biochemical study of enzyme activity in cane has shown significant differences following different levels of N treatment.

Some observations on propagation and selection in young potted sugar cane seedlings. D. W. Thomas. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 193-194.—Cane seedlings, which had been grown in pots for 8 months (the normal period in the breeding programme at Mount Edgecombe), were cut at soil level and weighed, and the juice Brix determined. Both the underground parts and the stalks (setts) were used to establish single stools in the field. When the underground parts were used, only 45-58% of the plants survived, whereas 82-98% of the stalks survived. A correlation coefficient of 0·34 was found between the above-ground weights of the potted seedlings and the weights of the field-grown stools, while one of 0·32 was established between seedling and stool Brix.

More discussion on new varieties. C. Ricaud. *Sugar Bull.,* 1978, **56,** (21), 12.—While CP 70-321 and CP 70-330 give adequate yields and are early-maturing high-sucrose cane varieties, their leaves remain upright during growth and do not form a canopy, so that weeds can grow between the cane. They are also susceptible to ratoon stunting disease, and setts must be heat-treated before planting. CP 70-330 is susceptible to cold and has a moderately high fibre content, while CP 70-321 has a slight tendency toward brittleness.

CoS 758 -a new mid-late sugar cane variety for east U.P. B. K. Mathur and A. Nath. *Indian Sugar,* 1978, **28,** 127-128.—A description is given of CoS 758 variety which, in trials during 1973-76, performed almost as well as the mid-season variety, BO 17, in respect of yield and juice purity.

CANE SUGAR MANUFACTURE

Problems associated with the operation of high-generation bagasse boilers. R. E. Bickle and M. K. Moir. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 249–253.—After two months' operation of a new Babcock & Wilcox bagasse-fired boiler installed at Pioneer factory in 1976, problems were encountered in the form of tube blockage by sludge (principally a mixture of calcium and magnesium silicate, carbonate and phosphate) and in breaks in bagasse feeding direct from the final mill to the furnace, eventually causing mechanical defects in the boiler. Remedial measures are described. It is stated that the design of the boiler, rated at 181,200 $kg.hr^{-1}$ and three times larger than one installed at the same factory 10 years previously, was sufficiently different that installation should have been accompanied by a critical analysis of all existing related equipment and past operating procedures in order to effect its complete integration into the plant.

'O' ring seals in juice heater headers. T. W. Gatley. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 255–258.—Erosion of juice heater tubeplates in the area covered by the header is a persistent problem which can be sufficiently serious to require the fitting of new tubeplates. However, one means of preventing it is the use of 'O' rings compressed between the outside of the tube, the tubeplate and the recess in the header. After the season's operation, there was little trace of leakage at one end of a juice heater modified in this way at Fairymead factory; previously, both tubeplates and headers had suffered bad erosion. However, the 'O' ring is more expensive than a flat seal.

Design data for bulk sugar storage bins. D. G. Fry. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 267–272.—After a 3000-tonne storage bin at Proserpine factory collapsed, inspection failed to show causes of the failure, although the design was considered satisfactory; overstressing of some inferior welded connexions between the bin shell and columns may have started a chain reaction of failure, it is suggested. The designer of the bin, which was subsequently rebuilt with only slight modification, examines various design factors; the information given is applicable to the design of bins of up to 1500 tonnes capacity.

The application of a programmable controller to a cane truck handling system at Pleystowe mill. R. Diplock and K. Marshall. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 313–316.—The system used at Pleystowe for automatic control of cane train movement, weighing of cane per bin, discharging of contents and removal of trucks carrying empty bins is described. The system performed excellently for a whole season during which 940,000 tonnes of cane were crushed.

Chemical cleaning of evaporators. P. C. Ivin. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 321–326.—Pilot-scale evaporators, operating under the same conditions as final effects, were set up at Racecourse and Kalamia sugar factories. Each comprised three stainless steel tubes surrounded by a steam chamber supplied directly with vapour from the full-scale effect. Syrup was also fed from the preceding main vessel. Examination of the scale in the pilot vessel revealed considerable variation in composition with time and from top to bottom of the tubes. When the syrup was supplied from the final effect, the pilot evaporator scale contained mostly silica; when syrup was supplied from the 4th effect, CaO became the dominant component and the silica content dropped to a low level. Similar variability in composition was found at Kalamia, where most of the scales were characterized by high silica and relatively low CaO contents. Chemical cleaning tests were conducted on the pilot evaporators While boiling for 1 hr with 20-25% w/v NaOH solution at atmospheric pressure, or boiling for 1 hr with 30% NaOH under vacuum, did not remove all scale, the evaporator performances were not greatly affected by this; the corrosion rates under the effect of the caustic soda were acceptable, but the use of additives such as 3% CD 280 permitted a reduction of NaOH concentration to 5%, while still giving similar results on 1 hour's boiling. A two-stage treatment involving boiling for 1 hr with a 1.5% alumina-ferric solution, followed by $1\frac{1}{2}$ hr at 85°C with 4·5% NaOH solution, required higher capital cost but used the least corrosive materials, was more economical in use and provided an efficient means of scale removal.

Introduction of a maintenance system. R. A. Allaway and N. H. Barnes. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 327–333.—The computer-based maintenance system introduced at Mossman is described, aspects covered including job planning, budgeting and job control and progress reporting. Since the system is in its early stages it is not yet known whether it has been effective in its primary aim of reducing maintenance costs.

Shredder hammer performance at three Bundaberg mills. I. G. Flanders, J. S. Glass and G. N. McLucas. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 335–342.—The design, performance, maintenance and costs of shredder hammers at Millaquin, Bingera and Fairymead factories are examined. The performances of the shredders were approximately the same. The capital and maintenance costs were higher for hammers having tungsten carbide tips and were lowest for those with removable cast steel heads having wearing faces of hard alloy. A club head hammer was cheapest to install but its maintenance costs were high. Extrapolation of costs to allow for magnetic protection of tungsten carbide tips and for shredders with equivalent loading showed that hammers with replaceable hard-faced heads were likely to be more economical.

The development of non-bituminous mill journal lubricants. I. D. Blackburne, R. G. Hafner, J. F. Rae and K. B. Hurst. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 343–348.—The advantages of non-bituminous lubricants over bituminous compounds used for cane mill journal lubrication are indicated in this examination of the performances of both types of lubricant. Laboratory tests were confirmed by data obtained from a number of mills using non-bituminous lubricants in the 1977 crushing season.

Sugar mill gearing. J. R. Partridge. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.,* 1978, 349-354. The types, arrangements, selection, design, lubrication and installation of gearing generally used for cane mills are discussed.

Mourilyan ash removal system. J. T. Logan and A. L. Fitzmaurice. *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.,* 1978, 355-358.—When a new Riley Dodds boiler was installed at Mourilyan, problems arose with the ash removal system which had been used for the previous boilers, the difficulties being due to the much greater quantity of very fine ash from the highly efficient dry arrestors. The settling tank for the ash slurry and the paddle-wheel settled ash remover were relocated above ground near the boiler, the drive was strengthened, and bagasse was continuously fed at about 44% on dry ash to the sluice way along which the ash travels to the settling tank (the bagasse having been found to improve settling, reduce the solids content of the sluice water and to contribute to easy discharge of the settled underflow from the paddle-wheel). One season of operation showed that the system is trouble-free, requires little maintenance and produces an ash which drains readily when piled and is easy to transport by truck without spillage. The ash is then spread on fields.

Fifty-third annual review of the milling season in Southern Africa (1977-1978). J. P. Lamusse. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 1-19.—Details are given of the performances of the eighteen South African sugar factories, the two Swaziland factories at Big Bend and Mhlume, Nchalo factory in Malawi, and Buzi and Maputo factories in Mozambique.

Activated sludge treatment of sugar mill/wattle bark mill effluents at Dalton, Natal. D. E. Simpson and J. Hemens. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 20-25.—The Union Cooperative Bark & Sugar Co. Ltd. processes some 500,000 tonnes of cane and 30,000 tonnes of wattle bark per year in factories at Dalton. The effluents from the mills are discharged, via drainage channels, to a series of ponds which act as sedimentation basins; effluent from these ponds is pumped to an aeration basin equipped with two rotary surface aerators. The overflow is transferred to a settling tank, from which the supernatant is used as make-up for cooling water supply to the sugar factory. Observations of the activated sludge process used showed that, during most of the period of the investigation, the final effluent had a high suspended solids concentration which adversely affected its re-use. When bark mill waste was the only feed to the ponds, sludge bulking was observed, but the settling quality was satisfactory when sugar factory effluent was included. It was found necessary to add N and P for the activated sludge treatment. The soluble COD of the mixed effluent was reduced by 94% and the soluble BOD by 99.3% at a flow rate of 302m^3 per day during a 4-month period. Capital and operational costs of the plant are summarized.

Optimization of the crushing programme for the season by dynamic programming. R. G. Hoekstra. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 26-32. Dynamic programming is a technique for determination of variables which eliminates most of the possible combinations of values of variables, so that eventually only a small proportion of the total number of combinations needs to be calculated. It is completely different from linear programming, its advantages being that non-linear relationships present no problems while the written computer programme is entirely self-contained, needing no interfacing with a special linear programming package. The author describes application of the technique to optimization of the season's crushing programme for a factory. It is shown how, within any given constraints on throughput rates, cane availability and starting and finishing dates, the programme will specify starting and finishing dates and month-by-month crushing rates. Expected monthly values of process variables and time utilization, the drop in overall recovery as a result of increased throughput, and the various types of costs are taken into account. The output includes monthly performances, efficiencies and costs as well as the final maximum profit for the season. An example is given of the procedure used.

Steamside chemical cleaning of evaporator tubes. J. W. V. Lewis, R. Archibald and C. Mack. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 33-35.—After routine examination of evaporator tubes at factories operated by Huletts Sugar Ltd. had revealed serious steamside fouling, laboratory investigations were carried out to find a suitable cleaning formula. The results were then used to establish factory cleaning procedures. At Amatikulu, brass tubes were treated with 10% acetic acid, 5% "Magnus 1007" and 85% water for 12 hours at 25°C; at Darnall, brass tubes were treated with 10% acetic acid, 0·5% NP6, 9·5% power paraffin and 80% water for 10 hours at 50°C, while mild steel tubes were treated with 10% acetic acid, 2·5% NP6, 7·5% "Solvesso 150" and 80% water for 72 hours at 25°C; at Mount Edgecombe, the procedure used was the same as at Amatikulu. Results showed that treatment considerably improved the heat transfer coefficient, the degree of improvement depending on the extent of fouling.

