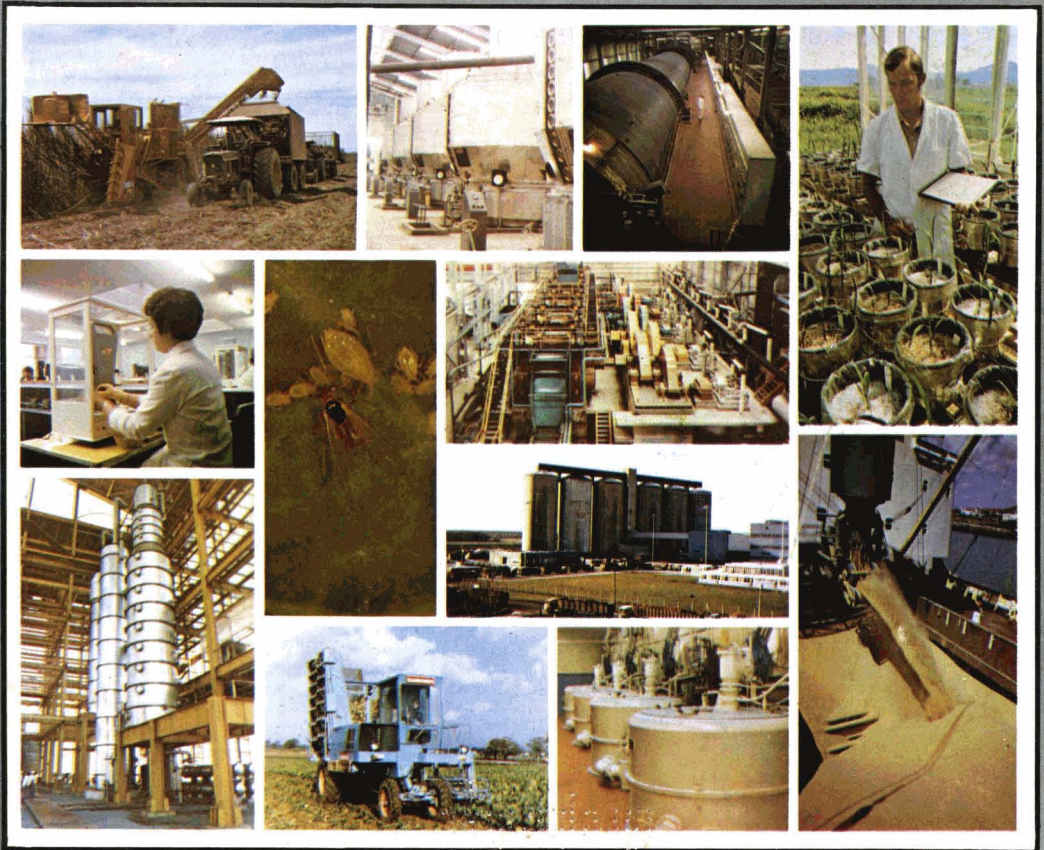


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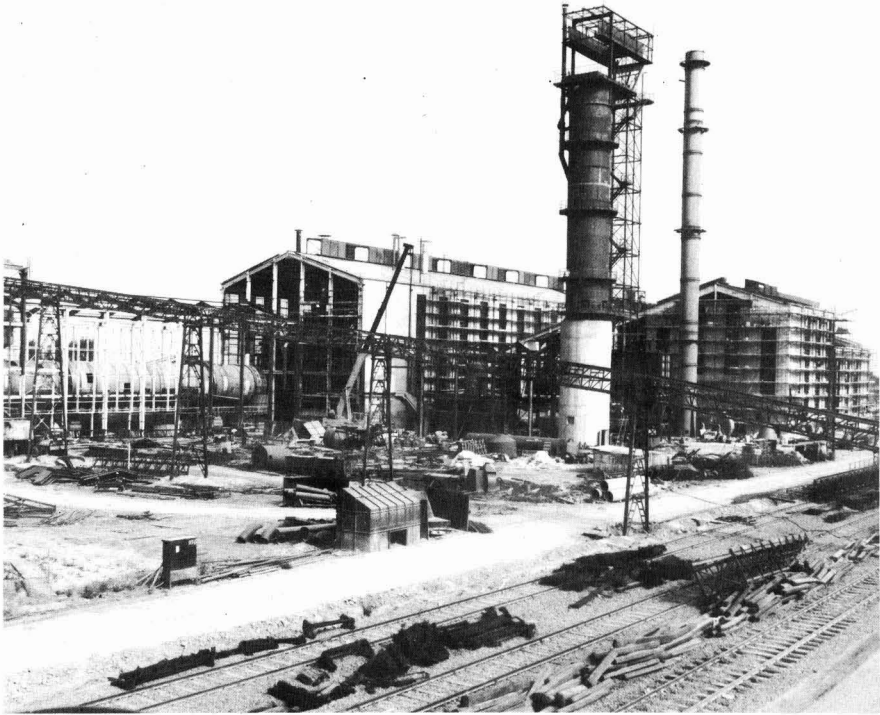


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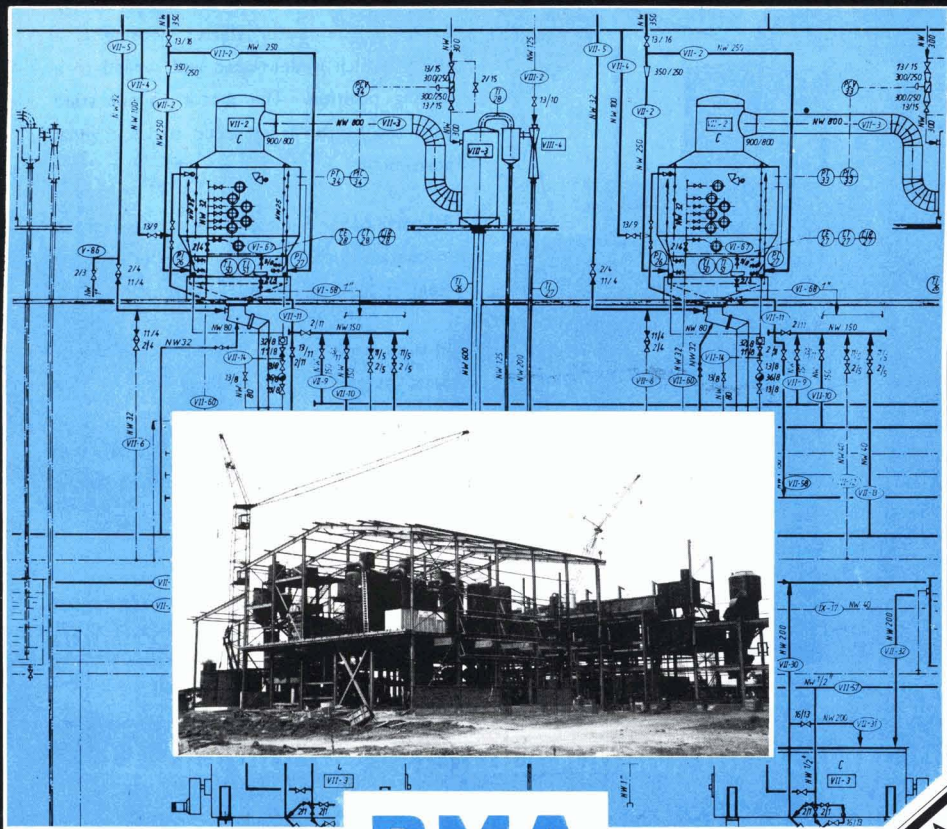
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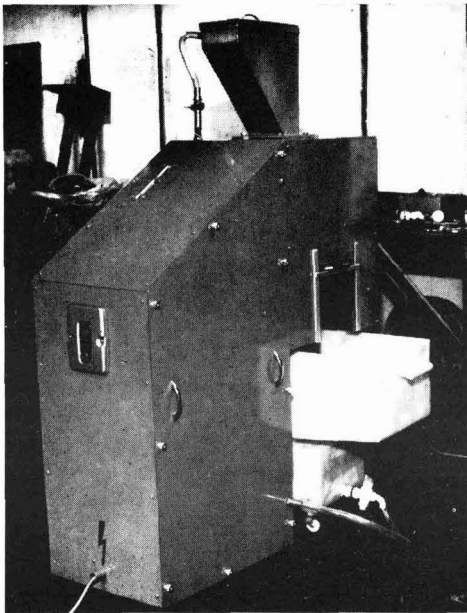
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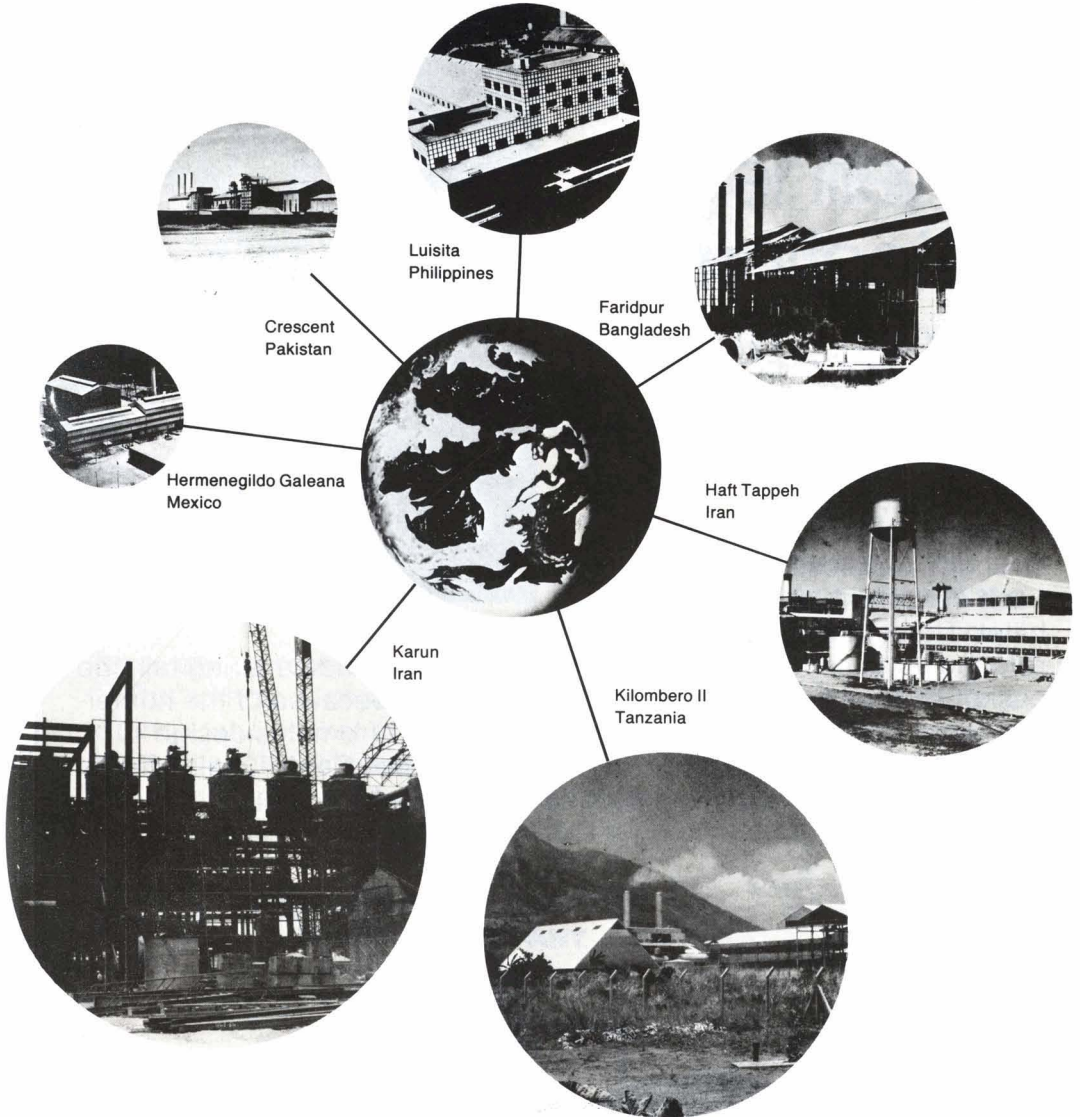
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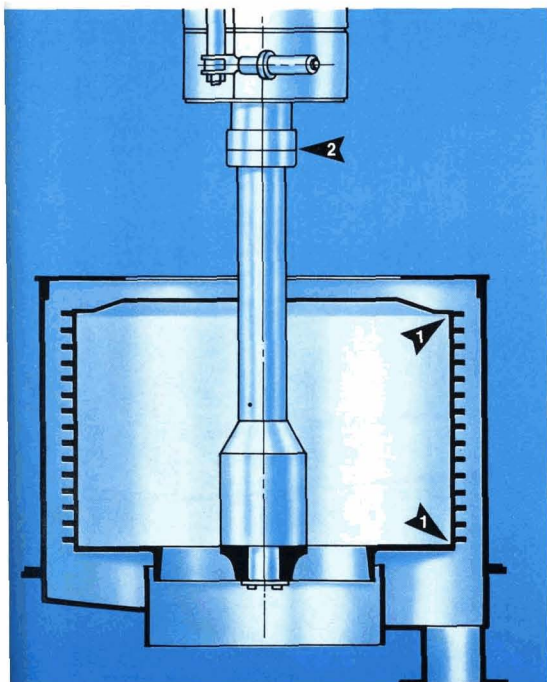
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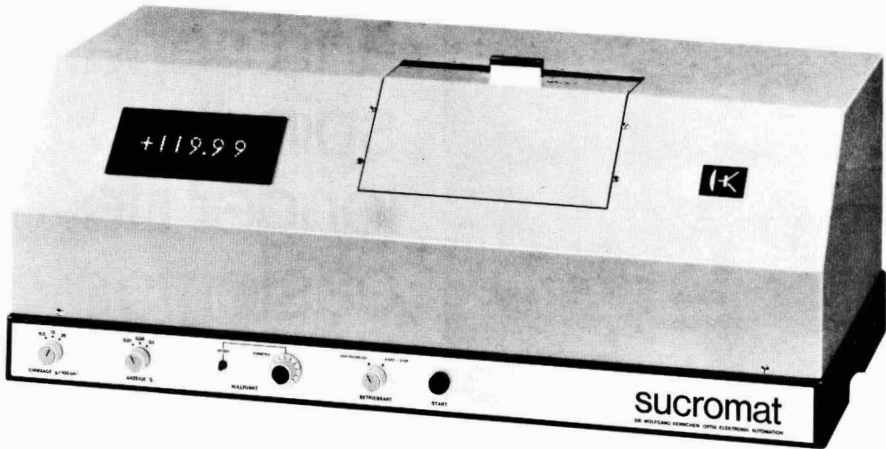