Justification of power factor correction equipment. J. van Dokkum. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 36-38.—The author demonstrates how to calculate power factor improvements with the aim of reducing electricity charges in a sugar factory.

A simple and inexpensive evaporator entrainment separator. R. Archibald and C. Mack. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 39-40.—Entrainment in two evaporator effects at Darnall factory was reduced by between 92·6% and 97·0% by means of a separator made from angle iron so arranged that it presents a corrugated configuration. The entire structure spans the full diameter of the evaporator and is suspended from two channel irons which are in turn supported by four legs resting on the tube plate. Slight tilting of the structure allows juice droplets to run off. Pressure drop was found to be negligible.

Development of a sweep sampling device for the direct sampling of knifed cane from a belt conveyor. R. Bodger and C. B. van der Riet. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.,* 1978, 41-44.—At Amatikulu, samples of cane passing on a belt conveyor from the knife sets to the shredders are pushed into plastic bags suspended from a side rail by an electrically operated sweep arm pivoted from a frame straddling the 2 metres wide conveyor. During three months' operation, nine times per day, the sampler presented no problems in operation.

BEET SUGAR MANUFACTURE

Precise chemico-technical control and calculation of a balance for production involving partial withdrawal, storage and processing of thick juice. A. Ya. Zagorul'ko *et al. Sakhar. Prom.*, 1978, (9), 48-52 (*Russian*).—A detailed balance was drawn up to determine the increases in losses resulting from thick juice storage and post-campaign processing and indicate those areas where the losses could be reduced. The additional losses amounted to 0·34% on weight of beet, made up of 0·05% in storage, 0·20% in processing and 0·09% in molasses.

Application of deionization purification to produce liquid sugar and spray-dried products. S. E. Bichsel. *Proc. 1976 Tech. Session Cane Sugar Refining Research*, 150–161.—The development of beet thick juice treatment by ion exchange in the US industry is summarized. The latest stage involves treatment of thick juice produced directly or from storage, followed by concentration to a liquid sugar or by spray drying, while the non-sugars are separated from the ion exchangers, reconstituted and partly used for addition to pulp and partly as a fertilizer. The liquid sugar obtained in this way is superior to conventionally produced liquid sugar, having lower colour, ash and floc content.

Coordination of mass flow in the beet end of a sugar factory using a computer. J. Oledzki, D. Piotrowski, M. Szczeniowski and K. Urbaniec. *Gaz. Cukr.*, 1978, **86**, 194–196 (*Polish*).—A block diagram is used to demonstrate a system devised by Chemadex for coordination of material flow between individual stations extending from the hopper feeding the beet slicers to the evaporators. Tests at Chelmża sugar factory confirmed the validity of the basic theory.

Final tests and thoughts on improving the quality of thin juices without alkalinity reserve by partial anion exchange. F. Perschak. *Zuckerind.*, 1978, **103**, 743-747 (*German*).—The tests conducted in 1976 and reported earlier[1] were continued in 1977, and the dimensions worked out for an ion exchange unit handling juice from 7000 tonnes of beet per day at an exchange rate of 10 equivalents per tonne of beet. The costs of 70 days' operation (expressed in tonnes of white sugar) are also calculated on the basis of an extra 1667 tonnes of sugar recovered by the process in the earlier experiments; at a 5-year amortization and an interest of 10%, the defrayed costs are estimated to be the equivalent of 3032 tonnes of sugar. While there is no obstacle to installation of a full-scale unit at the author's factory (Hohenau), the project was postponed because of high beet quality and the lack (with one exception) of need for alkalinity correction. Where there is sufficient natural alkalinity during a campaign, or where the unit is somewhat over-dimensioned, cations corresponding to the excess OH^- ions can be exchanged for ammonium, to give a desalting effect similar to that of the carbonate process[2,3]; part of the thin juice softening plant could be used for the ammonium exchange and regeneration carried out with an ammonium salt instead of NaCl, while the other part would operate on the Na^+ cycle.

Reduction in energy and investment costs by use of electronic data processing. E. Farwick. *Zuckerind.*, 1978, 103, 748-753 *(German)*.— The application of a computer to calculate heat and mass balances (which have a considerable effect on the energy and capital costs of a sugar factory) is explained, and programmes for diffusion, juice purification, evaporation and boiling described. A computer-designed 3-massecuite boiling scheme is reproduced, as are tables of data for evaporator bleed users and for the individual bodies in a quadruple-effect evaporator. Application of the programmes has been of benefit in the planning of new factories, expansion of existing factories and examination of current operational practices.

Constructional problems of modern induction motors for driving sugar centrifuges. A. Glowacki. *Przeglad Elektrotechniczny*, 1973, **49**, (1), 12–16; through *S.I.A.*, 1978, **40**, Abs. 78-1122.—Mathematical theory for and problems in the design of induction motors to drive batch sugar centrifugals are discussed and illustrated by existing designs. Attention must be paid to cooling of the motor and thus protecting insulation, and also to the strength to withstand alternating dynamic forces. Two electromagnetically independent parts are necessary: the high-speed part has a cage and a separate resistance; the low-speed part is a low-power motor with many poles. It is hoped that such motors driven by thyristorized inverters will soon replace constant-current motor + thyristor assemblies. The constant-current type accommodate well to varying demands, and may consume only 1 kWh/cycle of a 1000 kg centrifugal (compared with 2 kWh for induction motors), but cost three times as much to install, and are worthwhile only when power is very expensive.

Standard applications of thyristor drives for various branches of industry. F. Bändel, G. Beringer and R. Stöckmann. *Technische Mitteilungen AEG Telefunken*, 1976, **66**, (1), 9–15; through *S.I.A.*, 1978, **40**, Abs. 78-1123.—Operating principles and advantages of converter-fed D.C. drives are described, and some particular applications are discussed. Thyristor-fed D.C. shunt motors are very suitable for driving sugar centrifugals; they permit rapid transition between speeds for filling, centrifuging and discharge without peaks of current, and speeds can be adjusted during operation if required. Other advantages include constant acce.eration and braking moments and high electrical efficiency compared with A.C. motors.

The optimization of the energy economy in the sugar factory. P. Christodoulou. *Hellenic Sugar Ind. Quarterly Bull.*, 1978, (34), 207-244 (*Greek*).—See *I.S.J.*, 1978, **80**, 212.

A modern non-stirred main limer. I. Vigh. *Cukoripar*, 1978, **31**, 98-99 (*Hungarian*).—A liming system is described which consists of two identical vertical vessels linked by a juice and lime feed and juice discharge line. Lime is fed to the incoming heated, prelimed juice before it is distributed from a horizontal line passing across

[1] Perschak: *I.S.J.*, 1978, **80**, 182.
[2] Moebes: *ibid.*, 1960, **62**, 257.
[3] Elmer *et al.*: *ibid.*, 1970, **72**, 214.

both vessels. In each vessel it flows down through a series of perforated plates and enters a rising exit pipe towards the bottom and to one side of the tank. From this riser, the juice enters a slightly inclined pipe to be transferred to carbonatation. At an active volumetric capacity of 53 m^3 and a residence time of 20 minutes, the limer is capable of giving a well homogenized juice-lime mixture from 3000 tonnes of beet per day at a raw juice draft of 135%. In 1976/77, use of fractionated cold and hot liming permitted 89·3% invert sugar destruction and a colour of 16·6°St/100°Bx compared with 85·8% and 35·1°St/100°Bx, respectively, in the previous system used during 1971-75.

Current situation in the Spanish sugar economy and prospects of integration in the EEC. F. Lozano B. *Sucr. Franç.*, 1978, **119**, 403-413 (*French*).—A survey is presented of the Spanish sugar industry and economy, the major part being concerned with beet sugar production, since cane sugar accounts for only 2% of the total national output.

Use of sleeve-type filter cloths on FiLS filter-thickeners. Yu. F. Tsyukalo, V. T. Rud', A. P. Belenko, E. F. Pinchukova, L. V. Lipai, Yu. V. Anikeev and V. A. Chernenko. *Sakhar. Prom.*, 1978, (10), 28-29 *(Russian).* TT-842 sleeves made from a mixture of caprone and a "Terylene"-type synthetic fibre have proved satisfactory when used in FiLS filter-thickeners for the treatment of 1st carbonatation mud, meeting requirements of mud density, filtrate turbidity and service life.

The discrepancy between the sugar content of beet supplied for processing and the sugar content of beet cossettes. G. F. Tyazhelova. *Sakhar. Prom.*, 1978, (10), 66-71 (*Russian*).—Data from Ramon sugar factory, covering the period 1965-74, have shown differences between the sugar content of beet samples as determined in the tarehouse and the sugar content of cossettes. The discrepancies, ranging from 0·31% to 1·47% (absolute), were attributed to dirt and leaf tare, to sugar losses in flume-wash water and to free and absorbed water, as well as to storage losses and analytical error.

The difficult problem of sampling industrial beets at reception. D. Bourdon. *Ind. Alim. Agric.*, 1978, **95**, 707-713 (*French*).—Factors determining beet sugar content (climate, soil type, variety and agronomic factors) are discussed, and the importance of correct sampling at the beet yard examined. The point in a load from which samples are taken and the minimum number of samples to give an accurate, representative reading of sugar content are considered, and the viewpoints of a farmer and of a factory manager on the subject are expressed.

Treatment of sugar factory vegetal waste. M. Cuer. *Ind. Alim. Agric.*, 1978, **95**, 759-762 (*French*).—A description is given of the plant used to separate and wash the 450 tonnes of extraneous matter a day which is removed from beet at Pithiviers sugar factory in France; of this trash, 6% is soil, 1% is sand and stones, 20% is beet rootlets and pieces, and 63% is leaves and weeds. All of the extraneous matter passes on a belt conveyor at 15-20 tonnes.hr^{-1} to a hopper which feeds it to a Mick horizontal, rotary drum formerly used for milk-of-lime preparation. Some of the sand and dirty water is discharged at a point halfway along the drum, while the rest of the waste is discharged at the end. Decanted water recycled from tanks located after the other separation plant is split into two streams, one of which flows, at 30 $m^3.hr^{-1}$, back through the Mick drum to the halfway discharge port, while the other, at 50 $m^3.hr^{-1}$, flows to the feed hopper. The remainder of the impurities pass from the drum to a vertical tube (which they enter at a point two-thirds towards the top) immersed in a vertical tank having a funnel-shaped bottom section Water is injected into the tube at a point one-third from the bottom; the ascending current separates the impurities into two groups according to their densities: the weeds, leaves and beet fragments are carried up to a discharge port towards the top of the tank, while the sand and stones fall to the bottom, from which they are discharged to an inclined paddle-type separator. The green trash and beet fragments pass to a sloping screen (from which the water is decanted for recycling), after which the weeds and leaves fall onto a crusher and are subsequently fed by screw conveyor to a press. The beet fragments are eventually fed to the diffuser after chopping or coarse crushing.

Diffusion juice purity. M. Roche. *Ind. Alim. Agric.*, 1978, **95**, 767-769 (*French*).—Since determination of raw juice purity is subject to errors, the sources of which do not have the same effect on thin juice purity determination, the author questions the value of determining raw juice purity, particularly in view of the fact that the difference between the two purities does not represent purification efficiency. However, on examination, he does feel that raw juice purity is still of value as a guide to diffuser performance and as an indication of beet quality.

The determination of residence time distribution, of cossettes and juice in diffusion, and in other sugar factory processes. T. Cronewitz, G. Müller and H. Schiweck. *Ind. Alim. Agric.*, 1978, **95**, 771-777 (*French*).—Determination of residence time in sugar factory processes is discussed. While LiCl can be used for juice and massecuite (since the Li^+ ion does not generally occur, at least in determinable quantities, in these products, and Li salts are readily soluble), it is unsuitable for determination of cossette and juice residence times in diffusion because of constant change in the cation composition of the juice phase as a result of the carboxylic groups present in cell wall pectins and the ion exchange properties of the cell walls. However, staining with methylene blue or using red beet gives a satisfactory indication of residence time; various acetates (particularly ethyl and methyl acetate) also act as suitable tracers and are easily determined by gas-liquid chromatography using the head-space technique. Advice is given on the procedures to use with the various tracers mentioned, and details are given of a GLC method used for juice and cossette residence time determination.

A new technique of sugar drying: the rotary multi-tube, concentric-nest dryer/cooler. V. Duhem. *Ind. Alim. Agric.*, 1978, **95**, 795-803 (*French*).—Details are given of a Fives-Cail Babcock sugar dryer/cooler which consists basically of two sets of horizontal tubes located concentrically around a central shaft. Sugar to be dried is fed through the inner circle of tubes together with hot air; when it reaches the end of the tubes, it is transferred via enclosed chutes to the outer circle of tubes and flows back along these against the flow of cold air. Typical data quoted are reduction of moisture content from 1% to 0·03% and cooling to a temperature 15°C above ambient at a sugar flow rate of 20 tonnes.hr^{-1}.

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SUGAR REFINING

Studies on desalting of sugar solution with ion exchange resin in a sugar refinery. I. Contamination of the I-type strongly basic anion exchange resin by desalting sugar solution in the reverse system. F. Maekawa, K. Kawasaki, Y. Horiki and T. Saito. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1978, **28**, 78-85. **II. Restorative treatment on the I-type strongly basic anion exchange resin contaminated by desalting sugar solution in the reverse system.** K. Kawasaki, F. Maekawa and Y. Horiki. *ibid.*, 86-92 *(Japanese)*.

I. Examination of resin fouling in the course of liquor demineralization on the reverse cycle showed that it was chiefly due to inorganic compounds such as magnesium oxide and silica, as well as colouring compounds, most of which were formed by alkaline decomposition of sugars in contact with the strongly basic anion exchanger in OH^- form. Static investigations showed that the total capacity of all the resins studied fell by more than 20% in 50 cycles, their salt-splitting capacities being particularly affected. The degree of fouling depended on such factors as resin structure and reactivity, from which it is assumed that the best type is the porous resin having macro- and micro-pores; however, pore size and distribution considerably affect exchange capacity. It is suggested that a study should be made of resin suitability according to sugar solution properties, of means of preventing fouling, and of optimum restoration of resin properties after fouling.

II. Restoration of contaminated resin was investigated. Of four treatments studied, use of a 10% NaCl solution containing 1% NaOH was found to be the best with regard to organic fouling, while 4% HCl solution was the most effective against inorganic fouling; the other solutions tested were 10% NaCl with and without 1% HCl. Hence, the method adopted for resin restoration was treatment with the HCl followed by the NaCl + NaOH, both stages being carried out at 70°C.

Decolorization of sugar solution by a new ion exchange resin. K. Sasaki, T. Naito and K. Tsukui. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1978, **28**, 39-46 *(Japanese)*. – A new resin, "Ionac 3AS", was tested at the authors' refinery on 62° Bx liquor decolorization in 1976. The results of the tests (up to 35 cycles) are reported. While the effluent from the early stages of the cycle had the fishy smell of amine, in later stages this was not apparent. The greater the initial colour content of the liquor, the greater was the amount of colour removed by the resin. The average decolorizing capacity was high, even with 35 cycles, the treated liquor: resin volume ratio being 40:1. The decolorizing efficiency (84% in the initial cycle) was almost the same as that of other low cross-linkage resins such as "Amberlite IRA 401" and "Dia Ion SA-11A". Since "Ionac 3AS" is of smaller particle size than these other two resins, there was some loss of resin during back-washing at a "normal" flow rate; flow rate was limited when a high-concentration liquor was being treated. Further tests are to be carried out to determine, among other things, the effect of regeneration with HCl on the chemical and physical properties of the resin.

A maintenance management system of steam traps. K. Nakazato and E. Fuwa. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1978, **28**, 47-51 *(Japanese)*. As a contribution to fuel economy, a system of steam trap inspection and maintenance was introduced at the Tobata refinery of Meiji Sugar Mfg. Co. Ltd. From inspection of the traps in each process station, a damage rate of 22.3% was found; relating this to the inspection cycle showed that an inspection should be made every six months in order to keep the damage rate low at 5%. The monetary losses resulting from faulty steam traps are shown, and a graph is presented which shows the financial effect of inspection and repair frequency.

Treatment of waste water from a sugar refinery by the activated sludge process. K. Akiyama and M. Okada. *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1978, **28**, 52-60 *(Japanese)*. – Details are given of the activated sludge process adopted at the authors' refinery in 1974 in answer to local authority regulations relating to effluent discharge into the harbour at Kobe. Results include a 94% COD reduction to a level of 20 $mg.litre^{-1}$ or less (the average daily level stipulated in the regulations), even when the initial loading was 3000 $mg.litre^{-1}$ suspended solids. An excess sludge quantity of 720 $kg.day^{-1}$ occurred as suspended solids. The treatment effluent temperature was maintained at 20-30°C by the use of coolers. The running costs of the system designed to handle 3500 m^3 per day, are indicated.

Applications of flocculants in the carbonatation refining process. F. M. Runggas. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 118-122.—See *I.S.J.*, 1979, **81**, 184.

The activation of bone charcoal by thermal and chemical treatment. I. The effect of high kiln temperature on bone charcoal structure. J. C. Abram and M. C. Bennett. *Proc. 1976 Tech. Session Cane Sugar Refining Research*, 1-18.—It had been concluded from work by the Bone Char Research Project[1] that, because of severe loss of B.E.T. nitrogen surface area on heating of char above 550°C, the optimum temperature for kilning char was 500°C for colour removal. It was subsequently found that decolorization activity of a nearly new char kilned at about 630°C was extraordinarily high, and this also occurred with fine grist char at Thames, kilned at 750°C, provided it was washed with water or NaOH solution afterwards. The effects on char structure of heating at temperatures between 400 and 1000°C were therefore studied using electron microscope examination, X-ray diffraction, gas adsorption measurements of surface area, mercury porosimetry, nitrogen desorption and gas phase density determinations, as well as absorption from solution to measure area changes in the hydroxyapatite and carbon components. The improvement was found to be associated at above 700°C with formation of lime, perhaps by loss of CO_2 from calcium carbonate present as part of the char structure or as carbonatation precipitate. A marked change in structure occurred with decreases in total and apatite surfaces and in carbon content (but with no change in carbon surface area), but these probably did not affect decolorization activity, the increase in which is probably due to the gain observed in the number of pores of 40-100 nm diameter.

[1] *Tech. Rpt.*, 1960, (56); 1961, (60).

LABORATORY STUDIES

Application of gas chromatography in a preliminary investigation into changes in some non-sucrose constituents during sugar boiling. P. G. Morel du Boil and K. J. Schäffler. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 96-105.—A description is given of a gas-liquid chromatographic method for determining sucrose, dextrose and levulose in sugar factory products. The samples are first treated with sodium benzoate to dissolve the sugars, and oximation carried out in the presence of dimethyl-amino-ethanol (added to hydroxylamine hydrochloride just before use). Silylation is performed by addition of hexamethyldisilazane and trifluoroacetic acid, and GLC separation then carried out, using xylose as internal standard for the monosaccharides and trehalose for sucrose. Full details are given of the quantities involved. Comparison of this oximation-silylation procedure, using temperature programming and applied to 30 samples of syrup and molasses, with direct silylation under isothermal conditions showed no significant difference, while the direct silylation method often presents difficulties in quantitative evaluation because of production of a large number of overlapping anomeric peaks by dextrose and levulose. Application of the modified method to determine the fate of the two monosacharides in the boiling house, using chloride as reference for direct comparison of the syrup and molasses streams, showed that there was a seasonal trend in the levulose: dextrose ratio in molasses; reducing substances other than the monosaccharides are formed during boiling house operations, increase in the levulose:dextrose ratio being mainly due to a loss of dextrose. Amino-nitrogen levels fell between syrup and molasses, although there was no apparent seasonal trend. An increase in optically active substances between syrup and molasses was also found. A tentative correlation was established between pol and sucrose, dextrose and levulose contents.