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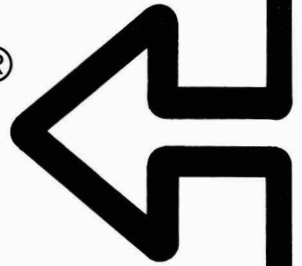
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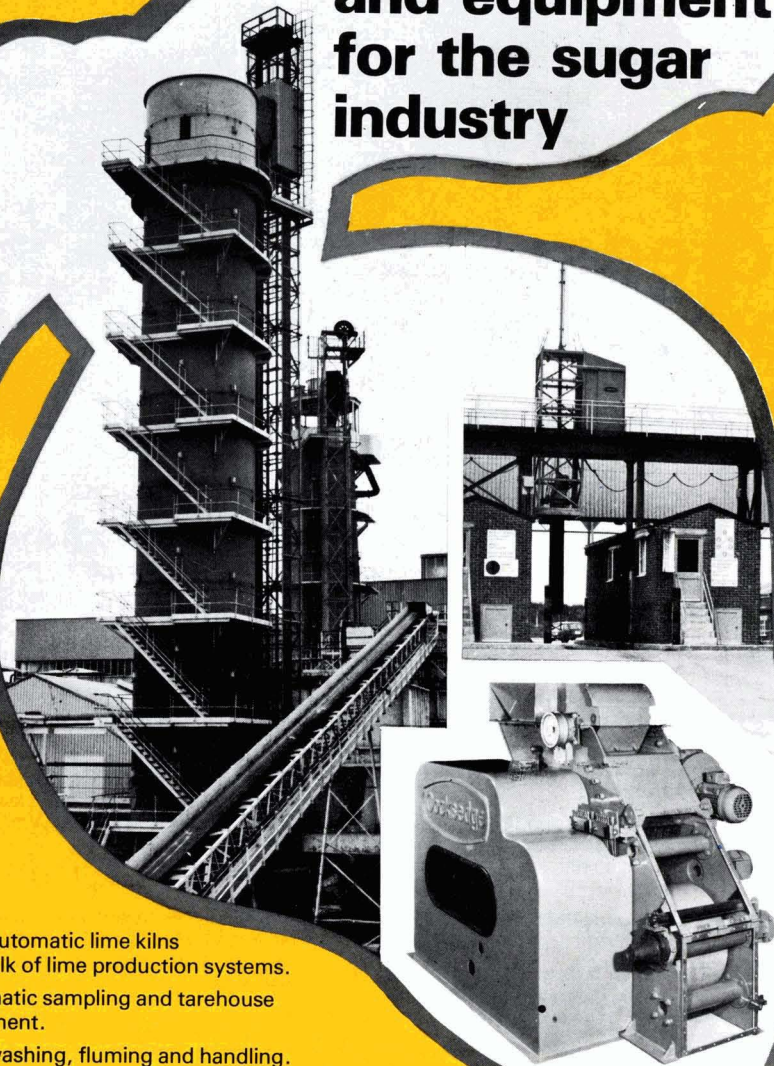
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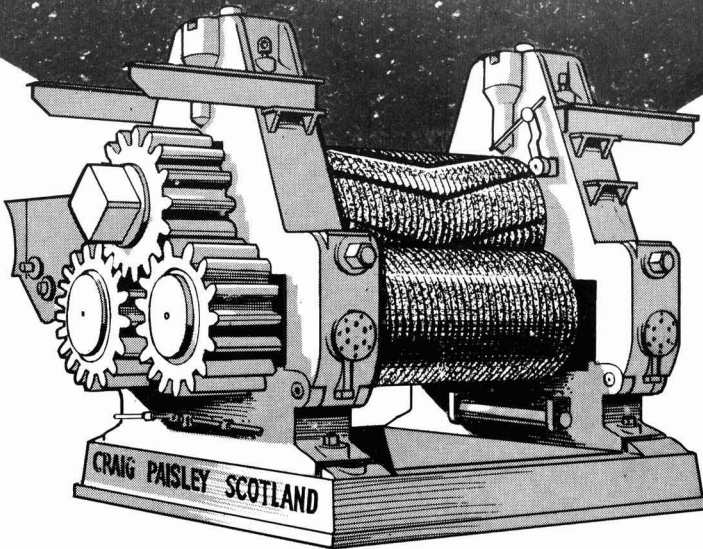
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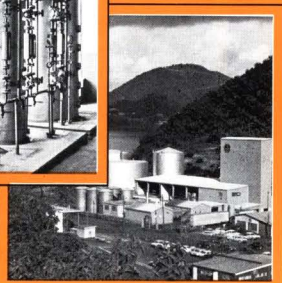
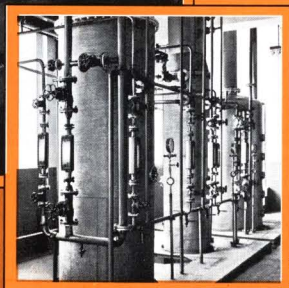
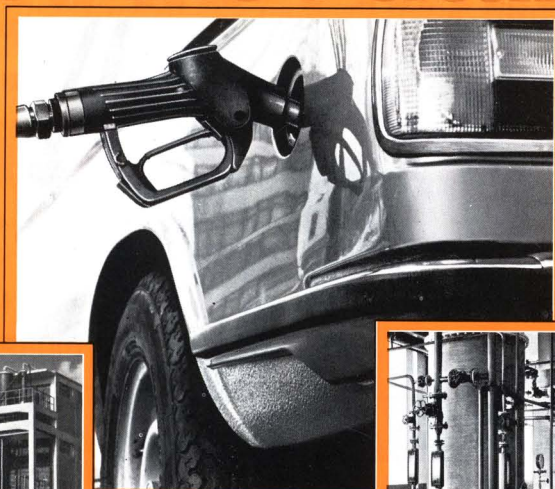
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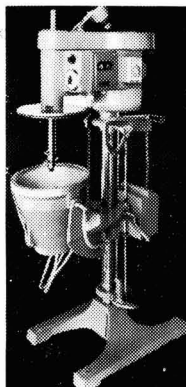
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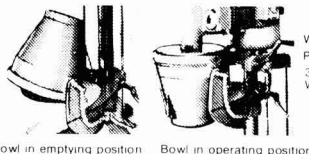
Above right Illustration of internal cutting arrangement. The cutters which are mounted on a vertical spindle perform a scissors action with the four blocks in the head of the machine. Screen plates with holes of various sizes are available. DIMENSIONS: Cutter grinder. (Packed 29" x 51" x 53") = 45.5 c.ft. (1.285 m³) Weight 1100 lb. (499 kg)

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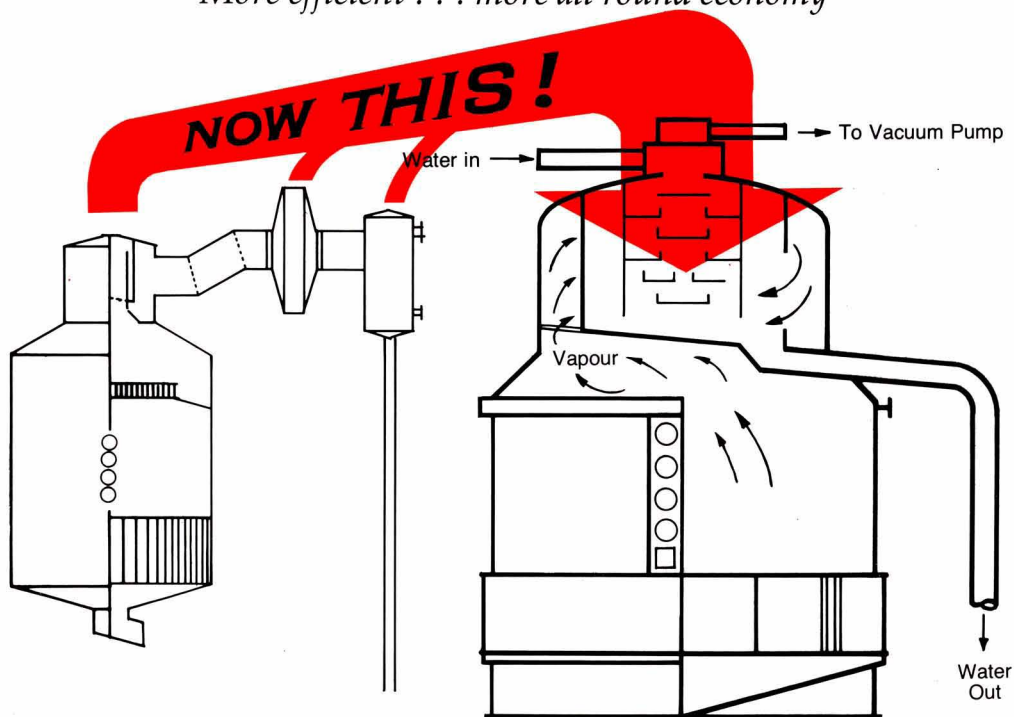


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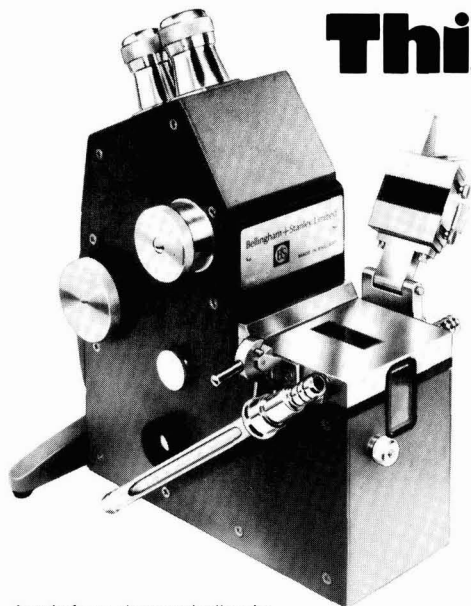
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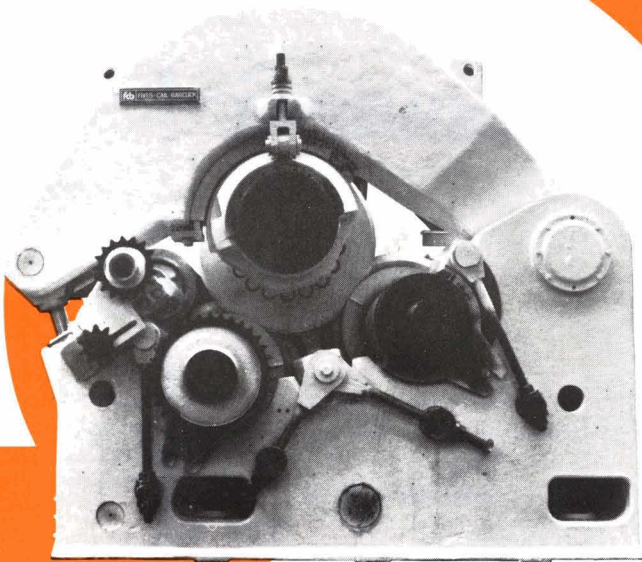
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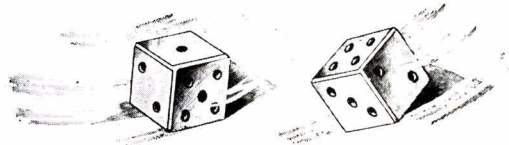
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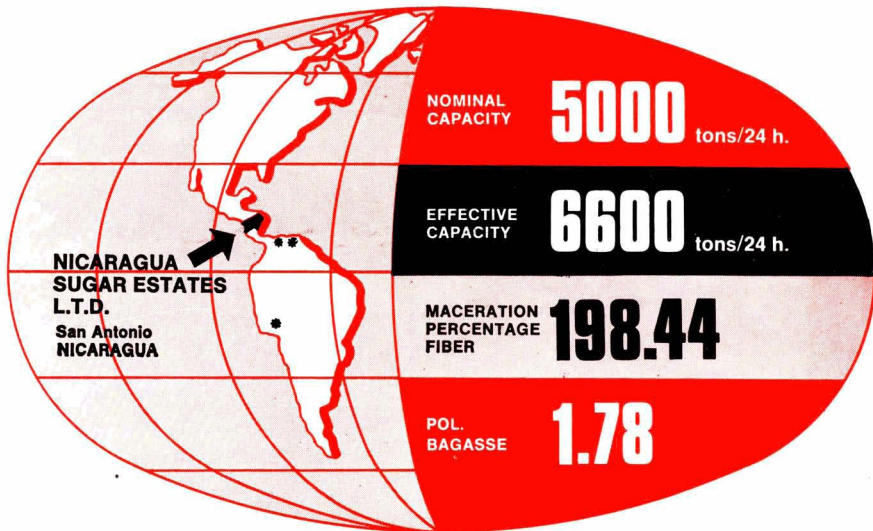
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NOTES AND COMMENTS

World sugar markets in 1979

Most observers seem to agree that 1978/79 sugar production will once again be in excess of consumption, but by only a fraction of the 1977/78 surplus; indeed, some consider that a balance will exist for the first time after five years of excess. But stocks have already reached alarming levels and may go even higher in the year. The French company Sucres et Denrées have recently analysed¹ supply and demand of raw and white sugar in order to estimate the effects of the 1978/79 crops on the markets. In regard to raw sugar they conclude that the main characteristic is the dominating influence of the ISA on the market; all countries exporting raw sugar are members except for Colombia, Taiwan and the EEC whose sales represent only 6-7% of worldwide sales. Consequently the ISO is able to control the availabilities of raw sugar.

Authorized exports for members have been maintained at their 1978 levels and sales by non-members have also remained nearly unchanged. Overall, the supply of raw sugar on the international market will be the same as last year, give or take less than 1%, supposing that the quota system remains solid. Demand, on the other hand, should be appreciably greater than in 1978; the huge sales which occurred in October-December 1977, before the entry into effect of the quotas, were not repeated in 1978 and demand for the calendar year 1979 should recover to its normal level. This increased demand for raw sugar in the face of regulated exports should ensure a relative equilibrium between supply and demand.

Nevertheless, there has been a decrease in prices since the beginning of the year, in contrast to what might have been expected. The most important factor is, without doubt, the "thinness" of the raw sugar market; certain importing countries have covered nearly all their needs for 1979 through long-term contracts while others have taken advantages of low prices in recent months to fill their needs. In summary, with the exception of China and the USA, all importing countries have on average already covered three-quarters of their raw sugar needs for 1979, resulting in a considerable amplification of Chinese and US influence and impact on the market. The Carter Administration has introduced measures in favour of domestic producers (a price objective of 15 cents/lb) which penalize refiners and render foreign sugar less competitive. At the same time, China, which intervenes on the market at rare intervals, has been absent—a fact that has certainly helped to maintain the present trend.

At the same time a very aggressive sales policy is being conducted by the exporters, who are bearing the weight of huge stocks which they are forbidden to sell by the ISA and who are, in consequence, interested in selling as quickly as possible to avoid unnecessary stocks.

It must be noted nevertheless that the thinness of the market plays in both senses; renewed Chinese purchases, an acceleration of American buying or the appearance of an unexpected buyer could intervene at any moment. The market could then become bullish as there is no real oversupply of raw sugar as long as quotas remain in effect.

The principal characteristic of the white sugar market is that it escapes the control of the ISA. The majority of European exporters are non-members and represent more than 60% of the white supply, with the balance supplied by Brazil, Argentina, Cuba and Bolivia (these are members of the Agreement but their white sugar imports are variable and dependent on market conditions); by refiners who are not concerned by quotas; and by India which is the only exporting member which produces only white sugar.

Despite the relative liberty gracing sellers of white sugar, this year supply will be stagnant at 1978 levels; the EEC foresees exports more or less identical to those of last year, while Austria and Poland will reduce their exports. This decrease will be counterbalanced, however, by new availabilities in Yugoslavia and Hungary. Overall, European exports should maintain their 1977/78 levels. Only Spain could upset this equilibrium; this country holds large stocks and could be tempted to sell on the international market.

In Latin America the sales of white sugar will probably decrease in favour of raw sugar. On the other hand, Indian exports during 1978/79 should be greater than exports during the same period last year. Hence, the relative stabilization of supply shows that mediocre prices have the same dissuasive effect as quotas.

The analysis of demand for white sugar is more delicate. Certain countries effected abnormally large imports during the last campaign. The stocks which they have thus accumulated will reduce their purchases in 1979. This reduction, difficult to evaluate, should be offset by a greater demand on the part of other importers who must respond to increases in consumption and, in some cases, poor harvests. On the whole, one must expect a stabilization of demand owing to exaggerations which occurred during the last campaign.

With supply and demand stable at 1977/78 levels, we may expect similar price tendencies.

China sugar production 1977/78²

The US Department of Agriculture estimates China's sugar production in the 1977/78 season at 2,300,000 tonnes, down from 2,340,000 tonnes previously forecast. In a field report from Hong Kong, the USDA said that new information gathered from the *People's Daily* indicated that cane sugar production had been underestimated and output of beet sugar had been overestimated. Cane sugar is now estimated at 2,020,000 tonnes compared with 1,670,000 tonnes previously and beet sugar at 280,000 tonnes against 670,000 tonnes estimated earlier.

The Department said that the article disclosed a great difference in per-hectare yields between the various growing areas, noting that the cane yield in Kwantang province in 1977 was 18% above the national average while, in the Pearl River delta, the yield was

¹ January 24, 1979.

² *Public Ledger*, January 13, 1979.

46% above the provincial average. A similar situation also exists in the beet growing areas, with some major beet producing areas requiring only 0.4 hectares of beet to produce 1 tonne of sugar compared with a national average of 1.07 ha.

UK sugar industry expansion¹

White sugar production in the UK, assuming constant prices, would amount to about 1.2 million tonnes in 1983 against just over 1 million tonnes in 1978/79, according to a study of possible patterns of agricultural production by the Ministry of Agriculture. On the same basis, the UK's beet area will rise to about 230,000 ha in 1983 from 210,000 ha in 1978, according to the study which accompanies a Government report on medium-term prospects for UK agriculture. The study says that, with constant prices, sugar yields are assumed to reach 5.2 tonnes.ha⁻¹ in 1983 against an estimated 4.9 tonnes.ha⁻¹ in 1978 and an actual 4.72 tonnes.ha⁻¹ in 1977. With a decline of just over 6% in real prices between 1977 and 1983, the projected area would be 215,000 ha in 1983 and white sugar production just over 1.1 million tonnes. The study expects the demand for white sugar at constant real prices to fall by about 4% by 1983.