Some factors affecting the performance of polyacrylamide flocculants in juice clarification. G. S. Shephard. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 106-112.—Laboratory studies were conducted on polyacrylamide flocculants of different degrees of hydrolysis (DH) to determine the effect of preparation of the polymer solutions on clarification efficiency. While a flocculant concentration below 0.05% led to a rapid decrease in efficiency, above this concentration a constant settling rate was observed, although variations in concentration appeared to have no effect on turbidity or final mud volume. Flocculant solution pH and ionic strength also affected only the settling rates, the effect of pH being governed by the DH. While water of high ionic content should be avoided, since this caused a fall in settling rate, there was little advantage in using distilled or deionized water in place of tap water, since the quantity of dissolved ionic species would have to be raised considerably before there was any significant decrease in efficiency. Solution equilibrium was attained after 2 hours, while further agitation did not bring any improvement in settling rate. The flocculant of low (30%) DH ("Superflox A110") increased the initial settling rate with increase in the quantity of phosphate precipitated to a maximum at 360 ppm, after which it was almost constant to 400 ppm, while the flocculant of intermediate (45%) DH ("Superflox A130") gave maximum initial settling rate at 270 ppm P_2O_5 precipitate, after which the rate fell. The flocculant of high (60%) DH ("Superflox A150") gave a much lower initial settling rate which remained almost constant over the entire range of phosphate precipitation. As regards turbidity, all three flocculants fell to relatively close minima at 300 ppm phosphate, after which the turbidities remained constant. The calcium concentration in the limed juice also had varying effect on the flocculant efficiencies, the turbidity values and the pattern of the turbidity curves being very similar to those for phosphate precipitation effect, while mud volume was constant after 200 ppm Ca^{++} with the flocculant of lowest DH, rose slightly with that of intermediate DH and rose more markedly with the flocculant of highest DH.

Sugar entrainment monitoring. K. J. Schäffler. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 123-124.—The flame photometric method described by Dale & Lamusse for on-line evaporator and vacuum pan entrainment monitoring[1] is considered to have a number of disadvantages which are listed. However, a technique has been devised at Huletts Sugar Ltd. in which sucrose is inverted in the presence of a solution of resorcinol in HCl at 95°C and the levulose reacts with the resorcinol to form an orange coloured compound which is measured at 520 nm. Ferric sulphate serves as sensitizer and cancels out any iron interferences. While continuous monitoring using the method still suffered from a number of serious drawbacks, the problems were overcome by using sequential automatic analysis. Flocculation is necessary because of the turbid nature of condenser and other factory waters, but treatment with basic lead acetate solution produces a water-white solution having 95-97% transmission at 514 nm. A Technicon AA II auto-analyser installed in the Research & Development Dept. of the company analyses samples from five raw sugar factories at the rate of 30 per hr.

An improved method for the determination of soil "available" phosphorus. J. R. Burrows. *Proc. 52nd Congr. S. African Sugar Tech. Assoc.*, 1978, 195-199.—Details are given of a modification of the Murphy & Riley method for determination of available P in soil[2], based on use of a 12-molybdoantimonylphosphate complex; the method has been adapted for automatic routine analysis using a LKB 2071 sample processor and a LKB 7400 calculating absorptiometer. Colorimetric measurement of orthophosphate by the new method gives results comparable to those given by the Dickman & Bray method[3], while use of the automatic analyser saves 7 man-hours per 200 samples.

***Theoretical aspects of detection of sugars in high-pressure* liquid-chromatographic systems by polarimetry and refractometry.** G. B. Cox and I. K. O'Neill. *UV Spectrom. Group Bull.*, 1977, (5), Suppl., 64-70; through *Anal. Abs.*, 1978, **35**, Abs. 3C16.—Because of the problems arising in the U.V. detection of sugars, optical rotation is

[1] *I.S.J.*, 1978, **80**, 180.
[2] *Anal. Chim. Acta*, 1975, **6**, 95-112.
[3] *Ind. Eng. Chem., Anal. Ed.*, 1940, **12**, 665-668.

proposed as an alternative detection principle for carbohydrate analysis. The theory of polarimeter and chromatographic sensitivity is discussed and consideration given to the problems of cell volume, time constant, sensitivity and temperature effects; optimum instrument parameters are derived mathematically. By comparison with the response of the refractive index detector, that of the polarimeter is assessed to be slightly less sensitive but less affected by variations in temperature and eluant composition.

Gas-chromatographic determination of di- and trisaccharides. H. Schwind, F. Scharbert, R. Schmidt and R. Kattermann. *J. Clin. Chem. Clin. Biochem.*, 1978, **16**, (2), 145-149; through *Anal. Abs.*, 1978, **35**, Abs. 3C18. Three methods are discussed. In the first, the sugars are converted into their methoximes and acetylated with acetic anhydride; then the resulting derivatives are subjected to GLC at 260°C on OV-225, with gentiobiose as internal standard. Monosaccharides can also be determined by this method, with use of an ECNSSM column at 190°C. The second method involves reduction with $NaBH_4$ and acetylation of the resulting alditols with acetic anhydride; GLC is then carried out as in the first method, but trehalose is used as internal standard. With use of temperature programming, the derivatives of monosaccharides, amino-sugars and disaccharides can be separated on the same column. In the third method, methoximes formed as in the first method are trifluoroacetylated; derivatives of disaccharides can be separated on OV-101 at 130°C, with trehalose as internal standard, and those of trisaccharides on the same column at 160°C, with raffinose as standard.

Notes on control and sugar balance. E. David. *ATAC*, 1977, **36**, (6), 51-53 (*Spanish*).—The author discusses the significance of new equipment and techniques employed in sugar laboratories, including the use of the refractometer for Brix determination, balances based on the load cell principle, automatic saccharimeters, etc., all of these tending to eliminate human errors. A modern trend is to true sucrose balances instead of using polarization, especially in the case of molasses and intermediate products. Use of Clerget double polarization for sucrose and refractometric Brix produces much more accurate figures for sugar loss in molasses, and an example is quoted of how two different factories with "high" and "low" molasses apparent purities were in fact operating at comparable efficiency when the true purities were worked out. The use of continuous belt weighers for bagasse, together with weights of cane and maceration water, now makes it easier to calculate the weight of mixed juice by difference where juice scales are not employed.

Colorimetric determination of reducing sugars in mixed juice, final molasses and raw sugar. I. Díaz, M. Juanes and C. García. *ATAC*, 1977, **36**, (6), 57-65 *(Spanish)*. Application of the colorimetric method for reducing sugars determination devised by Edson & Poe[1] has been studied for sugar industry products. To 2 cm^3 of a standard is added 6 cm^3 of 2,4-dinitrophenol solution in a basic medium comprising phenol, NaOH and Rochelle's salt, and the mixture heated in a boiling water bath for 6 minutes, after which it is immediately cooled and its absorbency measured at 420 nm. Standard solutions of 0·01-0·1% w/v of dextrose were employed and linear graphs prepared of absorbency *vs.* concentration. The effect of heating time was examined and absorbency found to increase between 2 and 6 minutes, after which time it became constant. The colour was stable, no change in absorbency being observed during a period of up to 70 minutes after cooling. Replicate tests on mixed juice, molasses and raw sugar samples with two colour instruments demonstrated the precision of the technique, while recovery experiments showed values of 100–112% on the added dextrose. The values obtained are very similar to those given by the Eynon & Lane method, greatest differences being found with molasses. The cost of the analysis and the time taken are less for the colorimetric method than for the Lane & Eynon method, and it is recommended that the colorimetric method become the official method of the Cuban sugar industry.

Fractionation of sugar colorants by high-pressure liquid chromatography. N. H. Smith. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 19-34.—A high-pressure liquid chromatographic technique has been applied to fractionation of sugar colorants. In contrast to gel-permeation methods, which yield few colour peaks, the technique separates more than a dozen colorants, although these are not identified. Applications of the method are described to illustrate its usefulness; these include examination of colorant composition variation between individual raw sugars, the role of enzymatic browning in sugar colour, and the colorant composition of granulated refined sugar.

A study of sugar inversion losses by high-pressure liquid chromatography (HPLC). M. A. Clarke, M. A. Brannan and F. G. Carpenter. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 46-56.—The technique was applied to study of the decomposition of sucrose at pH levels between 2 and 10, at 20, 40, 60 and 80°C, over 1–20 days; measurements were made of sucrose, dextrose and levulose changes with time. The more rapid loss of levulose after formation, by comparison with dextrose, was observed. Dextrose concentrations were more readily and accurately followed, but the technique is not accurate enough to measure precisely the loss of sucrose.

Determination of refined sugar proteins by polyacrylamide gel electrophoresis. M. A. Godshall and E. J. Roberts. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 57-72.—The proteins in raw and refined sugars were separated by dialysis and individual proteins examined by means of polyacrylamide gel electrophoresis. Semi-quantitative measurement of the proteins separated was possible using a colorimetric method based on elution of the protein dye, Coomassie Blue R-250, from the gels. The quantities of protein found ranged from slightly more than 1 ppm in raw sugars to 0.011 ppm in refined sugar. The separated proteins were found to cause flocculation of indigenous sugar cane polysaccharide in sugar solutions. One protein class was reduced markedly by affination and carbonatation and eliminated by char treatment, the other persisted to refined sugar but was largely reduced during refining, especially in the affination and crystallization stages.

The role of charged particles in floc formation. E. J. Roberts and M. A. Godshall. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 73-81.—It has been shown that all cane sugars contain a heterogeneous polysaccharide which is indigenous to sugar cane. This polysaccharide forms a colloidal solution which carries a

[1] *Anal. Chem.*, 1932, **4**, 300-302.

negative charge over a wide pH range. It was also shown that refined cane sugar contains protein which changes its charge from negative in alkaline and neutral solutions to positive in acid solutions. Combining solutions of the isolated polysaccharide and the isolated protein at low pH in the presence or absence of sugar results in floc formation. It seems reasonable, therefore, to conclude that the two materials are the basic factors in floc formation in acidified sugar solutions.

Microbiology of sugar: a taxonomic study . R. D. Skole, J. N. Hogu and A. B. Rizzuto. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 81-99.—A survey is presented of the various micro-organisms encountered in raw sugars of different origins received by Amstar Corporation refineries. The yeasts included *Saccharomyces cerevisiae, S. rouxii, S. mellis, S. cerevisiae* var. *ellipsoideus, S. carlsbergensis* and *Hansenula* spp., while the most common moulds were *Aspergillus* spp., with smaller numbers of *Penicillium* and other genera. Representative cultures of aerobic bacterial groups present were identified as *Bacillus stearothermophilus, B. brevis, B. coagulans, B. circulans* and *B. subtilis.* Aerobic mesophilic bacteria included *B. megaterium, B. subtilis, B. brevis, B. circulans, B. sphaericus, B. coagulans* and *B. polymyxa,* while the only anaerobic thermophilic bacteria encountered were *Clostridium nigrificans* and *C. thermosaccharolyticum.* A spore-forming anaerobic mesophilic bacterium was identified as *C. butyricum,* while an aerobic spore-forming bacterium was found to be *B. cereus.*

Codex standards for sugars. J. A. Hupfer. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 100-117. The work of the Codex Alimentarius Commission's Committee on Sugars in developing international standards for sugars is discussed by the Committee's US representative. Standards devised for 10 carbohydrate sweeteners are reviewed, including those for white sugar, powdered sugar and soft sugars. The current status of each standard and the progress made toward acceptance of Codex standards in the USA are noted.

Determination of cadmium, zinc, lead and copper in refined sugar by an electroanalytical technique. R. Cormier, L. H. Mai and A. D'Antico. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 162-174.—The determination of metal elements in sugar products usually requires tedious preparations which may give rise to a loss of accuracy in the results. Use of a differential pulse anodic stripping voltammeter, coupled with a rotating mercury film electrode, may overcome this problem. Such analysis can be done, down to a sub-ppb level, without any prior ashing, ion exchange or other similar treatment.

Raw sugar quality analyses, from 1968 to 1976, at the New York Sugar Trade Laboratory. W. Altenburg. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 175-182.—The moisture, ash, colour, grain size and polarization of more than 500 raw sugar samples are measured at the New York Sugar Trade Laboratory each year, and the averages of the values obtained each year from 1968 to 1976 are recorded and discussed.

Raw sugar quality standards. J. V. Lopez-Oña. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 195-213.—The No. 10 contract standards (for grain size, colour, ash and safety factor) were introduced in 1968, and the author discusses the variations in raw sugar quality, as defined by the standards, of cargoes received by the National Sugar Refining Co. in Philadelphia. The numbers of premium and penalty cargoes (*i.e.* above and below standard) received in 1974 and 1975 are analysed. The author questions the value of the safety factor or moisture standard.

Ten year trend in raw sugar analysis. Anon. *Proc. 1976 Tech. Session Cane Sugar Refining Research,* 214-224. Graphical records are presented of the characteristics of raw sugar refined by BC Sugars since 1966; in the first half of this period they were mainly from Fiji and in the second half mostly from Queensland, while sporadic cargoes came from other origins, and their data are recorded separately.

Cane payment on a sucrose content basis. N. A. da Gloria, J. F. G. Pereira and A. A. Rodella. *Saccharum* (STAB, Brazil), 1978, **1**, (1), 15-25 (*Portuguese*).—A study on sampling and analytical methods necessary for introduction of a cane payment system based on sucrose analysis began in Alagoas in 1972/73 but was extended to São Paulo on the institution of Planalsucar. The paper is a summary of work carried out in Brazil to date, with reference included to work in other countries; it is appreciated that, with the National Alcohol Programme, the prices of sugar and alcohol are the same, so that use of cane for either is equally economical and this may affect the conclusions reached as regards cane analysis and payment. Studies have been made on sampling, especial reference being made to use of the core sampler, and the digestion and press methods for cane analysis are described, with a table showing the effect of fibre content on pol % cane. Core sampling followed by the more rapid press juice extraction is recommended because of the practice of cane storage at the factory for night crushing. Development of formulae for calculating pol % cane and the cane value are discussed, and it is recommended that the system be adopted in Brazil in order to encourage maximum sugar production per unit area.

Method for assessment of sugar cane quality. A. P. Gupta. *Indian Sugar Crops J.,* 1977, **4**, 87-88.—A method for estimation of pol % cane, based on analysis for pol % juice and pol % bagasse, and a procedure for determining fibre % cane are described.

Interaction of surface-active agents with sucrose molecules in aqueous solutions. N. S. D'yachenko. *Ukrain. Khim. Zhurn.,* 1978, **44**, 995-996 (*Russian*).—Nuclear magnetic resonance was used in a study of the interaction between surfactants and sucrose molecules in sucrose solutions of 10, 20, 30, 40 and 50% concentration to which 0·03, 0·06 and 0·09% cetyl trimethylammonium bromide was added. With increase in the sucrose concentration (in the absence of surfactant), the sucrose-water reaction becomes stronger than that between sucrose molecules, as indicated by a shift in the NMR signals of the water protons to a stronger magnetic field. When a surfactant is introduced, the energy of the water molecules bound by the hydrogen bonds to the sucrose molecules becomes dissipated by the dispersive interaction between the surfactant and the sucrose. The water molecules are then replaced by surfactant molecules. Hence, the surfactant is adsorbed by the sucrose and the latter becomes hydrophobic.

BY-PRODUCTS

Commercial manufacture of citric acid by fermentation. III. Effect of fermentation conditions and different growth media on citric acid production by *Aspergillus niger*. P. K. Agrawal, C. S. Bhatt and L. Viswanathan. *Sharkara*, 1975, **14**, (3), 3-14. – A local strain of *A. niger* was isolated and cultured under controlled conditions, after which spore suspensions were grown on various media. Investigation of the effects of fermentation parameters on citric acid production showed that maximum yield after 7 days was obtained with a Doelger & Prescott medium (prepared from NH_4NO_3, KH_2PO_4 and $MgSO_4$) in which the sucrose concentration was 14%. Increase in the sucrose content to 20% increased mycelial growth and energy production rather than citric acid yield up to 7 days, after which it resulted in a much greater quantity of citric acid (54.06 $g.cm^{-3}$ after 14 days) than did 14% sucrose (47.94 $mg.cm^{-3}$). Other media gave much lower yields, while both clarified and unclarified molasses were found to be unsuitable. Optimum pH of the medium was 2.0 and optimum temperature 25°C. Surface fermentation gave much more citric acid with the Doelger & Prescott medium than did submerged fermentation.

GH2 pulp presses at Sárvár sugar factory. G. Katics. *Cukoripar*, 1978, **31**, 70-73 *(Hungarian)*. – Information is given on the GH2 vertical pulp presses at the author's sugar factory which are manufactured in East Germany under licence from Selwig & Lange Maschinenfabrik. Some performance data are given.

Alcoholic fermentation. C. J. Franco. *Proc. Symp. Industrialization Sugar Cane* (STAB, Brazil), 1978, 16 pp (*Portuguese*).—Aspects of alcoholic fermentation are discussed, including selection of the yeast to be used, initiation of fermentation and the desirability of running two parallel fermentations in case of accident which interrupts one, preparation of dilute must and maintenance of reducing sugars content for continuous fermentation, mineral nutrition, industrial multiplication and prevention of infection, and preparation of the yeast suspension. Factors which interfere with fermentation are reviewed, as is the control of temperature, and the analyses needed for fermentation control, as well as determination of the sugars fermented and alcohol produced.

Preparation of juice for alcohol manufacture. L. A. R. Pinto. *Proc. Symp. Industrialization Sugar Cane* (STAB, Brazil), 1978, 10 pp (*Portuguese*).—Fermentation of a must is most efficient if the feed is maintained with optimum characteristics, *i.e.* sterile, at between 28 and 30°C and from 18 to 20°Bx with 15-16% reducing sugars. This contrasts with the variability of raw material, *viz.* juice of between 6 and 20°Bx and molasses of between 80 and 85°Bx. The molasses may be diluted with various other materials or mixtures of *e.g.* clarified juice, water, last mill juice, filtrate, etc., to give the desired characteristics; the last two are most favoured, since they can lead to problems in sugar manufacture but do not have any harmful effect on fermentation. A flow diagram of the process used for alcohol manufacture at Usina Santa Lydia is presented and discussed, and the results of operation are tabulated.

Concentration of vinasse. L. P. de Biase. *Proc. Symp. Industrialization Sugar Cane* (STAB, Brazil), 1978, 6 pp (*Portuguese*).—Vinasse is used widely in Brazil as a fertilizer but it is recognized as being ecologically harmful. At Usina Santa Elisa a plant has been installed for concentration of 70 $tonnes.hr^{-1}$ of vinasse from 6° to 60° Bx. The plant, its operation and automatic control are described and the advantage discussed of being able to dispose of the vinasse as a non-polluting fertilizer and as an animal feed supplement.

Cost of sugar and direct alcohol parity. P. B. Neto. *Proc. Symp. Industrialization Sugar Cane* (STAB, Brazil), 1978, 22 pp (*Portuguese*).—At Usina da Pedra, in the 1977 season, 795,962 tonnes of cane were crushed for sugar manufacture while 403,634 tonnes were used for the direct production of alcohol, the latter also being produced from molasses. Using the detailed figures from the season, an economic examination is made and graphs produced to find the break-even points in terms of sugar and alcohol production.

Saccharification of bagasse pith. C. I Nee and W. F. Yee. *J. Appl. Chem. Biotechnol.*, 1977, **27**, (12), 662-666; through *S.I.A.*, 1978, **40**, Abs. 78-1034.—Laboratory-scale experiments are described. On the basis of previous tests, a process for hydrolysis of pentosans was devised, in which bagasse pith was treated with 2% H_2SO_4 in an autoclave at 125°C. The average pentose concentration in the hydrolysate was 3%, and total pentose yield was 93·2% of the theoretical. An improved process for hydrolysis of the pentose-exhausted cellulosic residue to glucose was developed. The residue was milled with 3·5–4·0 parts 41–43% HCl at 25–30°C for 4–15 hours. HCl was distilled off under vacuum; the solution was diluted and heated at 100°C for 3 hr to convert the oligosaccharides to glucose, and the lignin was then separated by means of a suction filter. Under optimum conditions, the glucose yield reached 91·9% of the theoretical, and $>90\%$ of the HCl was recovered. It is stated that it would be easy to crystallize glucose from the solution, which was of high purity.

Analysis of fatty acid esters of sucrose by means of HPLC. R. Cormier, L. H. Mai and P. Pommez. *Proc. 1976 Tech. Session Cane Sugar Refining Research*, 35-45.—High-pressure liquid chromatography has been applied to the separation and determination of individual sucrose fatty acid esters, including the complex of esters formed by esterification of sucrose with tallow.

Cane diffuser for autonomous distilleries. C. Ebeling. *Brasil Açuc.*, 1978, **91**, 249-257 (*Portuguese*).—Application of a diffuser to production of cane juice for direct fermentation to alcohol is discussed. It is possible to eliminate separate liming, heating, clarification and filtration of juice as normally carried out after milling, since these processes can be embodied in the diffuser operation, while losses are also lower than in a mill, and it is calculated that an additional 540 m^3 of alcohol would be produced from a distillery processing 2000 tcd over a 150-day season.

TRADE NOTICES

New silo discharger. Bowerhill Engineering Ltd., Lysander Road, Bowerhill, Melksham, Wilts., SN 12 6SP, England.