Under the EEC sugar regime the UK was allotted a basic production quota of 1.04 million tonnes which the country was not able to fill in 1977/78. In 1978/79 it seems unlikely that the UK will produce any B-quota sugar. If the projections by the UK Ministry of Agriculture are thought to be realistic there will, in F. O. Licht's opinion, be no need for the United Kingdom to press for a higher A-quota during the forthcoming negotiations on the EEC's common sugar policy after 1980.

UK sugar imports and exports, 1978²

There was a time when most of the white sugar traded internationally was the product of the in-transit refiner. British refiners were leaders in this field and on more than one occasion managed to export more than 700,000 tonnes in a single year. Indeed, as recently as 1975, British exports exceeded 350,000 tonnes but since that time competition from sugar produced by the direct process has whittled away the markets so that only those countries requiring a particularly high quality product can now be considered a regular and continuing outlet.

Over the past four years shipments to Norway and Nigeria have remained fairly constant but the market in Switzerland has fallen away practically to nothing while several other countries which would on occasion purchase a cargo or two of British sugar did not do so in 1978. Indeed, total British exports amounted to a modest 85,000 tonnes, barely half the tonnage attained in the previous year. Partly reflecting the smaller need for the in-transit trade, imports by the UK during 1978 were also reduced. Another factor in the diminishing level of imports during the past two years has, of course, been the recovery in domestic beet sugar output. Nevertheless, Britain still remains a major importing country and in 1978 took 1,670,000 tonnes of sugar from overseas.

As has been the case for the past several years, Mauritius was the largest of these overseas suppliers, delivering more than 460,000 tonnes. After Mauritius came Guyana with 178,000 tonnes, Fiji with 170,000

tonnes, Jamaica with 139,000 tonnes and Swaziland with 127,000 tonnes. Statistics of UK sugar imports and exports during the past three years appear elsewhere in this issue.

Sugar supply and demand balance

It is striking that, over the past few years, sugar production in one year has been approximately the same as consumption a year later. As a consequence there has been a continual accretion to stocks; if production had stood still for a year an approximate balance would have been established. N. G. Osman, writing in *World Sugar Journal*³, has drawn attention to his latest assessment of the statistical position which sets the real surplus stocks at about 4 million tonnes of sugar, representing about 25% of the requirements of the world free market.

Consumption has been rising at about 3.5% which, on present levels, is about 3.2 million tonnes. Given the present price level, and supply availability, a similar expansion in 1979/80 could be taken as a foregone conclusion. If production were to remain at around 90 million tonnes for 1979/80, with very small or no expansion, this normal consumption growth would reduce the estimated surplus stocks of sugar to around 0.8 million tonnes, which should be manageable. Such a situation would bring about a return of stability to the market.

"Present price levels must certainly act as an inducement to increased consumption and as a discouragement to production expansion. We believe that such discouragement, when combined with export limitations under the ISA, will serve as a powerful tool. The only unknowns, therefore, are the intentions of the non-ISA members, in particular the EEC, and weather conditions . . . Will the sugar producing nations be able to refrain from expanding production for one year to help bring about the much needed stability? We will know in 12 months time (when production outlooks for 1979/80 are available)".

US sugar legislation

The debate on US sugar policy continues to drag on, with conflicting bills introduced by Congressmen seeking to protect the interests of sugar growers and producers on one hand and refiners and consumers on the other. An interesting amendment to the House Agriculture Committee's bill was approved which provides for up to \$25 million in loans for construction of facilities to produce alcohol from sugar and corn products. It had been hoped that a compromise bill might be reached earlier in March but by the end of the month discord among sugar interests had rendered the hope forlorn.

The USA has still not ratified the International Sugar Agreement, which came into effect in January 1978, and, in order to do so, must first settle its domestic sugar policy. Until the US ratifies the Agreement, payments cannot be made to the special fund to finance stocks held back by exporting members. As a result, the International Sugar Organization has once again postponed the start of fund contributions to allow the USA more time. The US had told the ISO that legislation was unlikely to be passed before April and the Organization is to review the situation again on June 1, with an intended start for the fund on July 1.

¹ F. O. Licht, *International Sugar Rpt.*, 1979, 111, 102.

² C. Czarnikow Ltd., *Sugar Review*, 1979, (1427), 31-32, 34.

³ 1979, 1, (8), 4-5.

US sugar import fee¹

On March 23, the US Secretary of Agriculture announced that the import fees for sugar would be reduced by 0.59 cents/lb with effect from April 1. The new fees will be 2.76 cents/lb for raw sugar and 3.28 cents/lb for refined sugar. The new fees were calculated as described earlier² on a 20-day average world price which, computed from ISO quotations, was equivalent to 8.53 cents/lb.

World sugar prices

Sugar markets have been very dull during the month of March, with the London Daily Price for raw sugar varying only between £101 and £105 and the LDP(W) between £102 and £106 per tonne. The month began and ended with a premium for white sugar over raws but there was a considerable part of the period when white sugar was cheaper than raws, reflecting the pressure of availabilities, especially from the EEC, and the lack of outlets.

ACP-UK sugar consultations

Consultations took place on March 14, 1979 between Ministers of countries which supply Britain with cane sugar and the British Minister of Agriculture. The governments of the supplying countries had requested the consultations in order to express their deep concern at the reference to the expansion of beet sugar production in the White Paper "Farming and the Nation" and in the paper "Possible Patterns of Agricultural Production in the United Kingdom by 1983". This concern was especially great when viewed in the light of the declared policy of expansion set out in the Annual Report of the British Sugar Corporation. They also reminded the British Government of the assurances concerning cane sugar from the developing countries made by Britain in the context of its accession to the EEC.

Mr. Silkin said that Her Majesty's Government fully accepted the importance for the ACP countries of their present access to the Community market and in particular of their traditional outlets in the United Kingdom market. He underlined the importance attached by HMG to the Sugar Protocol of the Lomé Convention and assured the supplying countries that HMG would fully honour the obligations it had undertaken in the Protocol. He further assured the supplying countries that the White Paper did not represent the adoption of policies which in any way ran counter to preserving the traditional outlets in the UK market for ACP sugar.

The supplying countries welcomed these assurances. They further stressed that, since quotas under the Sugar Protocol were fixed, any sugar surpluses which might arise in future in the United Kingdom would not be the responsibility of ACP imports and that accordingly any costs which might arise in disposing of them should not be attributed to cane producers.

The British Minister of Agriculture and the Ministers of the supplying countries noted the problems caused by the disposal on the world sugar market of surpluses produced in the EEC.

The supplying countries further expressed their regret that the EEC had not yet found it possible to accede to the International Sugar Agreement and expressed the hope that the Community would soon be in a position to adopt the necessary market disciplines.

Europe sugar beet area, 1979

F. O. Licht GmbH recently published their first estimate of areas to be sown to beet for the 1979/80 campaign³ and the figures appear below. The beet area for the EEC as a whole is expected to remain virtually unchanged from 1978, although this masks a fall in those countries where substantial quantities of C-quota sugar were produced last campaign (France, West Germany) and an increase in those countries (Ireland, Italy and the UK) where production did not fill the total of A+B quotas.

In some other West European countries expansion programmes are being pursued irrespective of world prices; Yugoslavia, a former sugar importer, has announced plans to sell on the world market this year while Turkey is also increasing production although for domestic consumption only. Elsewhere beet areas are stable except in Spain where a burdensome sugar surplus is inducing an appreciable reduction.

Only a very small overall increase is expected for the East European beet area, the greatest change being of 22,000 ha for Poland. Here an official announcement has been made of the reduction, although there have been conflicting unofficial statements made reporting an increase in area. The rise of 20,000 ha in the Soviet area represents only just over 1/2% and, while the changes for other countries are larger in proportion, they still represent only small absolute area changes.

| | 1979 | 1978 | 1977 |
|------------------------------|------------------|------------------|------------------|
| | hectares | | |
| <i>West Europe</i> | | | |
| Belgium-Luxembourg | 115,000 | 115,000 | 98,000 |
| Denmark | 73,000 | 76,000 | 84,000 |
| France | 506,000 | 523,000 | 544,000 |
| Germany, West | 403,000 | 411,000 | 433,000 |
| Holland | 132,000 | 134,000 | 132,000 |
| Ireland | 38,000 | 36,000 | 35,000 |
| Italy | 275,000 | 255,000 | 240,000 |
| UK | 217,000 | 204,000 | 201,000 |
| <i>Total EEC</i> | <i>1,759,000</i> | <i>1,754,000</i> | <i>1,767,000</i> |
| Austria | 45,000 | 44,000 | 56,000 |
| Finland | 32,000 | 30,000 | 30,000 |
| Greece | 46,000 | 45,000 | 43,000 |
| Spain | 200,000 | 225,000 | 253,000 |
| Sweden | 52,000 | 52,000 | 54,000 |
| Switzerland | 13,000 | 13,000 | 12,000 |
| Turkey | 311,000 | 277,000 | 250,000 |
| Yugoslavia | 160,000 | 120,000 | 118,000 |
| <i>Total West Europe...</i> | <i>2,618,000</i> | <i>2,560,000</i> | <i>2,583,000</i> |
| <i>East Europe</i> | | | |
| Albania | 8,000 | 7,000 | 7,000 |
| Bulgaria | 85,000 | 78,000 | 75,000 |
| Czechoslovakia | 220,000 | 210,000 | 208,000 |
| Germany, East | 270,000 | 267,000 | 271,000 |
| Hungary | 115,000 | 122,000 | 113,000 |
| Poland | 538,000 | 560,000 | 532,000 |
| Rumania | 270,000 | 260,000 | 255,000 |
| USSR | 3,750,000 | 3,730,000 | 3,761,000 |
| <i>Total East Europe ...</i> | <i>5,256,000</i> | <i>5,234,000</i> | <i>5,222,000</i> |
| <i>Total Europe</i> | <i>7,874,000</i> | <i>7,794,000</i> | <i>7,805,000</i> |

¹ Lamborn, 1979, 57, 51.

² I.S.J., 1979, 81, 66.

³ International Sugar Rpt., 1979, 111, 147-149.

Sugar Industry Technologists Inc.

38th Annual Meeting, Boston, May 6—9, 1979

AMSTAR Corporation and Revere Sugar Corporation were co-hosts for the 38th Annual Meeting of S.I.T. held during May 6-9 at "The Colonnade" hotel in Boston, MA, USA.

The S.I.T. hospitality room was open on Saturday, May 5 to welcome early arrivals. On Sunday, May 6, Executive Committee and Board of Directors meetings were followed by the S.I.T. annual mixer and a buffet dinner hosted by Amstar Corporation and Revere Sugar Corporation. Monday and Tuesday, May 7 and 8, were devoted to technical sessions. A reception and banquet were held on the evening of May 7 to honour recipients of the George & Eleanore Meade Award for the best paper read at the 1978 S.I.T. Meeting held in London, and the S.I.T. Honorary Award. On Wednesday, May 9, visits were made by participants at the Meeting to two local sugar refineries—the Boston refinery of Amstar Corporation and the Charlestown refinery of Revere Sugar Corporation.



Stanley E. George

The President, Stanley E. George, of BC Sugar, Vancouver, greeted members of S.I.T. as follows: "One of the pleasant duties of being President is being given the opportunity to extend Greetings to all attending the Annual Meeting of the Sugar Industry Technologists, Inc. This, I happily do on the occasion of this, the 38th Meeting.

"I believe it is most fitting that following last year's meeting in London, that ancient and historic city of the old world, that this year's meeting is being held in Boston, Massachusetts, that old and historic city of the New World. London, with its age pushing 2000 years, is truly entitled to the term, 'ancient'. Boston, with its age at 350 (349 actually), is equally entitled to the term 'old'—at least by North American standards. The city quite simply drips with American history—there may even be a few soggy tea bags left over from that famous party.

"It was founded in 1630 by a group of English Puritans, led by John Winthrop, who were seeking religious freedom not available to them in England. A search which others have undertaken in very recent days—a different religion—a different country, but the same old search. Of course, the Puritans were not above whipping or hanging the odd Quaker when they sought these very same religious freedoms in the new colony. Not much fun for those involved but one of the interesting quirks of history—or is it quirks of man?

"By 1750 Boston had grown to a population of about 15,000 and rivalled Philadelphia as the political and cultural centre of the American colonies. Now, some 230 years later, Boston has finally pulled ahead of Philadelphia by being the host city for this prestigious S.I.T. Annual Meeting.

"In the 1760's and 1770's Boston led the American colonies in their 'cold war' with England. John Adams, Samuel Adams, John Hancock, James Otis and other Bostonians were leading figures in arousing the colonial people with speeches and pamphlets to revolutionary war. The Boston 'Massacre' occurred on March 5, 1770 when English soldiers fired on a crowd of townspeople—killing 3 and wounding 8. Although the toll was less, I'm sure, than in today's traffic accidents on a Boston holiday weekend, the event was important in crystallizing (a good sugar word) the colonists' bitterness towards the British.

"The famous Boston Tea Party took place on December 16, 1773, resulting in the British closing the port to commerce. The early battles of the American Revolutionary War took place in and around Boston; Lexington, Concord, and the bloody battle of Bunker Hill in which the British suffered more than 1000 casualties and the Americans about 400. The Somme, Chateau-Thierry, Vimy Ridge, Guadalcanal it was not, but it ushered in an era of revolution in Europe, in Latin America, and eventually in Asia and Africa that is still



Warren L. Reed

with us. That fact should not be forgotten when others make their revolutions, even in the year 1979.

"In 1776, American troops under the command of George Washington, that intrepid American (born an Englishman) laid siege to the city and on March 17 the British sailed away—an American victory in the most important and far-reaching revolution in the history of mankind. On which note I'll bring this short résumé to a close with the hope that it will stimulate all attending this 38th S.I.T. Annual Meeting to visit the historic sites of Old Boston and reflect upon their influence in our lives today.

"I'm sure cane sugar refining fits into all this somewhere—if only in the sugar that wasn't used at the famous tea party—or did that go overboard too? I'll leave that bit of research for another day."



Randall Craig

In a message of greeting from the Chairmen of the Local Arrangements Committee, Warren L. Reed and Randall Craig, they recorded that Amstar and Revere, the two New England cane sugar refineries, were proud to welcome the Sugar Industry Technologists to their 38th Annual Meeting and the first in Boston, Massachusetts:

"For those of you visiting Boston for the first time, the local arrangements committee has collected a wide variety of information and material to permit you to make the most of your stay. We hope you will have some extra time so that in addition to enjoying the session you may sample the wide variety of cultural pleasures and activities available in this area.

"Those who have been to Boston before know many of the enjoyable activities and places to see. Arts and Technology are widely represented in the museums and displays available. The Aquarium is one of the most unusual and complete aquariums in the US and has the largest glass viewing tank in the world. The rugged coastline and sandy beaches, rolling hills and meadows, the many types of architecture as well as the historical exhibits will delight the visitor and particularly the photographers in the group.

"The two host sugar refineries each have a rich history in the industry, as well as each having cele-

brated over 100 years as a major New England business. They have a wide variety of different technical operations to display to the visitors on Wednesday, May 9, because of major differences in their refining processes. These will be very interesting and rewarding trips to those who have not visited Revere and Amstar in recent years.

"The extremely high cost of oil in the Northeast US has led to a large amount of work on energy reduction and control in the refining process. The plant trips, plant manuals, and discussion with local personnel will permit sharing of progress in this area. The Raw Sugar Symposium is a timely one and a vital subject to all. This will be well attended, and we hope all will contribute with results of their experiences and information on their needs or recommendations on this subject.

"The ladies' committee has worked out a very interesting time for all the ladies attending this session. The most difficult part of their job was selecting from such a wealth of activities and trips. They have selected one of the newest and exciting parts of Boston for one day's activities to be supplemented with a quite different and exciting trip to our colourful coastline on the other day.

"It is always stimulating to go to these technical sessions and meet again the fellow technologists one has worked with over the years and to make new friends. We are sure that both our technical programme and also our supplementary non-technical activities will give all of you a very worthwhile time in Boston. It will give you the stimulation you need to return home and continue work on the many serious problems facing the sugar industry today".

Abstracts of the papers presented at the technical sessions appear below.

Liquid sugar by chromatographic molasses desugarization process

H. J. Hongisto (*Finnish Sugar Co., Helsinki, Finland*)

In cane molasses desugarization by means of a chromatographic separation process, sugar is recovered as a fraction very amenable to further treatment to give different kinds of liquid syrups. It is possible to choose between two different alternatives: The sucrose in the molasses is not inverted prior to separation, in which case it can be recovered, or it is inverted. The necessary ion exchange and adsorption processes are described and the results of some alternatives are compared. It is possible to produce practically colourless, first-class invert syrups at a very reasonable cost. The economic aspects are discussed.