A new discharger from Bowerhill Engineering is designed for installation in flat-bottomed silos or storage vessels. It can be fitted to round or square units up to 12 metres in diameter and is suitable for silos with capacities up to 2500 tonnes. A drive mechanism is housed within a triangular cross-beam over the floor of the silo, supported at each end, and permits a screw auger to rotate around the base area, drawing material to the centre of the silo for discharge through an aperture onto a cross conveyor. Deflectors over the outlet prevent any gravity flow of the silo contents. The rate of extraction may be varied by remote control.

Self-optimizing weigher control. Richard Simon & Sons, Park Lane, Basford, Nottingham NG6 ODT, England.

A new self-optimizing control facility has been devised which, when fitted to Simon high-speed gravity and belt-feed net weighers, ensure that product "give-away" (to ensure compliance with minimum net weight legislation) is kept to a minimum and that containers are packed to finer limits. The controller has two separate sections, encased in a lockable, sealed cabinet containing the basic weighing function and the correction unit. A compact and ultra-precise load-cell is used to transmit to the basic weighing portion of the controller the weight required; when accurate weighment has been achieved, the controller cuts off the feed in, discharges the load and restarts the filling cycle.

The correction unit acts as an in-built checkweigher but with one important advantage; the checkweigher detects any tendency of the weighments to vary from the desired weight and feeds back corrections to the basic weighing section to have effect on subsequent weighments. This completely automatic function allows the weigher to cope with changes in material density, etc., and with dust build-up on the weigh pan. An optional print-out facility is available to monitor weighments.

PUBLICATIONS RECEIVED

Serving the sugar industry. VEB Chemieanlagenbau Stassfurt/ Kombinat, Atzendorfer Strasse 19, DDR-325 Stassfurt, East Germany.

Descriptions are given of sugar factory equipment manufactured by VEB Maschinenfabrik Sangerhausen, an enterprise of the VEB CAS/Kombinat. The range includes plant for automatic beet sampling, sample washing and analysis for sugar, wet unloading of beet, a beet slicer, pulp press, filters, lime kiln, vacuum pans, crystallizers, distribution troughs, sugar screens, white sugar silos and pulp drying and pelleting units.

High-pressure water jetting. – One of the latest applications of high-pressure water jet equipment manufactured by Harben Systems Ltd., of Salisbury, Wiltshire, England, is maintenance of asbestos roofing material at sugar factories in the West Indies in a clean and white state so as to attain maximum possible reflection of sunlight and thus minimize the working temperature within the factory. Marine and Industrial Cleaners Ltd., of Bridgetown, Barbados, have been appointed as distributors.

Power transmission and conveying components. Rexnord Inc., P.O. Box 2022, Milwaukee, WI 53201, USA.

A 624-page catalogue from Rexnord gives detailed descriptions and product index of the company's power transmission and conveying components, including chains and sprockets, roller bearings, shaft couplings, belt conveyor idlers and spray nozzles, as well as bucket and apron elevators, apron feeders and belt conveyor trippers. Apart from specification information, the catalogue covers product applications and, maintenance procedures, and contains selection and rating charts plus various engineering data.

PUBLICATIONS RECEIVED

Sugar factory process automation. Fischer & Porter GmbH, Postfach 701, D-3400 Göttingen, Germany.

A paper presented at the Spring Meeting of the Yugoslavian Sugar Association and Yugoslavian Sugar Institute in 1978 has been reproduced as a special bound version. Written by Hans Kemter, Sales Director of Fischer & Porter GmbH, it is concerned with the trends in automation within the sugar industry, as exemplified by Appeldorn and Wevelinghoven sugar factories in West Germany. Fischer & Porter equipment described in connexion with Appeldorn includes the SIGMA 4000 process control system, electromagnetic flowmeter, liquid vortex flowmeter, differential pressure transmitter, instruments for continuous measurement of process variables and control components; at Wevelinghoven, boiling is automatically controlled by the Fischer & Porter rheometer system involving a DCI 4000 microcomputer. Some 150 automatic rheometer boiling systems are at present in operation. The article is well illustrated.

Liquid level switches. Delaval Turbine GmbH, D-6361 Reichelsheim 4, Germany.

A recent brochure from Delaval Turbine GmbH gives details of "Gems" liquid level switches, available as metallic and non-metallic types, single- or multi-level stations, with floats of various materials.

BAI activities. Booker Agriculture International Ltd., Bloomsbury House, 74/77 Great Russell Street, London WCIB 3DF, England.

A colourful 24-page brochure describes BAI activities in the field of agricultural management, consultancy and technical services. Since 1964 assignments have been undertaken in more than 50 countries, and information is given to demonstrate the type of work entailed in such assignments, including those of a continuing nature.

Queen's Award for the "Talofloc": process. – A presentation of the Queen's Award for Technological Achievement was made on September 24 at the Bromley headquarters of Tate & Lyle Agribusiness by H.M. Lord Lieutenant of Greater London, the Right Hon. The Baroness Phillips. The Award was accepted on behalf of TALO Products and Processes, a division of Tate & Lyle Process Technology Ltd., by Dr. Michael Bennett, Chief Executive. Also attending the ceremony were the Mayor of Bromley, Earl Jellicoe (Chairman, Tate & Lyle Ltd.) and Saxon Tate (Group Managing Director, Tate & Lyle Ltd.) as well as other senior directors of the parent company. The Award was made for inventing and pioneering the "Talofloc" process for removing impurities in the refining of raw sugar. It involves the use of a non-toxic, sparingly soluble surfactant that enables colour to be removed quickly and economically by a simple chemical process. The precipitated coloured impurities can be separated by flotation, an operation which is much quicker than sedimentation and uses much less equipment than filtration. Tate & Lyle Engineering has obtained US Food and Drug Administration approval for the "Talofloc" process. It has been adopted in 26 countries and there are 78 operating licensees; approximately 25% of the world's refined cane sugar is now made with its aid while it is incorporated into the majority of new refineries being built. Since the first commercial operations in 1970, annual turnover has grown to over £2,000,000. Recognition of the Company's achievement in the form of the Queen's Award, said Dr. Bennett, leader of the team which pioneered the development, has given the process a distinction much appreciated in overseas markets and has contributed significantly to increased recent interest.

Statements published in this section are based on information supplied by the firm or individual concerned. Literature can generally be obtained on request from the address given.

BREVITIES

A/S De Danske Sukkerfabrikker Annual Report 1978/79. Because the EEC is not a member of the ISA but Norway is, the traditional supplies of sugar by Denmark to that country have had to be on a basis of the refining of raw sugar originating from ISA member countries. Should a working relationship between the EEC and ISA signatories be worked out for the new sugar regime after July 1980, Danish sugar will again have free access to Norway, but reductions in sugar production and free market exports will be necessary. During 1978 drought and low temperatures hindered germination of the beet seed, and the wet, dull summer and autumn gave a low sugar content. Only 352,000 of the contracted 365,000 hectares was harvested, and the contracted area offered for 1979 has been reduced to 353,000 ha. Of the 352,000 tonnes of sugar produced in the 1978/79 campaign, domestic consumption took 200,000 tonnes, the balance being exported to Britain, the Faroes, Iceland, West Germany, etc., as well as the refined re-exports to Norway. Investments in the factories are for increasing efficiency and no capacity increases are planned. Capital is also being spent on environmental protection. Reduced beet area and so beet seed requirements in Spain have been compensated by increased sales in Italy, while the sugar machinery division has received an order for a complete cane sugar factory in Vietnam, among other plant sales. Membrane filtration and ultrafiltration equipment sales have developed well.

Guyana crop data 1978. — Tabulated data published by the Guyana Sugar Corporation Ltd. show that a total of 4,218,302 long tons of cane were crushed in 1978 as against 3,108,378 tons in 1977 and 4,037,314 tons in 1976. Pol % cane was lower than in 1977 and markedly lower than 1976 (9.71 *vs.* 9.78 and 10.12%) and sugar production was 324,805 tons against 241,527 tons in 1977 and 332,457 tons in 1976. Lost time through strikes was only 3.50% of gross crushing time, against 24.82% in 1977.

Cuban cane harvest 1978/79[1]. — Further to the Cuban sugar production figures previously reported[2], details of harvesting and processing performance have become available. Chopper-type cane harvesters are said to have cut 44% of the cane crushed, the average daily output per machine reaching 92 tonnes, about 3.5 tonnes more than in 1977/78. Machine efficiency fell short of the plan by 25%, mainly because of stoppages due to breakdowns, rain and organizational shortcomings. 300 more machines worked in the harvest than in the previous one. Some 38% of the cane was handled green. Lost mill time due to breakdowns and other operating stoppages was reduced to 7% in 1978/79 against over 19% in the 1971 harvest. Some 180,000 hectares of new cane were reportedly planted during January — May 1979, 18% short of the target but over 30,000 ha more than in the corresponding months of 1978. Although it is not likely that a further 60,000 ha would have been planted in June, to meet the target, the relatively high renewal rate achieved indicates a substantial area of comparatively high-yielding plant cane will be available for harvesting in 1979/80. Attention to the ratoons is also reported to have improved, some 1,450,000 ha having been cultivated or over 330,000 ha more than at the corresponding date in 1978. Compared with 1978, an additional 20,000 ha has received compound fertilizer and about 46,000 ha more has received nitrogen. Given reasonable weather, these preparations point to another bumper Cuban crop in 1979/80.

Early ripening cane varieties in India[3]. — Three new early maturing varieties have been developed at the Sugarcane Breeding Institute, Coimbatore, and allocated the numbers CoC 607, CoA 7601 and Co 7201. They reach peak ripeness in eight months with a slight decline in sucrose after the ninth month, and could therefore permit growth of three crops in two years. The varieties will yield as much as 169-221 tonnes of cane per hectare with 18-19% sucrose in juice of 90% purity, giving 20-27 tonnes of sugar per hectare. By contrast, the late-maturing variety Co 6304 reaches 16% sucrose and 85% purity juice at 12 months with yields of 210 tonnes of cane.