White sugar crystallization by implementing a three-phase boiling system

J. N. Richards (*Savannah Sugar Refinery, GA, USA*)

This paper explores a three-phase boiling scheme. Flow schematics indicate the successive phases of the boiling system. Boiling is methodically carried out in three vacuum pans. By analysis, the essential features of the various syrups before and after each boiling cycle are established for: (1) "E" pan (conventional or straight high-grade crystallization), (2) "F" pan (modified back-boiling system), and (3) "G" pan (sequential back-boiling system). The higher yield, greater capacity and reduction in the required syrup storage tankage are discussed.

The design, start-up and operation of a continuous liquid sugar manufacturing facility

D. E. Webster (*B.C. Sugar, Vancouver, B.C., Canada*)

A review of actual liquid sugar sales over the previous 10 years and an estimated projection from 1975 indicated the need for a new liquid sugar manufacturing facility. The basic process considerations from which the station design evolved are discussed. Equipment components and automatic control systems are described. Initial start-up problems, design modifications and operation over the past 1½ years together with photographs of the installations are presented.

Sucrose reactions in phosphatation

M. A. Clarke and M. A. Brannan (*Cane Sugar Refining Research Project Inc., New Orleans, LA, USA*)

High-pressure liquid chromatographic methods are used to examine sucrose decomposition and concomitant colour formation in refineries using phosphatation clarification.

Effect of temperature upon filtration efficiency

E. J. Roberts and M. A. Godshall (*Cane Sugar Refining Research Project Inc., New Orleans, LA, USA*)

The effect of filtration temperature on the removal of colloidal materials from sugar liquors has been studied. Liquors from selected stages in the refinery were filtered at temperature intervals of 10° from 25°C to 95°C. The high molecular weight material not removed by filtration at each temperature was determined. The implications of the results in the refining process are discussed.

The air oxidation of granular carbons and bone charcoal

V. R. Deitz, J. B. Romans and P. Rongpat (*Naval Research Laboratory, Washington, D.C. 20375, USA*)

The air oxidation has been studied using programmed heating in air flows of 5 litres.min⁻¹ (linear rate = 1 m.min⁻¹) and heating rates of 30°C.min⁻¹ and 1.6°C.min⁻¹. The CO emission was measured from 1 to 1000 ppm and the CO₂ emission from 10 to 2500 ppm. New bone char was found to have a spontaneous ignition temperature (SIT) of the same magnitude of many granular carbons, indicative of a similar chemical reactivity of the carbon networks with oxygen of the air. Measurements were repeated with the same sample after it had cooled to room temperature (without air flow) and the results indicated a slower regeneration of the reactive sites (that from CO and CO₂) in granular carbons than in bone charcoal. The emission from granular carbons gave well defined maxima and minima in the concentrations of both oxides at the same points in heating time and temperature. A knowledge of the SIT of a carbon adsorbent, lowered by adsorbed impurities, should be helpful in the control of burn-off in thermal regeneration processes.

The solubility of sucrose in water

A. VanHook (*College of the Holy Cross, Worcester, MA, USA*)

The recent claim of Smelik (*Zucker*, 1977, **30**, 113-120) that the solubility of sucrose is increased in the presence of excess solid is refuted. The purported explanation

based on hydration is not sustained by the behaviour of sodium sulphate, in which instance the effect should be greatly emphasized. Aging and pH influences are also discussed.

Cane sugar refiners short course at Nicholls State University

R. N. Falgout (*Nicholls State University, Thibodaux, LA, USA*)

In July 1978 Nicholls State University conducted its 1st Annual Cane Sugar Refiners Short Course. Its purpose was to provide short-term training for engineers, technicians and management personnel in the cane sugar refining industry. The objectives were (a) to promote training which will upgrade the skills of participants, making them better employees, (b) to provide background knowledge so that participants will be better prepared to assume positions of responsibility and leadership, and (c) to develop in participants an appreciation of the total operation of the plant. The format was a two-week intensive learning situation with some topics being covered by full-day sessions and some by half-day sessions. Classes included lectures and discussion with many informal sessions during "out-of-class" hours. Some twenty-nine participants from all over the world completed the short course. The reaction from both students and teachers was overwhelmingly favourable. Response was so good that we are planning a similar short course, we hope even better than the first one.

Recent developments in refinery technology in Belgium

A. Genart (*Raffinerie Notre-Dame, Oreye, Belgium*) and L. Sué (*Raffinerie Tirlemontoise S.A., Tienen, Belgium*)

This paper includes short descriptions of new developments in refinery technology in Belgium: at Raffinerie Notre-Dame d'Oreye, the installation of a continuous Fives-Cail Babcock boiling pan in the recovery house; at Raffinerie Tirlemontoise, two projects are starting: evaporation of refinery liquors in Alfa-Laval multiple-effect evaporators, and monitoring of under- and over-weights on different packing lines and treatment of results by micro-processor.

Low-temperature regeneration of granular carbon

W. L. Reed (*Revere Sugar Corporation, USA*)

This paper describes the problems encountered and the steps taken in the conversion of our 15,000 lb per hour Herreshoff rotary char kiln to its current condition and operating procedure of 500 lb per hour of granular carbon at about 1000-1200°F. It graphs 4½ years of continuous operation, covering maintenance, oil usage of the kiln and pertinent analytical data on the carbon stock, process colour removal, etc. It lists cautions to be observed and recommendations for an ideal low-temperature regeneration system as we currently see it. It also discusses our current carbon use procedure and regeneration system, and future plans. It also includes sample analyses and specific results of investigations by the Pittsburgh Activated Carbon Co., who have tested many samples and have worked with us on controls and evaluation of an ideal low-temperature granular carbon regenerating system.

Sucrose process for evaporative continuous crystallization

M. Dmitrovsky (*American Sugar Division of Amstar Corporation, New York, NY*)

The method involves combining two batch vacuum pans in series in order to crystallize granulated sugar continuously. The first of the two vacuum pans is used to seed and mature the seed continuously until the average size is sufficiently increased so that it can be transferred to the second vacuum pan. The second vacuum pan grows the sugar to commercial size and discharges the product continuously at proper density.

A symposium on "The effects of raw sugar quality on the refining process" was also held on Monday afternoon. The moderator was J. V. López-Oña, of National Sugar Refining Company; the panelists were D. M. Humm (California and Hawaiian Sugar Company) concerning "Polarization", L. G. Sansaricq (American Sugar Division of Amstar Corporation) on "Colour", S. J. F. Winn (Tate & Lyle Technical Services Ltd., England) on "Filtrability", and W. R. Tuson (Colonial Sugars, Borden Inc.) on "Ash".

The purpose of the symposium was to update the available information on the effects of raw sugar quality on the refining process. The last time previous that S.I.T. had a panel discussion on this subject was in 1967, and it seemed appropriate to discuss it again, since cane sugar refiners have always been interested in the quality of their raw material input because of the correlation that exists between this factor and the resulting yields, characteristics of the finished products and production costs. In sugar refining, the raw material to be processed receives a large share of attention because it is much easier to avoid trouble in this manner than to cure it after the first materials have entered the refining process. Last year at the London meeting of S.I.T., several technical papers were presented on

energy savings, and in the 1979 symposium the emphasis was continued on energy savings by an improvement in the quality of the raw sugar input.

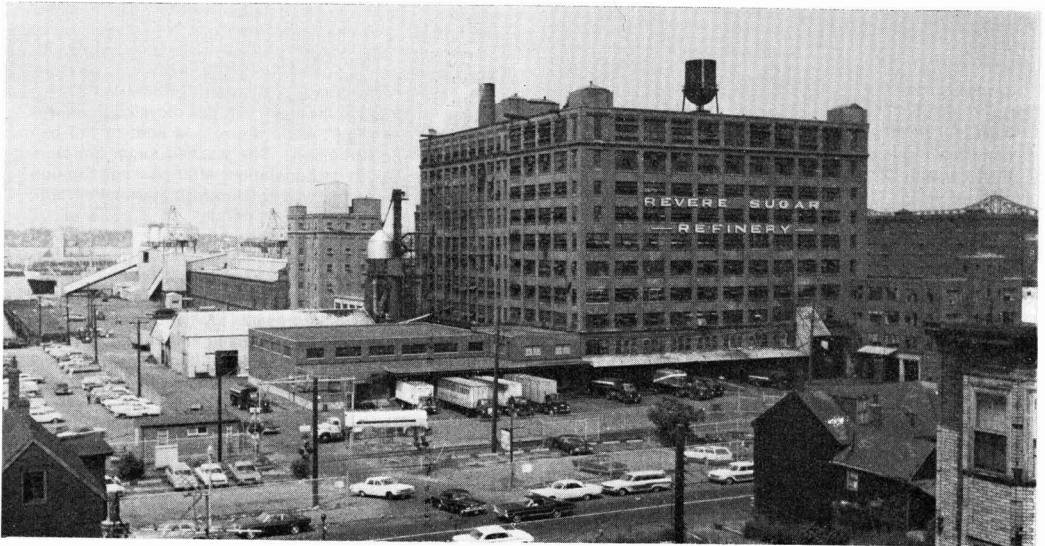
The ladies programme was organized by Marie Mahoney and Arlene Craig, of the Ladies Hospitality Committee. On Monday morning they left the Colonnade to visit the scenic coastal towns on the North Shore, sharing the delightful sights of Beverly Farms, Magnolia and the famous "Gloucester Fisherman", dedicated to sailors lost at sea. They stopped to browse at Rockport's Bear Skin Neck, famous for its artists' colony and quaint shops. Returning along the coast, a stop in Marblehead allowed them to relax and dine at Rosalie's, to taste the finest gourmet cooking on the East Coast, after which they returned to the Colonnade in time to plan for the evening's gala event.

On Tuesday the ladies' tour buses left the Colonnade and headed for the U.S.S. Constitution, the oldest commissioned war vessel still afloat, where they saw a re-enactment of the Boston Tea Party. Afterwards they visited historic places in Boston, including Paul Revere's house in the North End, the Old North Church, Faneuil Hall and Quincy Market. Luncheon was taken at the oldest restaurant in the North End—the European—and the tour concluded with a ride to Government Center, the Capital, the Boston Common (where some were able to ride the "swan boats") and Beacon Hill. After crossing the Charles river to Cambridge, the ladies were able to see M.I.T. and Harvard University before returning to the Colonnade.

Revere sugar refinery

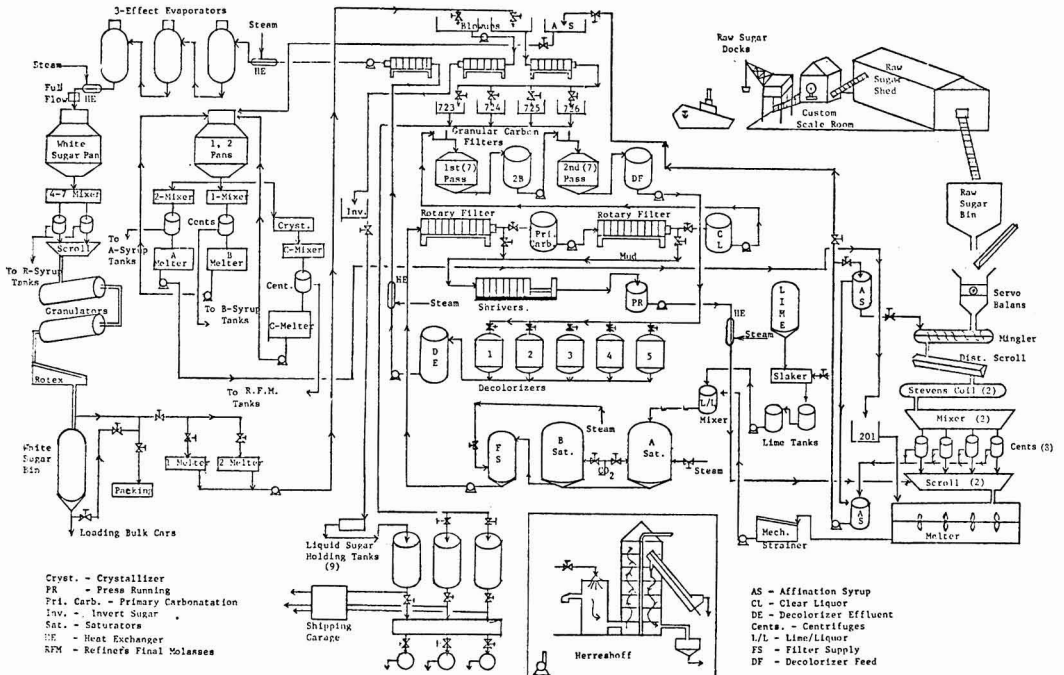
The history of the Revere Sugar Corporation goes back to 1864, but the name "Revere" did not appear until

1870, when expansion and remodelling of a refinery (the buildings had been originally erected for use as a



Revere sugar refinery

Revere sugar refinery



Process flow sheet at Revere sugar refinery

slaughter house) were completed. In 1907, it was decided to find a new location for the plant and increase its daily melt capacity to 750,000 lb. A 7-acre site was purchased in Charlestown on the Mystic River; however, in 1914 the business was acquired by the United Fruit Co., which for several years had owned two raw sugar plants in Cuba and had sold the sugar to various refiners on the open market. However, the logical market was the USA, and Cuban producers had enjoyed a preferential tariff on raw sugar since 1903, so that it was in the interests of Cuba to encourage refining in the USA. Hence, the Charlestown refinery was designed to handle a maximum quantity of raw sugar, viz. a daily melt capacity of 2000 short tons. It was completed in 1918.

In the mid-1960's, the refinery underwent extensive modernization, including an entirely new raw sugar unloading dock with two gantry cranes each of 300 tons.hr⁻¹ capacity, and a new raw sugar receiving scale. In the melt house, all the processing equipment, including mingler, centrifugals and melter, was renewed and the manpower reduced from 4 men to 1 man per shift as a result of automation. In the filter house, the clarification process was replaced by carbonation and a new Herreshoff kiln was installed for bone char revivification.

In 1974, the refinery was sold to the SuCrest Corporation, and a very extensive renovation programme was immediately instituted, including replacement of the bone char system with one using granular carbon, and addition of a decolorizing resin scheme. The renovation programme has continued to date. In December, 1977, the Sweetener Division of SuCrest Corporation, of which Revere refinery was a part, was sold and Revere

Sugar Corporation was formed.

Bulk raw sugar is unloaded from ships, sampled and weighed into a storage shed having a capacity of about 25,000 short tons. From the storage shed, the raw sugar is transferred by belt conveyor and bucket elevator to a storage bin at the top of the melt house. (The raw sugar can be delivered directly from ship to bucket elevator to minimize rehandling.) The sugar is fed continuously to a weigher and thence to a mingler immediately below, after which the magma is sent to the centrifugals for affination. Some of the wash syrup is recycled for mingling with raw sugar, while the rest is sent to the pan house for remelt boiling. The washed sugar liquor is then subjected to carbonation; after passage through filter presses, the liquor is treated with granular carbon. Each of the carbon filters operates on a cycle of 1-2 months; after each cycle, the carbon is sweetened-off with hot water and hydraulically conveyed to a Herreshoff kiln where the colour impurities adsorbed by the carbon are burnt-off. After resin treatment and polish filtration on Sweetland presses, the liquor is sent to the pan house for conventional boiling and curing in centrifugals. After drying in the granulators, the sugar is packed into 5- and 10-lb packages or is shipped in bulk.

Brazil sugar detergents project¹—A factory is to be erected in the Campos Industrial Zone by Grupo Millen S.A. for the production of biodegradable detergents based on sugar. The factory, to be operated by Sacarose Química S.A., will cost some 300 million cruzeiros and will produce 50,000 tonnes per year.

¹ *Brasil Açuc.*, 1978, 112, 198.

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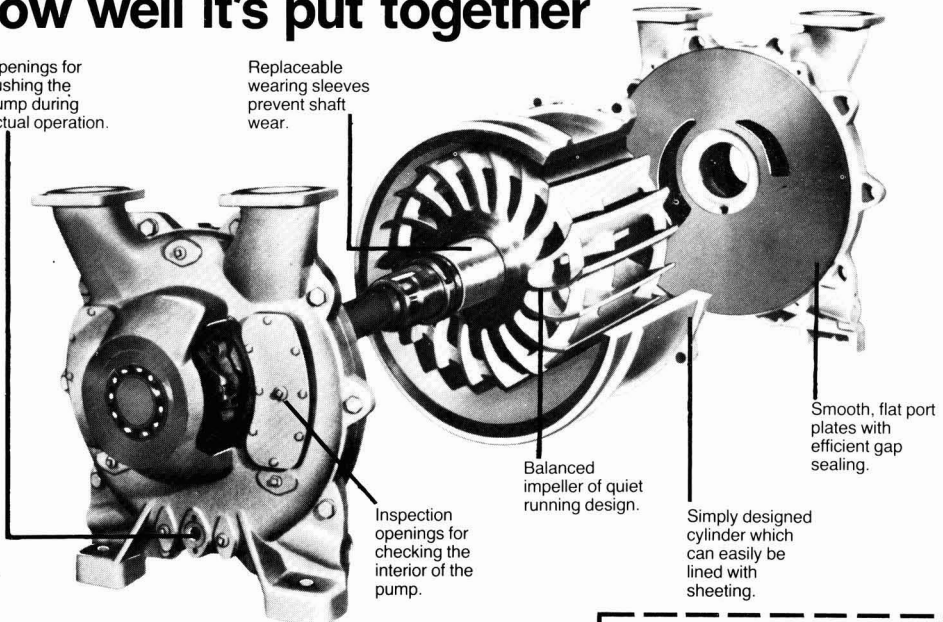
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Amstar Boston sugar refinery

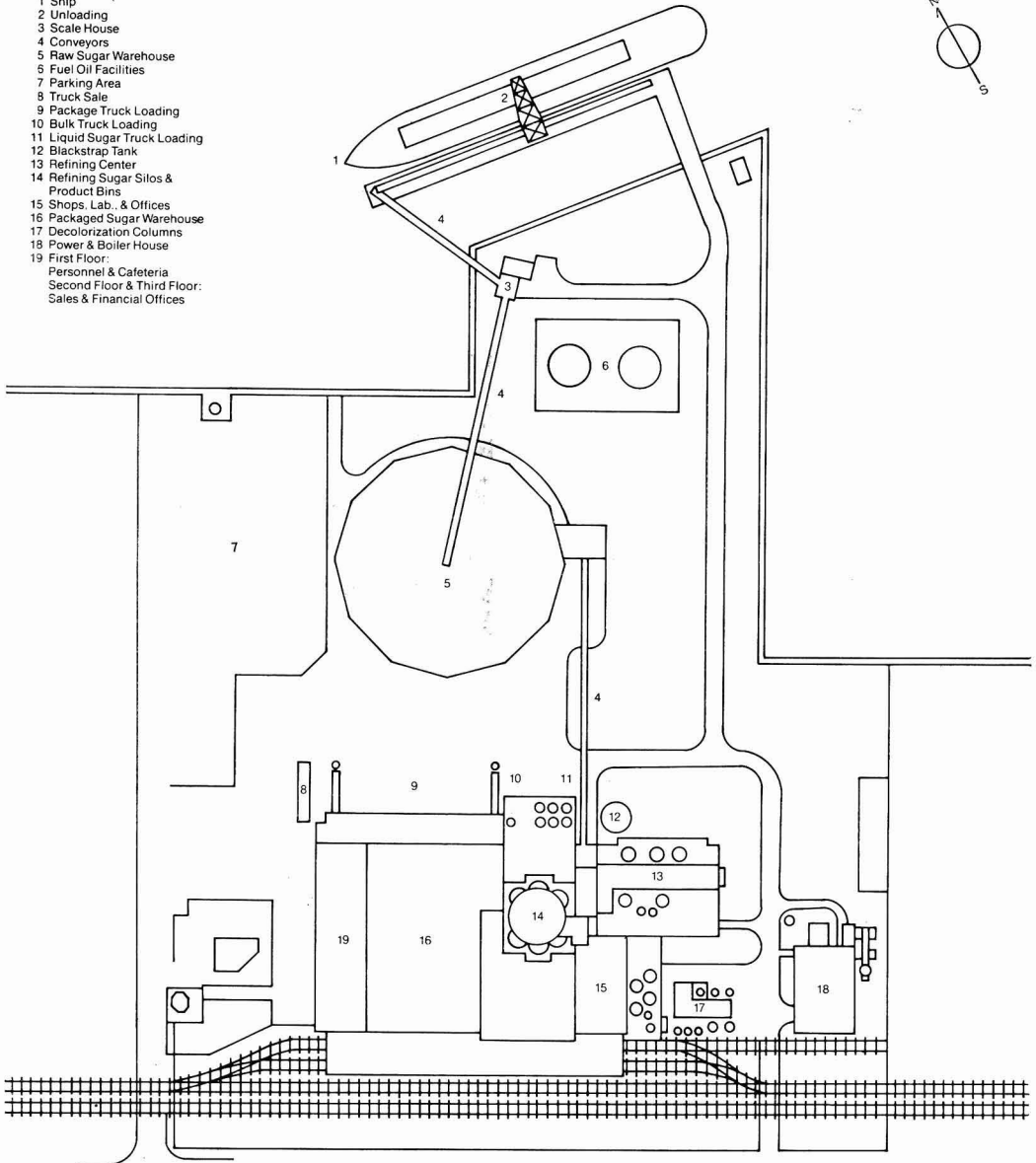
Amstar Corporation, the owners of the Domino sugar refinery in Boston, one of the plants visited by S.I.T. members during the 38th Meeting this month, is the largest manufacturer and distributor of nutritive sweeteners in the USA, supplying some 20% of the total national consumption.

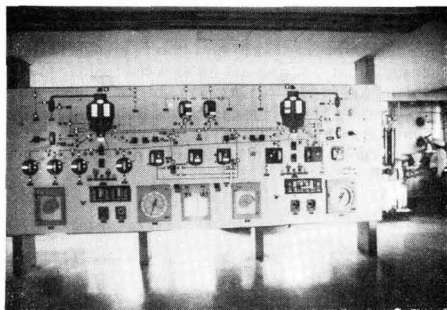
The American Sugar Refining Co., founded in 1891 in New Jersey, operated principally as a cane sugar refiner on the Eastern Seaboard and the Gulf of Mexico; Spreckels Sugar Co. was set up as a beet sugar manufacturer in California in 1897, 50% of its capital stock being owned by The American Sugar Refining Co. The two companies merged in 1963 to become the American Sugar Co. which changed its name to Amstar Corporation in 1970.



Boston Refinery Map

- 1 Ship
- 2 Unloading
- 3 Scale House
- 4 Conveyors
- 5 Raw Sugar Warehouse
- 6 Fuel Oil Facilities
- 7 Parking Area
- 8 Truck Scale
- 9 Package Truck Loading
- 10 Bulk Truck Loading
- 11 Liquid Sugar Truck Loading
- 12 Blackstrap Tank
- 13 Refining Center
- 14 Refining Sugar Silos & Product Bins
- 15 Shops, Lab., & Offices
- 16 Packaged Sugar Warehouse
- 17 Decolorization Columns
- 18 Power & Boiler House
- 19 First Floor:
Personnel & Cafeteria
Second Floor & Third Floor:
Sales & Financial Offices





Pan floor control panel at Amstar sugar refinery

About 75% of Amstar's sweeteners is sold to industrial customers in the form of granulated and liquid sugar and high fructose and other corn syrups. Grades of sugar sold include granulated, icing and brown sugar, tablets, packets, a sugar-cinnamon mixture, lemon-flavoured sugar and specialty sugars for various industries, including "Di-Pac" compacting sugar (used widely by the confectionery industry and by the pharmaceutical industry for tablet coating and chewable vitamin products), "Amerfond" fondant sugar, "Bakerfond", used in the baking industry to make cake frostings, and "Brownulated" granulated brown sugar, which has many applications in the production of breakfast cereals.

The American Sugar Division operates refineries in Brooklyn, Philadelphia, Baltimore and New Orleans as well as Boston, and has a large liquid sugar manufacturing and storage facility in Chicago. The "Domino" sugar produced is the largest-selling brand of sugar in the USA. The Spreckels Sugar Division operates five beet sugar factories: at Spreckels (Salinas), Manteca, Woodland and Mendota in California, and at Chandler in Arizona. The oldest of these is the Spreckels plant, which first operated in 1899 and now has a daily slice of 6000 tons of beet. The Chandler factory, which has a rated daily slice of 4000 tons of beet, is the newest factory of the five and was put into operation in 1967. The Spreckels Division also carries out farming and land management operations, chiefly in Arizona, and has

warehouse and liquid sugar facilities at Los Angeles, a liquid sugar plant at Portland, Oregon, a process research laboratory at Woodland and an agricultural research establishment at Spreckels.

The Boston refinery is situated on a 20-acre site along the Mystic River. It started operations in 1960, replacing a plant built more than 100 years earlier in South Boston. It is among the world's top refineries as regards automation; for instance, only nine process operators per shift are required to supervise the process flow of more than 1000 short tons daily. Raw sugar arriving at the wharf is unloaded by gantry crane, weighed and conveyed to a huge domed warehouse whence it is retrieved for processing by affination, after which the liquor is mixed with calcium saccharate and phosphoric acids for flotation clarification. After mixing with kieselguhr and pressure filtration, the liquor is subjected to CAP (continuous adsorption process), for which Amstar Corporation holds the patent and world rights. In this process, the liquor is forced up through a 40 ft \times 10 ft dia. vertical steel column against a downward moving column of bone char.

After further filtration, the liquor is evaporated, pan boiled and cured in centrifugals, followed by drying in granulators. Much of the sugar is sold in 2-, 5- and 10-lb packages, while thousands of individual packets of superfine sugar are produced daily for use in restaurants, etc. The refinery's warehouse has a capacity of 3500 short tons of packaged sugar.



Molasses tank and pipeline at Amstar sugar refinery

The Quentin process

By J. F. T. OLDFIELD, M. SHORE, D. W. GYTE, C. W. HARVEY and G. C. JONES

Paper presented to the British Sugar Corporation Ltd. 24th Technical Conference, 1978

PART II FACTORY PERFORMANCE

Introduction

The Quentin plant was intended to give about 0.75% magnesium in molasses when all the factory low green syrup was treated. As described, the ion-exchange part of the process was successful, but during the three campaigns from 1975/76 to 1977/78 various modifications were required to ensure successful sugar end operations as a whole, and, despite some features of the design having been imposed by expediency, excellent results overall were achieved by the end of the 1977/78 campaign.

Some aspects of factory operation

(i) A flash evaporator was installed to concentrate treated low green syrup from 70 RDS to about 84 RDS to enable final product vacuum pans to be boiled entirely from low green syrup, thus avoiding by-passing of the Quentin columns through the use of high green syrup as a footing. This latter expedient was necessary in 1975/76 and 1976/77 to reduce the boiling times of these pans when fed with 70 RDS treated low green syrup. An evaporator 1.98 m in diameter and 3.73 m high, positioned on the pan floor, was found adequate to concentrate all the Quentin low green syrup from a slice of 2900 tonnes per day. A third final product vacuum pan

was also installed for the 1976/77 campaign, but experience showed its use did not result in any significant decrease in the quantity of high green syrup used in the final product pans.

(ii) After failures of the type of plastic strainers which had been successful in the decalcification plant, the most suitable for retaining the resin were found to be Type S plastic strainers manufactured by Bran & Luebbe GmbH. To prevent the head of the strainer unscrewing from the body, a smear of solvent adhesive was applied to the thread during installation. These strainers did not fail during a complete campaign's operation, unlike other types tested, and inspection since 1977/78 campaign has shown them to be in good condition.

(iii) As a result of the conversion Brigg factory have since operated without decalcification. In practice, the disadvantages arising from this, such as increased frequency of evaporator boil-outs, were minimal as thin juice lime salts were kept low throughout most of the three Quentin operation campaigns. The inevitable slight disadvantages were considered acceptable for proving the installation.

(iv) The rheological properties of the Quentin masseccutes were such that they could be cooled in the crystallizers by some 5 or 6°C more than non-Quentin masseccutes and still be spun successfully in continuous centrifugals fitted with masseccute re-heaters. The average crystallizer retention time in the 1977/78 campaign was 26.5 hours.

(v) Laboratory analyses established that the white sugar produced during Quentin operation was of the same quality as that made at other times.

(vi) Analysis of samples of dried molassed sugar beet pulp indicated that, even when Quentin molasses was used exclusively in its production, the magnesium content did not exceed 0.5%, above which level a declaration of the magnesium content is required according to UK legislation¹⁸.

SUGAR RECOVERY

Methods of calculation

Sugar recovered by the Quentin process is calculated by comparing factory performance with and without the Quentin plant in operation. The comparison has to be made between periods which are truly representative, as otherwise the difference in non-sugars contents of the juices could bias the results, and the periods of operation must be sufficiently long to allow the sugar end of the factory to achieve optimum performance.

(i) *Method 1.* Each week the sugar in molasses % on beet is calculated from the weights and sugar contents of molasses to pulp and molasses for sale, allowance being made for the amount of sugar in process at the time of calculation. The values for representative Quentin operations are subtracted from a value obtained during representative non-Quentin operations to show the extra sugar recovered % on beet for each Quentin week. Assuming that the non-Quentin week is truly typical, then the accuracy of this assessment principally depends upon the accuracy of the molasses weights and sugar contents for the relevant weeks.

The molasses sugar content is measured by polarization on daily composites of molasses to pulp and for sale and is therefore an apparent and not an absolute value, but reasonable accuracy for sugar recovered should be obtained by difference if the variation in the

contents of optically active materials other than sucrose is small relative to sucrose.

(ii) *Method 2.* The molasses apparent purity is calculated from the polarization and true dry substance (by Karl Fischer titration), measured on a weekly composite of molasses to pulp from samples taken every 2 hours. From the magnesium exchanged in each Quentin week, the extra weight of non-sugars (K+Na) that would have been present each week in the absence of Quentin ion exchange can be calculated. This value, together with the sugar in molasses, molasses true dry substance for each Quentin week and the molasses purity for the typical non-Quentin week can be used to calculate the sugar recovery for each Quentin week. Also an estimate can be made of the proportion of sugar recovered due to the reduction in weight of total non-sugars from exchange of (Na+K) by Mg relative to the total recovered.

In addition, the true dry substance of molasses which would have been obtained in the absence of Quentin operations can be calculated from values for each of the Quentin weeks. These predicted quantities can be compared with the observed value for the typical non-Quentin week and the accuracy of the prediction can be taken as a measure of the correctness of the assessment of the sugar recovery.

Again, the accuracy of this assessment depends upon the accuracy of values such as the molasses weights recorded by the factory and the apparent sucrose contents.

A typical calculation is shown in Appendix I.

Sugar recovery in the 1977/78 campaign

The best opportunity for assessment of optimum sugar recovery occurred in the 1977/78 campaign and the plant was shut down for comparison purposes during weeks 9-11. Allowing for sugar end operations to stabilize, it was considered that week 11 would be typical of non-Quentin operation. During weeks 15-17, when the plant was operating at a typical 2.8% Mg on treated low green syrup non-sugars, the flash evaporator concentration system was working well and no high green syrup was being used in the final product vacuum pans and so these weeks were compared with week 11 to assess the sugar recoveries representative of optimum Quentin operation.

Table V gives the analysis of the weekly composites of molasses to pulp, while Table VI shows the sugar recoveries by methods 1 and 2 and the weights of molasses true dry substance (% on beet) for molasses in week 11 predicted from weeks 15, 16 and 17, assuming non-Quentin operation throughout.

For weeks 15, 16 and 17 the weighted average % Mg on non-sugars was 2.68 (43% exchange) and the total sugar recoveries when calculated by methods 1 and 2 respectively, were weighted averages of 0.49% and 0.51%, giving a mean of 0.50% on beet.

The average predicted weight of molasses true dry substance for week 11 is 3.54% on beet, assuming non-Quentin operation in weeks 15, 16 and 17, and this is sufficiently close to the observed value of 3.58% that the sugar recovery calculation by method 2 may be regarded as a reliable indication of Quentin process sugar recovery.

¹⁸ Statutory Instrument No. 840, The Fertilisers and Feeding-stuffs (Amendment) Regulations 1976, Schedule 1.

It is concluded that the average sugar recovery was **0.50% on beet** during weeks 15-17 when the Quentin plant and the flash evaporator were operating efficiently to give **2.5-2.8% Mg on non-sugars** (40-45% exchange). During the same period the recovery of sugar due to the reduction in weight of non-sugars resulting from the ion exchange was 0.10 to 0.12% with the remaining 0.4% recovery due to greater removal of sugar in the final pans and the crystallizers.

Similar analyses and calculations were carried out for the earlier weeks of Quentin operation and it was shown that, even when overall performance was not optimum, operation of the plant was still profitable, as the sugar recovery was 0.3-0.4% on beet.