South Korea sugar imports and exports[4]

	1978	1977	1976
		tonnes, raw value	
Imports			
Australia	281,098	298,468	179,751
Brazil	15,180	0	0
Peru	13,350	0	0
Philippines	37,120	5,976	0
South Africa	35,552	0	0
Taiwan	134,650	121,877	98,600
Thailand	39,772	2,093	34,785
	556,722	428,414	313,136
Exports			
Egypt	0	0	11,932
Hong Kong	69,176	55,723	35,056
Indonesia	36,887	9,000	5
Iraq	0	0	10,739
Jordan	0	9,750	11,936
Kenya	0	0	542
Kuwait	0	0	9,947
Spain	0	11,420	0
USA	976	200	868
	107,039	86,073	81,025

Dominican Republic sugar crop damage. — Hurricane David caused devastation in the Dominican Republic at the end of August, with many dead and thousands made homeless. Between 15 and 20% of the 1979/80 sugar crop is estimated to have been destroyed. Heavy rains in June and July had flooded plantations, washed away bridges and damaged roads and railway lines, bringing the 1978/79 cane harvest to a premature end, with a production of some 810,000 tonnes, 100,000 tonnes less than the target[5]. The average sugar content of the cane fell from a normal 11-12½% to about 8½-9½%. The Consejo Estatal de Azúcar incurred losses of 26.8 million pesos in 1976/77, 43.0 million pesos in 1977/8 and estimates losses of 25-30 million pesos for 1978/79. The CEA is arranging a ten-year loan equivalent to $90 million from a group of international banks.

Kenya project for alcohol from molasses[6]. — Kenya Chemical and Food Corporation has embarked on a project to convert the molasses made by Kenyan sugar factories into power alcohol for incorporation in motor fuel. The estimated cost of the complex, to be built near Kisumu in Western Kenya, will be 550 million shillings. When in full production the project will provide 20 million litres of power alcohol, 30,000 tonnes of citric acid, 18,000 tonnes of bakers' yeast and about 2 million litres of vinegar annually. The citric acid and yeast will be sufficient to meet the entire needs of the country and give a sizeable surplus to be exported.

Indonesia sugar production[7]. — Almost all of Indonesia's 58 sugar factories were built in the late 19th and early 20th centuries. The industry, which had produced more than 3 million tonnes in the early 1930's was badly damaged during World War II and, although the cane area was increased after the war, low yields meant that sugar production did not increase. As a result of measures adopted by the government, sugar production is gradually recovering and is expected to reach 1.45 million tonnes in 1979/80 against 1.3 million tonnes in 1978/79. Five new sugar factories have been built since the war and a sixth was due for completion at Jatitujuh at the end of June, with a capacity of 4000 t.c.d. Expansion and modernization programmes for nine other factories have raised their combined capacities by 16,750 t.c.d. while there are plans to rehabilitate two more.

1 F.O.Licht, *International Sugar Rpt.*, 1979, **111**, 497.
2 *I.S.J.*, 1979, **81**, 257.
3 *Indian Sugar*, 1979, **28**, 739.
4 I.S.O., through C. Czarnikow Ltd., *Sugar Review*, 1979, (1458), 187.
5 *Bank of London & S. America Review*, 1979, **13**, 560.
6 *Standard Chartered Review*, September 1979, 10-11.
7 *World Sugar J.*, 1979, **2**, (3), 16, 26.

Sudan sugar imports[1]

	1978	1977
	tonnes, raw value	
Argentina	11,305	0
Brazil	31,250	79,758
China	0	11,226
Cuba	10,500	0
Czechoslovakia	23,300	0
EEC	72,850	5,435
Egypt	0	3,473
Germany, East	3,900	0
Greece	0	2,717
India	67,088	34,837
Korea, South	0	35,218
Portugal	0	5,163
	220,193	177,827

Jamaica sugar crop reduction[2]. – Jamaica's sugar production seems likely to fall below its original production target of 350,000 tonnes by roughly 84,000 tonnes, largely as a result of adverse weather conditions, according to the Sugar Industry Authority. Heavy rains also affected juice quality and increased the TCTS ratio from 10.2 to 14. Smut and rust diseases were other factors contributing to the shortfall, reducing cane production by as much as 30% in some fields. In 1978, a prolonged strike and heavy rainfall in some areas led to an output of not more than 307,000 tonnes, substantially below that year's target also of 350,000 tonnes.

Papua-New Guinea sugar project. – Booker Agriculture International has been appointed by the Independent State of Papua-New Guinea to establish a domestic sugar industry at Gusap in the Ramu Valley in the northern mainland. The development will be undertaken by Ramu Sugar Holdings Ltd. and will involve an estate of 6000 ha of rain-fed sugar cane and construction of a factory to produce 40,000 tonnes of mill white sugar per annum, together with estate roads, housing, ancillary buildings and services. The project is estimated to cost some $100 million and is due to start commercial production in 1983.

Chemviron award 1980. – Chemviron S.A. created its award for outstanding contributions to the study of water treatment as it relates to environmental health. The prize – a cash award of $10,000 plus a commemmorative medal and certificate – is awarded every second year. It is limited to papers originating in Europe and to the area of physico-chemical treatment of potable and waste water, with candidature open to virtually anyone from universities, municipal authorities or industry. Details are available from Chemviron, Chaussée de Waterloo 1135, B-1180 Brussels, Belgium.

Sugar consumption in East Europe[3]. – The patterns of change in per caput consumption have differed markedly between six countries of Comecon (the Council for Mutual Economic Assistance), as indicated in the following table:

	1960	1970	1975	1977
		kg, white value		
Bulgaria	29.3	34.4	36.8	39.8
Czechoslovakia	17.7	32.9	32.5	34.0
Germany, East	36.3	37.7	38.0	38.0
Hungary	27.9	39.2	43.0	41.5
Poland	26.6	33.5	39.5	37.0
USSR	28.0	38.8	40.8	42.0

Headquarters move for the Queensland Bureau[4]. – The Bureau of Sugar Experiment Stations has sold its headquarters premises on Gregory Terrace, Brisbane, and work has commenced on site preparation and construction of a new headquarters building at Longpocket, adjoining the Brisbane suburb of Indooroopilly. Completion of the new premises is scheduled for early 1980. In mid-1978 the Bureau purchased from CSR Ltd. the site and buildings of the David North Plant Research Centre at Longpocket, and facilities at the Centre have since been modified to provide additional space for quarantine and the transfer of commercial cane varieties and germ plasm to and from overseas countries.

Iran sugar imports[5]

	1978	1977	1976
		tonnes, raw value	
Argentina	28,043	13,696	0
Austria	0	2,556	0
Brazil	170,104	64,307	9,724
Chile	30,839	0	0
EEC	555,636	166,379	12,434
Egypt	0	2,839	0
Finland	0	1,848	0
India	0	0	135,127
Poland	0	11,367	0
Portugal	0	0	7,594
Sweden	3,391	12,826	0
Switzerland	23	1,217	0
Thailand	87,809	99,783	23,140
Other countries	23	2	0
	875,868	376,820	188,019

Cane alcohol programme for the Philippines[6]. – The Philippines plans to build ten new sugar-using alcohol distilleries costing $US 380 million as a step towards widescale production of alcogas[7]. The Ministry of Energy said that the distilleries costing be built over the next ten years, are expected to produce 12,000 barrels of pure alcohol daily from sugar and cassava. The alcohol produced will be mixed with petrol as fuel and reduce Philippine dependence on oil by as much as 15%. Three distilleries, costing $38 million each, will be built within the next three years. The Government will develop 270,000 hectares of virgin lands into cane and cassava plantations to help supply the plants.

Tongaat Group Ltd. Annual Report, 1979. – A total of 785,437 tonnes of cane was harvested from company-owned and managed land in the 1978/79 season, against 824,698 tonnes in 1977/78. Some 37,000 tonnes were harvested mechanically with two chopper-type harvesters. Melville Sugar Estates was taken over during the year jointly with C. G. Smith Sugar Ltd. and the factory closed; a further 99,781 tonnes of cane from that company's 2155 ha under cane were harvested, 51,432 tonnes being harvested after the take-over, and diverted to the Tongaat factory. A total of 157,000 tonnes of cane was harvested in the Ndwedwe area of KwaZulu, of which 56,000 tonnes were harvested and delivered by Zulu contractors and the balance by locally organized labour. Crop restriction had been practised during the season in order to curtail cane and sugar production; this involved reducing the cane area and curtailing irrigation to reduce yield. This was necessitated by the South African sugar industry's agreement to reduce farm mean peaks in face of low sugar prices and oversupply. The Tongaat factory crushed 1,875,351 tonnes of cane to produce 210,038 tonnes of sugar in 1978/79, against 211,398 tonnes of sugar produced from 1,927,336 tonnes of cane in the previous year. Overall recovery was a record at 87.78%. Two new mechanically-induced draught cooling towers were commissioned towards the end of the season and will reduce the dependence of the factory on river water for cooling purposes.

World's largest bagasse boiler[8]. – A new boiler of 277,000 kg steam per hour capacity, consuming at that rating 125 tonnes of bagasse per hour, has been commissioned at the Victoria mill of CSR Ltd. in Australia. The firing system comprises 8 feeders, 8 pneumatic distributors and a multi-section dumping-type grate. For stable conditions, even when bagasse moisture is high, the furnace has a lining of refractory concrete and combustion air is preheated to 257°C. Flue gases are cleaned by six cyclone wet scrubbers operating in parallel, and gas flow is 646 tonnes.hr^{-1} at full boiler load, handled by a double-width induced fan. The unit is equipped with an advanced system to provide automatic control of steam pressure and of flow rate. The auxiliary oil burners can be operated remotely from the control panel. A self-supporting chimney 65 m high has been designed to withstand winds up to 240 km.hr^{-1} and is fitted with a device for constant monitoring of smoke density.

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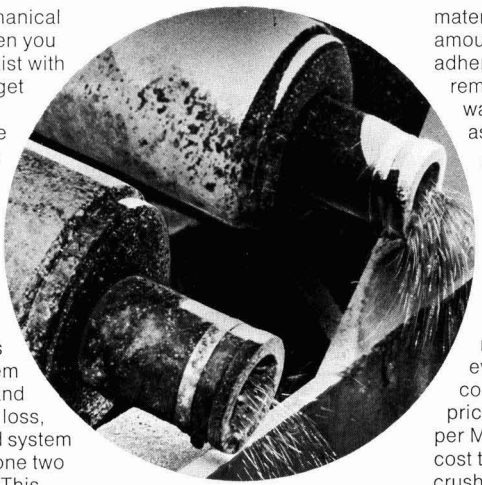
1 I.S.O., through C. Czarnikow Ltd., *Sugar Review*, 1979, (1454), 166.
2 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 472.
3 *Die Lebensmittelind.*, 1979, **26**, 359.
4 *Australian Sugar J.*, 1979, **71**, 156.
5 *Lamborn*, 1979, **36**, 143.
6 F. O. Licht, *International Sugar Rpt.*, 1979, **111**, 502.
7 See *I.S.J.*, 1979, **81**, 288.
8 *Australian Sugar J.*, 1979, **71**, 95.