Table V. Analysis of Brigg molasses to pulp weekly composites, 1977/78 campaign

| | Week | | | |
|--|------|------|------|------|
| | 11 | 15 | 16 | 17 |
| Mg, % w/w | 0 | 0.77 | 0.84 | 0.89 |
| Na, % w/w | 1.00 | 0.89 | 0.81 | 0.91 |
| K, % w/w | 3.94 | 2.30 | 2.02 | 2.25 |
| Mg on non-sugars, % w/w | — | 2.51 | 2.76 | 2.77 |
| Pol, % w/w | 55.2 | 50.8 | 48.6 | 48.8 |
| True dry substance (Karl Fischer) (TDS), % w/w | 83.6 | 81.5 | 79.0 | 80.9 |
| Purity from TDS | 66.0 | 62.3 | 61.5 | 60.3 |
| Zeiss refractometric purity | 65.8 | 59.9 | 58.6 | 57.5 |
| % exchange (Note 1) | — | 39.7 | 44.6 | 43.3 |

Notes.—1. $\frac{\text{Mg meq/kg}}{(\text{Mg} + \text{K} + \text{Na}) \text{ meq/kg}} \times 100$

2. Calcium concentrations were all negligible compared with the Mg, K and Na concentrations.

Table VI. Sugar recoveries by Brigg Quentin process, 1977/78 campaign

| Week | Sugar recoveries % on beet | | Predicted weight of molasses true dry substance for week 11 calculated as in Appendix 1 from analysis of solely weekly composite taken during Quentin operations in weeks 15, 16, 17. |
|------|---|---------------------------------------|---|
| | Method 2 | | |
| | (a) Total recovery | (b) Recovery solely from ion exchange | |
| 11 | 0 for each method by definition, (Note 1) | | 3.58 (Note 2) |
| 15 | 0.39 | 0.43 | 3.48 |
| 16 | 0.55 | 0.49 | 3.43 |
| 17 | 0.52 | 0.63 | 3.71 |

Notes.—1. Week 11 was used as the basis of comparison, so the sugar recovery, however calculated, is defined as 0. The sugar in molasses was 2.24% on beet for this week, reported by the factory laboratory.

2. The actual value for week 11 calculated from molasses weight and the measured true dry substance was 3.58% on beet.

Molasses purity

It has been widely reported^{9,15,19,20} that the refractometric dry substance of magnesium molasses is considerably higher than the true dry substance as measured by Karl Fischer titration or by vacuum oven drying, possibly because of the greater amount of water bound by magnesium ions compared with sodium and potassium ions^{4,7}. Thus a magnesium molasses apparent purity calculated using RDS solids will be considerably lower than one calculated using true dry substance (Karl Fischer titration), whereas the same purities calculated for non-magnesium molasses are almost

identical. The use of molasses purity to assess sugar recovery by the Quentin process should therefore be limited to purities calculated using true dry substance (Karl Fischer or vacuum oven drying) rather than refractometric dry substance.

ALTERNATIVE REGENERANTS

Magnesium chloride cost

The costings in Table VII show that, with magnesium chloride regenerant, 75% of the total costs of the Quentin process, at 0.4 sugar recovered % on beet per tonne of recovered sugar, are the regenerant costs plus the loss of value of molasses not produced. The regenerant cost as proportion of the total cost is at a level where the economic viability of the process in the United Kingdom is principally determined by this one factor. Furthermore, the cost of magnesium chloride has doubled from 1975 to 1978, and this has considerably reduced profitability.

Table VII. Proportions of cost per tonne recovered sugar as % of total cost of the Quentin process

| Daily slice, tonnes | 4000 | 6000 | 8000 | 10000 |
|----------------------------------|-----------------|------|------|-------|
| | % of total cost | | | |
| Molasses £45/tonne at 75 TDS* | 36.8 | 38.0 | 38.5 | 39.1 |
| Capital + interest + maintenance | 14.7 | 12.2 | 10.7 | 9.5 |
| Regenerant | 38.4 | 39.6 | 40.2 | 40.7 |
| Reprocessing recovered sugar | 1.9 | 2.0 | 2.0 | 2.0 |
| Steam | 4.0 | 4.0 | 4.1 | 4.2 |
| Resin replacement | 1.2 | 1.2 | 1.3 | 1.3 |
| Labour, power, sugar losses | 3.0 | 3.0 | 3.2 | 3.2 |
| Total | 100 | 100 | 100 | 100 |

* TDS = true dry substance.

Most of the world's magnesium chloride is produced as a by-product of the potash industry and large amounts are available from the Stassfurt potash deposits in Germany²¹. It is imported as a solution containing only 8.5% w/w of magnesium and thus most of the weight transported is water. Transport costs to the UK are a significant proportion of the cost.

Kieserite

Alternative sources of magnesium chloride, and of other soluble magnesium compounds were investigated, and it was found that the only alternative and sufficiently cheap bulk source of soluble magnesium available in the UK is kieserite which is an agricultural-grade magnesium sulphate monohydrate.

Kieserite is also found mainly in the same Stassfurt deposits in Germany²² in massive, compact or granular beds up to 12 ft thick with layers alternating with potassium and sodium chlorides. As sold, the higher grades of kieserite are crystalline solids (crude MgSO₄ · H₂O) containing about 13-16% magnesium and 6-9% insoluble matter. Kieserite is usually shipped and sold as mined and the quality as defined by its insoluble solids content and the quantity of sodium and potassium salts depends upon the source. It is extensively used as a fertilizer in the UK and several fertilizer manufacturers import the material.

At £367 per tonne of magnesium content the cost of a suitable kieserite is just more than half that of magnesium chloride solution at £682 per tonne of magnesium.

¹⁹ Schoenrock *et al.*: *Proc. 19th Gen. Mtg. Amer. Soc. Sugar Beet Tech.*, 1976.

²⁰ Oldfield *et al.*: Unpublished work.

²¹ Mellor: "Comparative Treatise on Inorganic and Theoretical Chemistry" (Halstead Press), Vol. IV, p. 298.

²² *ibid.*, p. 321.

Kieserite was assessed in the laboratory for its suitability as a Quentin regenerant and to provide design information for any plant modifications.

(a) *Ion exchange*: a laboratory Quentin column containing 1 litre of virgin Imacti C16P resin was put through a large number of exhaustion and regeneration cycles as follows: the resin was exhausted with 3.5 litres of 70 RDS low green syrup at 90°C and then regenerated with 2.64 litres of the appropriate magnesium chloride or kieserite solution at a concentration of 1.0% Mg w/v corresponding to the theoretical capacity of the resin, i.e. 2.2 equivalents per litre. Further experiments with the addition of increasing amounts of sodium and potassium chlorides added to the kieserite solution, to simulate use of very impure kieserite, were also carried out. The exhaustion capacity (equiv. Mg⁺⁺ per litre of resin) was calculated after each exhaustion from the quantity of magnesium ion exchanged into the low green syrup. Table VIII gives the mean results based on three cycles for each regenerant.

Table VIII. Kieserite and magnesium chloride as Quentin regenerants

| Regenerant | % w/w on original regenerant | | | Exhaustion capacity (equiv. Mg ⁺⁺ per litre resin) |
|-------------------|------------------------------|------|------|---|
| | Mg | K | Na | |
| MgCl ₂ | 8.50 | 0.19 | 0.08 | 1.92 |
| Kieserite | 16.10 | 0.12 | 0.39 | 1.91 |
| | 16.10 | 1.00 | 1.00 | 1.90 |
| " | 16.10 | 1.50 | 1.50 | 1.80 |
| " | 16.10 | 2.50 | 2.50 | 1.62 |

The results show that equivalent Quentin regeneration is obtained with kieserite containing up to 1% K and 1% Na. As expected, at higher levels of sodium and potassium the performance deteriorates because of the effect of these ions on the regeneration equilibrium. Further experiments with regenerant concentration of 1.5% Mg, or factory Quentin resin after 2 campaigns' use, or a simulated factory recovered regenerant system confirmed that kieserite should give equivalent regeneration efficiency to magnesium chloride under factory operating conditions.

It was concluded that kieserite containing more than 15% as Mg and less than 1% Na and 1% K should be suitable for use as an alternative regenerant to magnesium chloride for the Quentin process.

(b) Analysis of kieserite

Solutions of samples of available supplies of kieserites prepared by exhaustive extraction with hot water in a Soxhlet extractor were analysed for magnesium, calcium, sodium, potassium and chloride. The insoluble residues were dried at 105°C and weighed. Table IX shows the results, expressed as % w/w on kieserite.

Table IX. Kieserite analysis

| Supplier | Mg | Na | K | Cl | Insoluble residue |
|----------|------|------|-----|-----|----------------------|
| | | | | | |
| A | 16.3 | 0.07 | 0.3 | 0.8 | 5.9 |
| B | 15.6 | 0.45 | 0.5 | 2.9 | 6.0 |
| C | 13.8 | 3.3 | 2.7 | — | 8.3 |
| D | 12.6 | 2.2 | 8.1 | — | 7.1 |
| E | 12.5 | 1.7 | 5.4 | — | 9.5 |

Note.—All calcium levels were less than 0.1% on kieserite.

Suitable supplies of kieserite were available from suppliers A and B, but A, with the highest magnesium and the lowest sodium, potassium and chloride levels, was preferable and samples from supplier A were used for all the experimental work reported in the paper.

The consistency of kieserite from supplier A was determined by sampling the kieserite store immediately after the delivery of each of 2 separate 500-tonne ship loads five months apart. 15 samples were taken on each occasion and were all analysed for magnesium, calcium, sodium, potassium and insoluble residue. The results showed that the samples contained an average of 16.05% Mg ranging from 15.4 to 16.8% w/w, and none contained more than 1% potassium and 1% sodium.

Kieserite from supplier A was analysed for trace elements by atomic absorption spectroscopy as a check that the amounts were sufficiently low that even with a complete transfer in the molasses to dried molassed pulp there would be no risk of exceeding the maximum permitted levels. Iron and aluminium are present at sufficiently low levels in kieserite solutions for there to be negligible risk of resin poisoning by bead coating with hydrous oxides of these elements²³. Acid extracts of kieserite contained considerably more aluminium but laboratory experiments confirmed that this was not water-extractable under factory conditions.

(c) *Solubility*: Preliminary experiments showed that kieserite was slow to wet and dissolve even in warm water, and it would easily solidify to a concrete-like mass when wetted or partially extracted with water. These factors precluded the use of a saturator, as used for dissolving salt in the decalcification plants in the British Sugar Corporation, for preparation of kieserite solution.

However, a technique was designed and perfected²⁴ to dissolve all the extractable magnesium sulphate and produce a clear and colourless solution with a residue having little tendency to solidify. Solutions containing up to 5% Mg w/v could be produced by these means, but it was decided to limit the magnesium concentrations in factory plant to about 4% to avoid any possibility of magnesium sulphate crystallizing on cooling.

(d) *Handling and storage*: The handling of kieserite presents no special problems, but it must never be allowed into direct contact with water in storage as it sets solid and storage on a factory site should therefore be in a closed hopper.

The flow properties of kieserite as supplied were measured by standard techniques and converted to a flowability number by the method of Carr²⁵. The results indicated good flowability and no tendency to arch.

(e) *Corrosion*: Corrosion experiments were carried out using samples of type 304 stainless steel and mild steel held at 80°C in solutions of kieserite, magnesium chloride and sodium chloride of various concentrations for 500 hours. The results showed kieserite solution to be less corrosive than either magnesium chloride solutions of equivalent magnesium concentration or 10% sodium chloride solution as used for decalcification regenerant, indicating that no changes of plant protective coatings would be required.

Factory trial of kieserite

Equipment suitable to produce a 4% w/v magnesium solution was set up at Brigg factory. This solution, after

²³ Kunin: *Amber-Hi-Lites*, 1968, (107), (108).

²⁴ UK Patent Application.

²⁵ *Chem. Eng.*, 1965, 163-168.

dilution to about 1% w/v Mg, was used to carry out four regenerations, two on each column of the Quentin plant. Although every effort was made to operate the kieserite and magnesium chloride regenerations in as similar a manner as possible, the kieserite regenerations were unavoidably carried out with slightly less magnesium than the magnesium chloride runs used for comparison. Table X reports the means from the analysis of treated low green syrups from the four kieserite regenerations and from five magnesium chloride regenerations on each column sampled over the few days preceding the kieserite runs.

Table X. Summary of low green syrup analysis from kieserite and MgCl₂ regeneration

| Regenerant (18.2 m ²) | No. of regenerations | | Mean | Std. dev. |
|--------------------------------------|-------------------------|------------------------------|------|--------------|
| Kieserite (0.95% Mg w/v) | 4 | % exchange (note 1) | 43.3 | 0.92 |
| | | % Mg w/w in treated syrup | 0.48 | 0.01 |
| MgCl ₂ (1.0% Mg w/v) | 10 | % exchange (note 1) | 45.0 | 2.76 |
| | | % Mg w/w in treated syrup | 0.50 | 0.05 |

$$\text{Note.-(1) } = \frac{\text{Mg meq/kg}}{(\text{Mg} + \text{K} + \text{Na}) \text{ meq/kg}} \times 100$$

The results showed the slightly lower concentration of magnesium in the kieserite regenerant compared with the magnesium chloride regenerant had given a corresponding slight reduction in the average % exchange and average % magnesium in the treated syrups, but statistical tests showed that the differences were not significant at the 90% level of confidence.

It was considered therefore that dilute magnesium chloride regenerant and kieserite solution of the same magnesium concentration will have similar efficiencies as Quentin regenerants. Sufficient experience was gained in the large-scale handling, dissolving and filtration of kieserite to finalize the design of a full-size purpose-built plant²⁴.

Economics of the kieserite process

The replacement of magnesium chloride solution by kieserite, while giving a 37% reduction in regenerant costs, requires extra capital expenditure to provide for a dissolver and filter plus extra running costs in respect of filter aid usage.

However, even allowing for these extra costs, there is a saving, by use of kieserite, of 31% on the comparable costs for use of magnesium chloride. The Quentin process in the UK gives a return on capital of about 17% at a 4000 tonnes.day⁻¹ factory at 0.4% sugar recovery on beet, and this return should improve to 26% when using kieserite. The return for both types of regeneration increases with increased size of factory and potentially could be doubled at a 10,000 tonnes.day⁻¹ factory.

Summary

The Brigg decalcification plant has been converted to a Quentin plant in order to assess the technical feasibility and economics of Quentin operation within British Sugar Corporation. This paper describes the conversion of the plant, and reports on the results of its successful operation.

Sufficient data have been obtained for the design of purpose-built plants suitable for factories of daily slice from 4000 to 10,000 tonnes.

The economics of the Quentin process in the UK are largely determined by the price of magnesium chloride

regenerant. Laboratory and factory trials have shown that kieserite, an agricultural-grade magnesium sulphate monohydrate, is a suitable and much cheaper regenerant.

The economics of the Quentin process are discussed; the process is profitable in the UK when using conventional magnesium chloride regenerant, but gives an improved return on capital by use of kieserite.

Le procédé Quentin

L'installation de décalcification de l'usine de Brigg a été reconverte en installation Quentin dans le but de déterminer les possibilités technique et économique d'un travail en Quentin à la British Sugar Corporation. L'article décrit la reconversion de l'installation et renseigne les résultats de son exploitation qui a été un succès. On a obtenu suffisamment de données pour l'étude d'installations appropriées dans des usines d'une capacité journalière de 4000 à 10.000 tonnes. Au Royaume-Uni la rentabilité du procédé Quentin est déterminée en grande partie par le prix du régénérant, le chlorure de magnésium. Les essais en laboratoire et en usine ont démontré que la kieserite, un sulfate de magnésium monohydraté de qualité agricole, est un régénérant approprié nettement meilleur marché. La rentabilité du procédé Quentin est discutée; le procédé est rentable au Royaume-Uni si on utilise comme régénérant le chlorure de magnésium usuel, mais le bénéfice est amélioré par l'emploi de la kieserite.

Der Quentin-Prozess

Die Entkalkungsanlage der Zuckerfabrik Brigg wurde in eine Quentin-Anlage umgebaut, um die technische Durchführbarkeit und die Wirtschaftlichkeit des Quentin-Verfahrens innerhalb der British Sugar Corporation zu testen. Der Artikel beschreibt den Umbau der Anlage und berichtet über die Ergebnisse des erfolgreichen Betriebes. Für die Planung einer solchen Anlage für Fabriken mit einer Kapazität von 4000 bis 10.000 t Rüben/d wurden genügend Daten erhalten. Die Wirtschaftlichkeit des Quentin-Prozesses in Grossbritannien wird zum grössten Teil vom Preis des Regeneriermittels Magnesiumchlorid bestimmt. Laboratoriums- und Fabrikversuche zeigten, dass Kieserit, ein für die Landwirtschaft bestimmtes Magnesiumsulfatmonohydrat, ein geeignetes und wesentlich billigeres Regeneriermittel ist. Die Wirtschaftlichkeit des Quentin-Prozesses wird dargelegt. Der Prozess ist in Grossbritannien gewinnbringend bei der Verwendung von MgCl₂ als Regeneriermittel, wirft aber bei Verwendung von Kieserit einen höheren Gewinn ab.

El proceso Quentin

La planta en el ingenio Brigg para descalcificación se ha convertido en una planta Quentin para asesar la factibilidad y economía de operación del proceso Quentin en la British Sugar Corporation. Este papel describe la conversión de la planta, y relata los resultados de su operación con éxito. Se han obtenido un suficiencia de datos para diseñar plantas de construcción específica conveniente para fábricas de una capacidad diaria de 4000 a 10.000 toneladas de remolacha. La economía del proceso Quentin en el Reino Unido se determina en gran parte por el precio de cloruro de magnesio usado como regenerante. Ensayos en el laboratorio y en el ingenio han demostrado que kieserita, un monohidrato de sulfato de magnesio de un grado para agricultura, es conveniente y mucho más barato como regenerante. La economía del proceso

Quentin se discute; el proceso es provechoso en el Reino Unido cuando se usa regeneración con el convencional cloruro de magnesio pero los ingresos se mejoran por uso de quisericita.

Acknowledgments

The authors wish to thank: the Management and Staff of Brigg Factory whose enthusiasm and efforts contributed significantly to the success of the Quentin plant project; Mr. N. W. Broughton for advice and help in writing this paper; Mrs. S. Noakes and Mr. T. Chilvers for carrying out much of the laboratory work recorded in this paper, and for their assistance during the large-scale kieserite trial; Messrs. C. Ferguson, B. Johnson, D. Luckett, M. Senior and H. J. Teague for invaluable assistance during the commissioning of the Quentin plant.

APPENDIX I

Typical sugar recovery calculation by Method 2. Calculation from analysis of weekly composites of molasses to pulp

Please refer to Table V above for analytical data.

During week 15 of the 1977/78 campaign, Brigg factory had an average slice of 2987 tonnes beet per day and produced 3.69% molasses on beet, expressed as molasses to pulp (MTP).

From Research Laboratories analysis of the weekly composite of molasses to pulp:

| | | |
|--------------------|---|-----------|
| True dry substance | = | 81.5% |
| Apparent purity | = | 62.3% |
| Magnesium content | = | 0.77% w/w |

Thus 100 tonnes of beet gave 3.69 tonnes of MTP containing:

| | |
|------------|-------------------------------|
| Sugar | 1.87 tonnes |
| Non-sugars | 1.13 tonnes |
| Magnesium | 0.02841 tonnes = 2.337 keq Mg |

Now, week 11 was the typical non-Quentin operating week and, assuming the composition of molasses produced was identical to that of the molasses which would have been produced in week 15 if the Quentin plant had not operated, the extra K + Na in week 11 molasses compared with Quentin exchange week 15 molasses must then have been 2.337 keq/100 tonnes beet because its magnesium content was negligible compared with that for Quentin exchange week 15 molasses.

For every 100 keq of Quentin ion exchange:

| | | |
|---------------------|---|---------------------|
| Potassium exchanged | = | 71.8 keq |
| Sodium exchanged | = | 28.2 keq (see Note) |

∴ there must have been:

$$\frac{2.337 \times 0.718 \times 39}{1000} + \frac{2.337 \times 0.282 \times 23}{1000} = 0.0806 \text{ tonnes K+Na}$$

and these were exchanged for 0.02841 tonnes Mg

$$\text{i.e. } 2.337 \text{ keq Mg}$$

Thus, the extra non-sugars for week 11 must have been:

$$\begin{aligned} (\text{K+Na})\text{gain—Mg loss} &= 0.0806 - 0.02841 \\ &= 0.05219 \text{ tonnes non-sugars gain} \end{aligned}$$

Now, molasses apparent purity in week 11 was 66.0.

∴ if we take the increased sugar in molasses in week 11 due to non Quentin operations as $x\%$ on beet, then:

$$(\text{Sugar in week 15 molasses} + x) \times 100$$

$$\begin{aligned} \text{Solids in week 15 molasses} + x + \text{extra non-sugars in} \\ \text{week 11 molasses} \\ = 66.0 \end{aligned}$$

$$\text{i.e. } \frac{(1.87 + x) 100}{3.0 + x + 0.05219} = 66.0$$

from which $x = 0.43\%$ sugar on beet.

Thus:

The overall sugar recovery by Quentin operations in week 15 is 0.43% sugar on beet

This value depends slightly on the assumption that all the extra non-sugars in week 11 compared with week 15 are due to not operating the Quentin plant.

Now, assuming the molasses purity for week 15 to be the same as for the typical non-Quentin week 11, then the only sugar recovered would be as a consequence of the decrease in non-sugars weight resulting from the ion exchange, i.e. 0.05219 tonnes of non-sugars/100 tonnes of beet in week 15 would have been associated with:

$$\frac{0.05219 \times 66 \text{ tonnes sugar/100 tonnes beet}}{100 - 66}$$

$$= 0.10\% \text{ sugar on beet resulting from ion exchange}$$

To check these sugar recoveries, the TDS/100 tonnes beet was calculated for week 11 from the TDS for week 15 by adding the calculated extra sugar and non-sugars and comparing the result obtained with the observed TDS for week 11.

Hence, expected TDS in week 11 was:

$$3.0 + 0.43 + 0.05219 = 3.48\% \text{ on beet}$$

Note.—The relative exchange of sodium and potassium is calculated as follows:

Analysis of fifteen consecutive cycles of the plant gave mean potassium/sodium ratios of:

| |
|------------------------------------|
| 2.18 keq K/keq Na in supply syrup |
| 1.94 keq K/keq Na in treated syrup |
| (at a mean exchange of 44.8%) |

The difference in Na:K ratio between the supply and treated syrups has been confirmed in samples from other cycles throughout the 77/78 campaign, and by other workers^{9,26}.

Some of the cations in the supply syrup come from recycled sweet-water (for the dilution to 70 RDS) rather than from the factory low green syrup, but analysis of spot samples has shown that the K:Na ratio in this dilution water is approximately the same as in the supply syrup.

Suppose that of 2.18 keq K in supply syrup x keq K is exchanged, and of 1.00 keq Na y keq Na is exchanged, this leaves $(2.18 - x)$ keq K and $(1.00 - y)$ keq Na in the treated syrup.

$$\text{Then, at 44.8\% exchange } \frac{x + y}{2.18 + 1.00} = \frac{44.8}{100}$$

$$\text{and } \frac{2.18 - x}{1.00 - y} = 1.94$$

Solving these two simultaneous equations:

$$\begin{aligned} x &= 1.02 \text{ keq K exchanged} \\ y &= 0.40 \text{ keq Na exchanged} \end{aligned}$$

$$\text{total} = 1.42 \text{ keq (K+Na) exchanged}$$

$$\begin{aligned} 1.02/1.42 &= 0.718 \text{ keq K exchanged per 1.00 keq exchange} \\ 0.40/1.42 &= 0.282 \text{ keq Na exchanged per 1.00 keq exchange} \end{aligned}$$

Small changes in these ratios do not make a significant difference to the calculated sugar recovery.

²⁶ Neumann: *Zucker*, 1959, 12, 374-382.

SUGAR CANE AGRONOMY

Cultivation practices at Misan Sugar Company, Iraq. M. M. Salih. *Proc. 16th Congr. ISSCT, 1977, 1187-1194.*—Sugar cane was introduced to Iraq in 1965 and cultivation practices have been based on experience gained under similar conditions as developed by Misan Sugar Co. A description is given of saline soil reclamation, field layout, deep ploughing, furrowing at 150 cm, planting (August to beginning of November), covering, applying pre-emergence herbicide and irrigation. Ratoon management is started directly after harvesting and includes trash burning, furrow re-shaping, fertilizer and herbicide application, ditch opening and irrigation. All agricultural practices are mechanical owing to labour shortage. Yield ranges from 30 to 120 tonnes.ha⁻¹. The Research Dept. programme includes weather study, soil analyses, disease and pest control and trials on field operations, varieties, maturity determination, crop-logging and breeding.

Magnesium release characteristics of some Philippine soils. R. N. Nartea and V. G. Castro. *Proc. 16th Congr. ISSCT, 1977, 1203-1210.*—Five soils which had been cropped continuously with cane for more than 50 years were studied. Two were classed as high-Mg soils (containing 1.08 and 3.01 meq.g⁻¹) and the others low-Mg (0.22-0.91 meq.g⁻¹). Mg release characteristics were examined by leaching the soils with 0.01N nitric acid for 60 hours and by washing with HCl until Ca-free and with water until Cl⁻-free, followed by incubation at room temperature for four months. During the incubation, samples were taken monthly and analysed. Unlike the low-Mg soils, the high-Mg soils appeared to contain a fairly high proportion of non-exchangeable Mg which, however, became available in three stages, whereas the low-Mg soils released their Mg in two stages. The difference in Mg availability of the two types of soil lies in the difference between the first and second stages of release of the high-Mg soils.

Experimentation with DPX 3674 ("Velpar") alone and in mixtures with "Diuron" in plant and ratoon canes. L. F. G. McIntyre. *Proc. 16th Congr. ISSCT, 1977, 1211-1217.*—"Velpar" is a new herbicide which gives good pre- and post-emergence control of both graminaceous and broad-leaved weeds. It is phytotoxic to plant cane, however, especially under dry conditions, although damage was low when there was adequate rainfall and/or irrigation. Ratoon cane was tolerant to "Velpar", a reduction in cane yield occurring in only one instance when the maximum dosage (2 kg. a.i. per ha) was used. Addition of 0.2% of a non-ionic surfactant did not enhance the efficiency of "Velpar". The mixture giving optimum weed control with safety for cane is 0.5 kg a.i. "Velpar" + 2 kg a.i. "Diuron" per ha.

Drip irrigation of sugar cane. L. L. P. Shan, M. Hardy and P. Chan. *Proc. 16th Congr. ISSCT, 1977, 1219-1225.* Trials were made with three forms of drip irrigation and all gave significantly higher cane and sugar yields than did surface irrigation and cane grown without irrigation. Best results were given with one drip tube along every cane row which was slightly better than having one tube in the narrower inter-row of cane grown at alternate 0.97 and 2.26 m spacing (as against 1.62 m spacing for all other trials), and both were better than use of a tube in alternate inter-rows of equal row spacing.

Recent advances in weed competition studies in sugar cane in Argentina. R. A. Arévalo, E. A. Cerrizuela and I. L. Olea. *Proc. 16th Congr. ISSCT, 1977, 1227-1238.*—Trials showed that the cane variety NA 56-79 tended to tolerate competition by natural weed communities and *Sorghum halepense* (L.) Pers, but was very susceptible to competition by *Cyperus rotundus* L. The variety N:Co 310 was tolerant of competition by natural weed communities as well as *S. halepense* and *C. rotundus*, while the sugar yields of other varieties studied (NA 56-30, NA 56-62, L 60-25, Tuc 56-19 and CP 48-103) decreased with increasing weed competition, losses of up to 29 kg and 53 kg sugar per ha per day being caused by natural weeds and *S. halepense*, respectively. Weed control is more important than nitrogen fertilization, the latter causing weed aggressiveness. A high cane planting rate does not effectively control weeds. The critical competition period begins 60 days after cane germination in all varieties tested, except for NA 56-79 where it started after 90 days.

The influence of accessibility on moisture extraction by sugar cane. G. Kingston. *Proc. 16th Congr. ISSCT, 1977, 1239-1250.*—Soil moisture movement and withdrawal in field plots of cane were studied using a neutron moisture probe. There was an increase with depth in the moisture level to which roots could dry each 30-cm interval of the profile. The associated changing patterns of moisture uptake from various soil depth intervals throughout the drying cycle were reflected in root distribution and subsequent accessibility of moisture. In determining the effective crop root zone it was revealed that measurement of usable or accessible moisture was more realistic than traditional determination of available moisture limits.

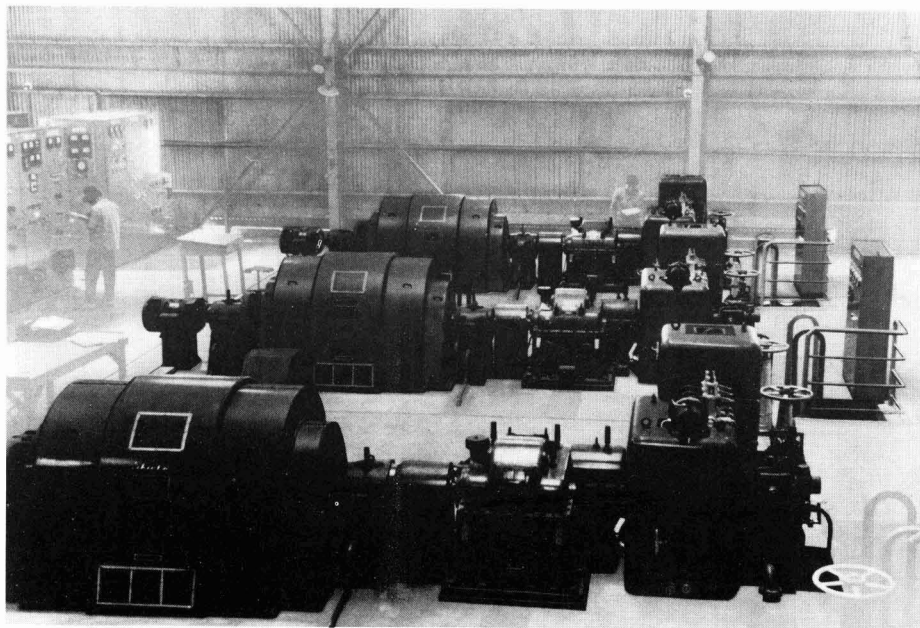
Identification of sugar cane zones from space. M. Nossier and R. Anderson. *Proc. 16th Congr. ISSCT, 1977, 1251-1257.*—An account is given of the use of spectral reflection data obtained for four different wavelength bands by the Landsat I orbital satellite and transmitted to earth which can be recombined to give a colour photograph representing the earth's surface on which vegetation can be discerned. Application of the method to known sugar cane areas gives a means of observing the state of the canopy and it is proposed by Planalsucar to make surveys of the whole cane growing zones in Brazil.

Evaluation of N fertilizer efficiency for plant and ratoon crops in irrigated sugar cane. F. Chui and G. Samuels. *Proc. 16th Congr. ISSCT, 1977, 1259-1264.* Trials on a volcanic ash soil in Nicaragua, using 0, 90, 120 and 150 kg.ha⁻¹ of N, were made for a plant cane and two ratoon crops. From the results it is calculated that the optimum N dose was 138 kg.ha⁻¹ for plant and first

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ratoons and 143 kg.ha⁻¹ for 2nd ratoon. The response in tonnes of cane per ha for the same N level increased from plant cane to 2nd ratoon, the average for the three levels being 9.2 for plant cane and 19.1 for 2nd ratoon. Similar results were found for tonnes sugar per ha (averages 7.8 and 20.6, respectively). The yield response in tonnes of cane per kg N fell from plant cane to 2nd ratoons, however, which is why ratoon crops require more N per ha than plant cane to obtain maximum cane and sugar tonnage.

Systematization of sugar cane irrigation. L. M. Blaquier, R. F. de Ullivarri, M. H. Gradowczyk and A. Tamsch. *Proc. 16th Congr. ISSCT, 1977, 1265-1282.* The cane area of an estate owned by Ledesma S.A.A.I. was expanded over two years from 1700 to 8000 ha and the irrigation system was makeshift, with the consequence that sugar yield per ha dropped by 37%. An account is given of steps to improve the irrigation and drainage system whereby, with better water efficiency and lower labour requirement, the system is more profitable as well as giving agronomic advantages.

Calibration of extractable phosphorus in soils for sugar cane in Alagoas, Brazil. M. L. Marinho and G. A. C. Albuquerque. *Proc. 16th Congr. ISSCT, 1977, 1283-1292.*—An account is given of 27 field experiments on phosphate fertilization of cane, with examination of correlation between extractable phosphate and yield. Using relative yields as criteria for the separation of groups, limits for soils of very low (below 5 ppm), low (6-9 ppm), medium (10-16 ppm), high (17-34 ppm) and very high (above 34 ppm) phosphate were established. The most economical dosages of phosphate fertilizer are calculated for each soil group, taking into consideration the value of the cane produced per tonne and the fertilizer cost.

Grouping and tracing of susceptibility of sugar cane varieties to "Ametryne". T. Kuntohartono, A. H. Nasoetion and F. Rumawas. *Proc. 16th Congr. ISSCT, 1977, 1293-1298.*—Tests were made of susceptibility to "Ametryne" of 70 cane varieties, only 19 being found to be tolerant to this herbicide. Examination of the origins of the varieties indicated that the tolerance had been contributed by *Sorghum vulgare* in the ancestry of the varieties, *Saccharum spontaneum* and *S. officinarum* being very susceptible and susceptible, respectively.