Beware of sand.

If you are involved with mechanical harvesting of sugar cane, then you face a problem that didn't exist with hand cutting. Soil and sand get into the process. Thorough washing won't always get the sand out. And all it takes is a little bit of sand to ruin expensive machinery. Or to overload equipment. And contaminate your juice.



Dorr-Oliver DorrClone discharging sand.

DorrClone® The easy, effective answer.

Ordinary desanding systems can't handle the sand problem adequately. For complete sand removal, with minimal sugar loss, you need the most advanced system on the market — the DorrClone two stage sand removal system. This economical system is designed to remove approximately 95% of coarse and fine material, up to about 300 mesh (50 microns). It handles any mill capacity.

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A vortex action is created inside the DorrClone separator by the tangential feed and pump pressure. Mineral particles in the feed are thrown against the walls and pass out through the bottom. Liquid overflow passes through the top.

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Because it's twice as effective. After the first desanding stage, gritty material is washed with a small amount of washwater to recover the adhering sugar. The second stage removes the grit from the sweet wash water. The two-stage approach assures minimum sugar loss.

Compact package. Low initial cost.

The compact packaged system can be located in any convenient area or elevation. And if you already have existing pumps, tanks or other machinery, your initial cost is even lower than if you buy the complete package. The package price is as little as $3-$6 (U.S.) per M.T.C.D., ex works. The actual cost to any given user depends on crushing capacity. Total installed cost depends on factory layout and location.

For further information, write Larry Engel, Dorr-Oliver, International Headquarters, Stamford, Connecticut U.S.A. 06904.

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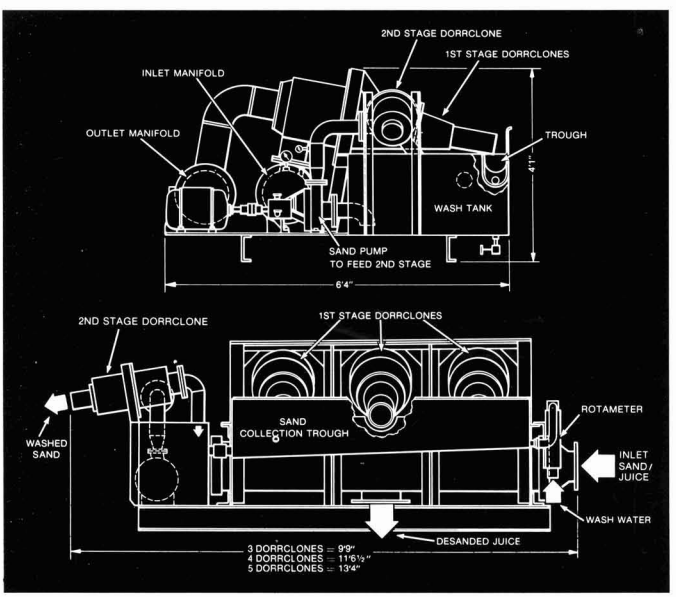

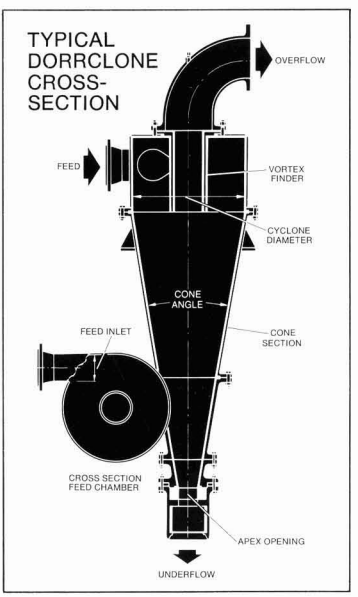

Index to Advertisers

Photo: Courtesy Richard Roxb

Main pump station No. 2 of the Kenana sugar project

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ERRATA AND CORRIGENDA

Page 15. Line 55 of Column 1. Read "1976" for "1978".
Page 15. Line 4 of Column 2. Read "1976" for "1978".
Page 53. Line 2 of Column 2. Read "P.B." for "B.P.".
Page 71. Line 44 of Column 1. Read "boiling" for "boiler".
Page 186. Line 48 of Column 1. Read "Korting" for "Kotting".
Page 219. Line 46 of Column 1. Read "Dauval" for "Daucal".
Page 240. Line 63 of Column 2. Read "81, 239" for "81".
Page 240. Line 64 of Column 2. Read "81, 239" for "81".
Page 245. Line 47 of Column 1. Read "Vigoureux" for "Vigoreux".
Page 250. Line 27 of Column 1. Read "Urbaniec" for "Ubraniec".
Page 279. Line 51 of Column 1. Read "evaporation^{5}" for "evaporation^{1}".
Page 284. Line 21 of Column 2. Read "Procter" for "Proctor".
Page 285. Line 57 of Column 2. Read "1979" for "1978".
Page 313. Line 56 of Column 1. Read "Bereshchuk" for "Bereschuk".

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INDEX TO VOLUME LXXXI

In using this Index it should be noted that the principal entries cover the several stages of production: CULTIVATION (*see* Beet; Cane; Diseases; Fertilizers; Irrigation; Mechanization; Pests; Soils; Transport; Varieties; Weeds, etc.): SUGAR PROCESSING (*see* Bagasse; Boilers; Boiling; Carbonatation; Centrifugals; Clarification; Crystallization; Diffusion; Evaporators; Filters; Massecuite; Milling; Mills; Molasses; Pans, Vacuum; Scale; Sucrose; Sugar; Sulphitation; Water, etc.); REFINING (*see* Bone Char; Carbon; Refining, etc.); and BY-PRODUCTS (*see* Alcohol; Animal Fodder; By-Products; Fermentation; Paper; Pulp; Yeast, etc.).

Subjects covered separately include Ash; Bulk handling and storage; Colour; Control, Automatic and Chemical; Countries; Ion exchange; Juice; Micro-organisms; pH; Polarization; Transport; Weighing, etc. Glucose and Fructose are to be found under Dextrose and Levulose. Statistics and Trade Notices are collected together under those headings. "Sucrose" implies the pure chemical; "Sugar" the commercial product; and "Sugars" the chemical family, rather than grades of sugar. When looking under the author's name, it should be remembered that the surname may be the penultimate in Spanish. Names starting with "Mc" are treated as if they start with "Mac", and the next letter in the name after the "c" will determine the position in the author index. Where a name includes the prefix "al", "d", "da", "de", "del", "el", "la", "van" or "von" it is indexed under A, D, E, L, or V, respectively. Where a name begins with the abbreviation "St." or "Sto." it is indexed as if this were spelt in full.

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SUBJECTS

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

NAMES

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

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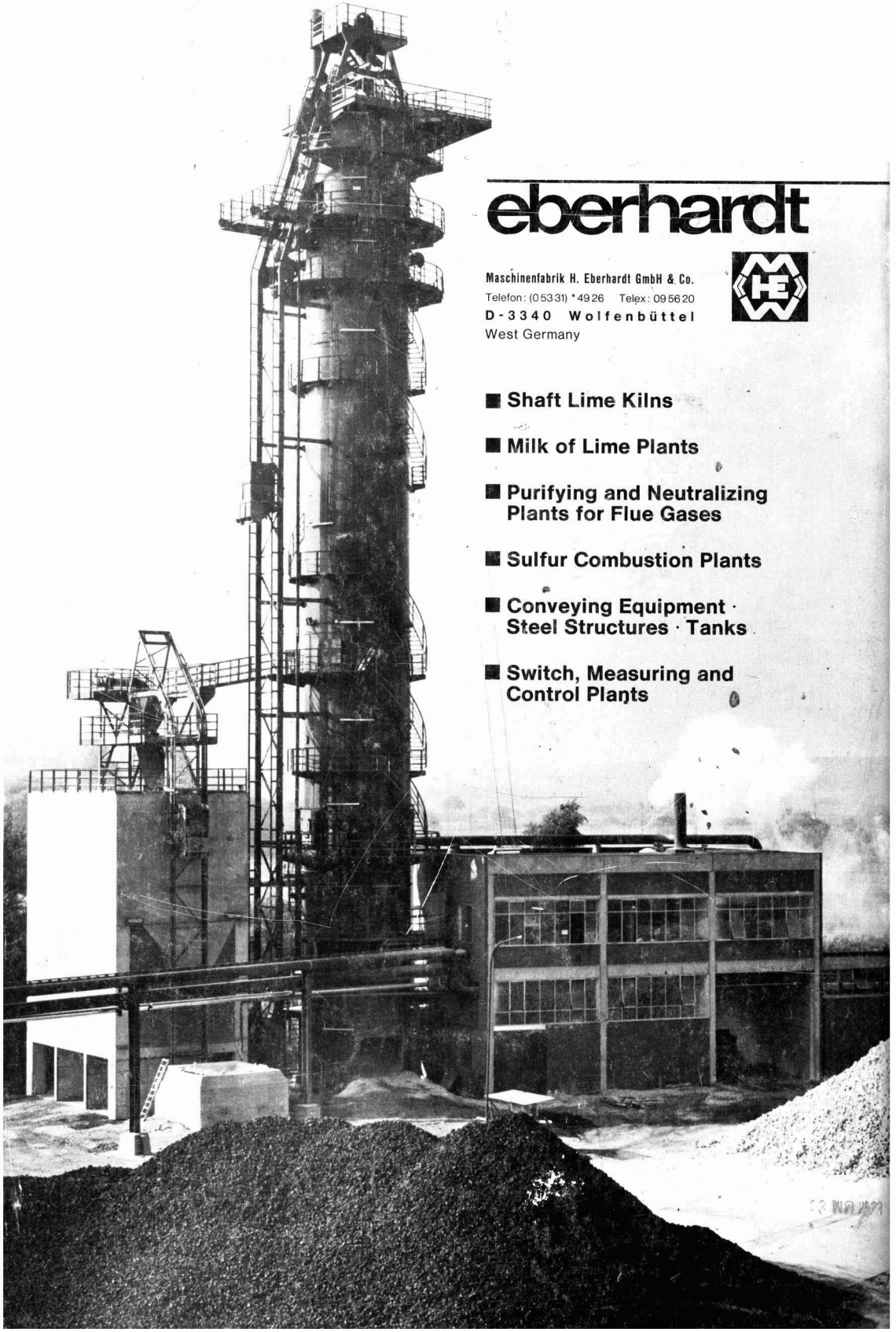

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