"Metribuzin" for pre-emergence control of Johnson grass and other weeds in sugar cane. R. W. Millhollon. *Proc. 16th Congr. ISSCT, 1977, 1299-1306.*—Field trials were made in Louisiana to compare "Metribuzin" with "Terbacil", a standard herbicide, for pre-emergence control of weeds. An autumn application of "Metribuzin" at 1.1 kg.ha⁻¹ controlled broad-leaved weeds and grasses through the winter while double this dose was required in spring to control seedling Johnson grass, *Sorghum halepense*. Cane is highly tolerant to "Metribuzin", with no reduction in sugar yield per ha after a spring application of 9 kg.ha⁻¹ below that of a hand-weeded control. Soil concentrations of both herbicides fell rapidly after application, with a 50% reduction time of 1 month and 2 months, respectively. "Metribuzin" was less persistent.

The analysis of sugar cane experiments. A. Martinez G. and F. Cienfuegos I. *Proc. 16th Congr. ISSCT,*

1977, 1307-1313.—An amalgamation is suggested of two methods for the assessment of the results of crop experiments, viz. that of Rojas¹, which emphasizes the actual value of the crop, and that of Martinez Garcia², which is based on the analysis of net income.

Influence of nitrogen on optimum yields of recoverable sugar for sugar cane harvested at different ages. S. Saldarriaga A., H. Tello A. and J. Aspillaga. *Proc. 16th Congr. ISSCT, 1977, 1315-1324.*—Field trials in alluvial soils at Hacienda Cayalti in Peru showed a significant response in cane yield to increasing N fertilizer, the maximum and optimum yields, expressed as tonnes 96° recoverable sugar per ha, being obtained with 423 and 378 kg.ha⁻¹ of N, respectively, for cane harvested at 21 months.

Improving sprouting of stubble crop in low temperature areas. R. S. Kanwar and H. Kaur. *Proc. 16th Congr. ISSCT, 1977, 1325-1331.*—Comparison of methods to encourage sprouting of ratoons after harvesting at the low-temperature part of the year showed that best results in terms of increased shoot and stalk population were given by spreading transparent 250-gauge polyethylene sheet over the stubble. Loosening of soil around the stubble also was of benefit but no improvement was given by use of black polyethylene or application of farm yard manure. Indole-3-acetic acid, indolebutyric acid (IBA), gibberellic acid, tri-iodo benzoic acid (TIBA), 2-chloroethyl phosphonic acid ("Ethrel") and 2-chloroethyl trimethyl ammonium chloride ("Cycocel") in varying amounts were tested by spraying over the shaved stubbles. All increased ratoon cane yield by comparison with the untreated control, best results being given by 500 ppm "Ethrel", 100 ppm IBA, and 50 ppm TIBA.

Intercropping of wheat with sugar cane. P. A. Kandasami, P. N. Santhakumariam and C. M. Radhakrishnan. *Proc. 16th Congr. ISSCT, 1977, 1333-1340.* Trials in South India showed that intercropping of cane with early varieties of wheat did not significantly reduce the cane yield or sugar content while harvesting of the wheat gave an extra profit of almost 1000 rupees per ha, raised to 1200 rupees.ha⁻¹ by application to the wheat of half the fertilizer normally applied to a wheat-only crop and so obtaining a higher yield.

"Velpar"—a new herbicide for use in sugar cane. F. E. Richardson. *Proc. 16th Congr. ISSCT, 1977, 1341-1352.*—The results of 26 field experiments with "Velpar", used alone and in combination with "Diuron", are presented. The herbicides were applied to a wide range of grass and broad-leaf species in the sugar industries of Southern Africa. "Velpar" at low doses (0.68 kg a.i. per ha) and low-dose "Velpar"/"Diuron" combinations (0.45 + 2.00 kg a.i. per ha) gave up to four months residual weed control when applied as pre- and early post-emergence treatment. Such low doses were not effective when late post-emergence sprays were applied and when grass had tillered. There was some control of *Cyperus esculentus* but *C. rotundus* was tolerant. The low doses used did not induce symptoms of phyto-

¹ *Proc. 9th Congr. ISSCT, 1955, 418-428.*

² *Proc. 14th Congr. ISSCT, 1971, 1069-1071.*

toxicity in ratoon crops. Newly planted sugar cane was not sufficiently tolerant to post-emergence sprays and some leaf chlorosis occurred. At double doses the treatments were suitable for long residual weed control on sugar cane breaks and on road verges.

Chemical weed control in sugar cane. An evaluation of pre-emergence and post-emergence herbicides in the Lower Rio Grande Valley of Texas. S. A. Reeves. *Proc. 16th Congr. ISSCT, 1977, 1353-1361.* Trials are reported of nine herbicides applied as pre-emergence and six as post-emergence treatments over three years at the Weslaco Experiment Station in Texas in a crop of N:Co 310 cane. "Trifluralin" at 2.24 and 4.48 kg.ha⁻¹ and "Tebuthiuron" at 1.68 and 3.36 kg.ha⁻¹ were the best of the pre-emergence treatments, while "Ametryne" at 3.36 kg.ha⁻¹ and "Velpar" at 0.84 and 1.68 kg.ha⁻¹ were the most effective post-emergence treatments for broad-leaved weeds and grasses, "Tebuthiuron" at 1.68 kg.ha⁻¹ also giving good control of grasses. Significant reductions in cane yield resulted from phytotoxicity to cane of pre-emergence applications of "Terbacil", "Tebuthiuron" and "Ametryne", but no crop yield reductions occurred with post-emergence treatments, although slight leaf burn occurred with "Ametryne" and "Velpar" treatment. No residual effects were noted.

The relative performance of six sugar cane varieties under three different regimes. D. B. Hellmann. *Proc. 16th Congr. ISSCT, 1977, 1363-1375.*—Six cane varieties were grown under three moisture regimes for a plant and four ratoon crops and then grown to a fifth ratoon under adequate water supply conditions to establish their potential for recovery after receiving inadequate water for the previous five crops. In the plant and first ratoon crops, 61 mm of water was applied at 14, 35 and 56 day intervals; for the 2nd ratoon crop the intervals were 30, 50 and 70 days, while for the 3rd and 4th ratoons they were 30, 45 and 60 days. Only in the 2nd ratoons was there a difference between all three treatments; in the others the two wetter treatments gave similar results. No statistical evidence was found for a variety × moisture interaction except in the 2nd ratoon where the response of N:Co 376, N:Co 334 and CB 36/14 was greater than that of N:Co 310, N:Co 382 and N 55/805. Except in N:Co 310 (which performed better than the other varieties under drier conditions) no general trends were observed with respect to varietal behaviour at the different moisture regimes. All varieties were able to recover once they received adequate water, the effect being an increase in the mass of individual stalks rather than a higher plant population.

The minimum tillage system for re-establishing sugar cane fields. P. K. Moberly and P. E. T. Turner. *Proc. 16th Congr. ISSCT, 1977, 1377-1382.*—Minimum tillage was compared with conventional land preparation on three different soils. Plant crop yields were enhanced by minimum tillage in light soils but slightly depressed in heavy, poorly drained soils. On a structured clay loam, yields were marginally superior, while the minimum tillage plot did not suffer the considerable soil erosion which occurred in the conventionally cultivated plot during a rain storm. Residual effects were small or non-existent in first ratoons.

An assessment of the phosphorus requirement of sugar cane grown on strongly P-fixing soils in South Africa. J. H. Meyer. *Proc. 16th Congr. ISSCT, 1383-1403.*—The results of a number of field trials to determine the P requirement of cane grown in highly weathered soils of a new cane growing area of the Natal Midlands showed a marked yield increase with single superphosphate at levels well above those indicated by standard Truog extraction procedures. Adsorption isotherm studies confirmed that this was due to soil phosphate retention. The use of a rapid screening technique to measure P fixation capacity, in conjunction with the Truog procedure, would enhance the accuracy of predicting fertilizer requirement in the soils, and indications are that they would benefit from high superphosphate fertilizer rates.

The results of recent pre-emergence herbicide screening trials for sugar cane in South Africa. P. E. T. Turner. *Proc. 16th Congr. ISSCT, 1977, 1405-1416.*—Of 23 new herbicides or herbicide mixtures evaluated, U27267 + "Atrazine", "Velpar" (DPX 3674), DPX 2851, "Velpar" + "Diuron", "Destun" (MBR 8251), "Destun" + "Atrazine", CGA 17020 + "Atrazine", CGA 17020 + CGA 29696, "Dowco 291", CGA 24705 + "Atrazine", CGA 24704 + "Atrazine", BFN + "Atrazine", MET 1486, EL 103 and AC 92553 were active against grasses at certain rates. "Velpar", "Velpar" + "Diuron", CGA 29696 + "Atrazine" and MET 1486 gave long-term control, whilst SN 40624, LS 691299 and "Dowco 233" were ineffective at the rates tested. On *Cyperus esculentus*, "Velpar", DPX 2851, "Destun", CGA 17020 + "Atrazine", CGA 17020 + CGA 29696, "Destun" + "Atrazine", "Velpar" + "Diuron", CGA 24705 + "Atrazine", CGA 24704 + "Atrazine", CGA 29696 + "Atrazine" and MET 1486 were all active. All the herbicides and herbicide mixtures, with the exception of U27267 + "Atrazine", SN 40624, LS 691299, AC 92553 and WL 63611, were active on broad-leaved weeds. Only EL 103 and "Destun" showed any activity on *Cyperus rotundus*.

Sugar cane production as a function of rainfall and nitrogen application. F. A. Fogliata and C. A. Gargiulo. *Proc. 16th Congr. ISSCT, 1977, 1417-1424.*—In Tucumán, cane is grown mainly without irrigation and trials have shown little response to P and K. An analysis was prepared therefore of nitrogen × rainfall interactions in the yield of NA 56-30 and NA 56-79, the two varieties occupying 60-70% of the total cane area of the Province, as well as CP 48-103 and cane grown at the Experiment Station. Minimum N doses necessary for maximum yields under different rainfall levels have been established. The rainfall level has a much greater influence on cane yield than N fertilization, however.

Modelling climatic factors for simulation of sugar cane production/processing systems. A. C. Early. *Proc. 16th Congr. ISSCT, 1977, 1425-1440.*—Analyses have been made of rainfall and potential evapotranspiration records, over periods of 10-55 years, from a number of zones of tropical monsoon climate of the Philippines. The analyses were to model these important climatic elements as stochastic water inputs and atmospheric water demands for sugar cane production. The major requirements are efficient, consistent and utilitarian properties and are met by a stochastic Markov chain model for monthly rainfall events and a deterministic mean monthly potential evapotranspiration model.

Contribution of nutrients by irrigation water in sugar cane areas of Peru. J. Pinna C. and S. Valdivia V. *Proc. 16th Congr. ISSCT, 1977, 1441-1453.*—No rain falls in the cane areas of Peru and water is supplied by irrigation from rivers or wells. Analyses have been made of some of the mineral constituents of these waters which have been found to provide, respectively, 6-23 and 12-92 kg N, 58-115 and 58-115 kg K₂O, 920-1840 and 1725-3450 kg Ca⁺⁺, 230-575 and 460-1150 kg Mg⁺⁺, and 230-4140 and 460-8280 kg SO₄⁻⁻⁻ per ha per year. No PO₄⁻⁻⁻ was contributed except in the case of two wells. Filter cake wash water and vinasse, added to irrigation water in certain areas, provide an appreciable amount of nutrients.

Nitrogen volatilization from urea applied as a top dressing or buried in calcareous sugar cane soils. J. Pinna C. and S. Valdivia V. *Proc. 16th Congr. ISSCT, 1977, 1455-1461.*—Urea was applied as a top dressing to moist and to dry calcareous soil, some of the latter being irrigated immediately. It was also applied by burying it at a depth of 10 cm. Samples were collected at 2-cm depth intervals and the total N, NO₃⁻ and NH₄⁺ analysed at intervals to measure the loss compared with corresponding measurements made at the time of application. The experiments were carried out in the winter and the summer and it was found that 50% of the surface-applied urea was volatilized within 7 days in winter and 70% within 4 days in summer, the loss being greater with moist or irrigated soil. The buried urea suffered a constant loss by hydrolysis which was complete in 2 days in summer.

Effect of tillage methods on production of sugar cane (*Saccharum* spp.) and on some hydro-physical soil properties. A. A. Casagrande and O. P. Godoy. *Proc. 16th Congr. ISSCT, 1977, 1463-1476.*—Cane and sugar yields did not indicate statistically significant differences over a plant and two ratoon crops for cane grown in soil cultivated by herbicide plus mechanical tillage, herbicide only, mechanical tillage only, mechanical plus manual tillage or manual tillage only. Soil macroporosity, microporosity, total porosity and available water analyses of the soils made after the plant and 2nd ratoon harvests did not reveal any differences which would indicate any particular tillage system as being favourable or harmful to the crop.

Soil erosion in cane fields in hilly lands in Trinidad. J. E. W. Georges. *Proc. 16th Congr. ISSCT, 1977, 1477-1487.*—Factors which might affect soil erosion were studied by measurement of erosion during two wet seasons. Slope (10-15° and 15-20°) and aspect (windward and leeward) had no significant individual effects but might interact, producing different slope effects on windward and leeward sides of a hill, especially on down-slope furrows. Longer plot lengths (6 and 8 m) produced significantly less erosion than shorter plot lengths (1, 2 and 4 m) while there was no significant difference in erosion between contour and down-slope furrows; these effects are attributed to soil deposition occurring at the same time as erosion. Planted cane effectively reduced erosion by comparison with bare soil, so that early planting is recommended to reduce soil loss as is the removal of ridges after planting and use of straight furrows on shallow slopes which will permit greater mechanization without increasing erosion.

Forms of phosphorus in soils and their availability to sugar cane. C. C. Wang, I. J. Fang and L. S. Robertson. *Proc. 16th Congr. ISSCT, 1977, 1489-1508.*—A large number of measurements have been made in the cane-growing areas of Taiwan to determine the removal by cane of the various forms of P in the soil, classified as Al-P, Fe-P, Ca-P and Red-P. Al-P was removed in the smallest absolute amounts and with the least variation; it was however the highest removed relative to the original amount in the soil at 20-37.9% (average 25.4%). Corresponding averages were 20.4% for Fe-P, 13.3% for Ca-P and 13.5% for Red-P. As a proportion of the total P present in the soil, the Fe-P and Ca-P were the most commonly removed by the cane crop. A high correlation was found between soil P measured with modified Bray's No. 1 extractant in a 1:50 soil:solution ratio and sugar cane yields in pot and field experiments, and this extractant is recommended for routine soil testing.

Elimination of internodes in sugar cane seed pieces. B. B. Ramaiah, G. N. Rao and G. H. P. Rao. *Proc. 16th Congr. ISSCT, 1977, 1509-1514.*—The use is described of "bud chips", i.e. buds with a minimum portion of stalk tissue, which germinate successfully to give cane seedlings in commercial planting without loss of cane or sugar yields. The weight of the 30,000 bud chips needed per hectare is only 300 kg against 8 tonnes of 3-bud setts, and the stalk tissue not used can be processed for sugar recovery. In addition treatment with fungicide before planting is easier, more effective and more economical.

Factors affecting the mineralization of CDU and its effect on sugar cane growth. Y. Y. Chan and T. C. Juang. *Proc. 16th Congr. ISSCT, 1977, 1515-1526.*—CDU is a slow-release nitrogen fertilizer, the mineralization of which has been studied by incubation of soil samples to which it was added, at pH 6 and at moisture contents 30, 60 and 90% of saturation capacity. After 60 days, 40% and 80% decomposition had occurred in the two test soils (as against 90% loss of urea after one week). Increase of pH to 8 doubled the rate of loss. In comparative leaching tests, loss of ammonium sulphate was three times as great as that of CDU. Because of this relatively low availability, it is necessary to supplement CDU with (NH₄)₂SO₄ as a more rapid-release fertilizer for young cane. Pot tests showed that urea was better than (NH₄)₂SO₄ and CDU in yield and N uptake by a plant crop but CDU was better in the first and second ratoons.

Leaf growth characteristics of three sugar cane varieties at different population densities and levels of nitrogen fertilization. E. L. Rosario, R. E. Tapay and V. Dosado. *Proc. 16th Congr. ISSCT, 1977, 1527-1538.*—Cane leaf characteristics were measured at monthly intervals for three varieties planted at three different population levels and given four levels of N fertilizer. Increased fertilizer under conditions of high population density maximized leaf area index (LAI) development—leaf area per stool ÷ ground area per stool—but restricted millable stalk formation and significantly reduced individual stalk weight, while increasing tiller production. Tillers which did not survive because of mutual shading indirectly affected stalk weight by competing for light and nutrients in early

growth. The experiment emphasized the importance of leaf area characteristics in determining sugar yield. At a low fertilizer level, varieties with good leaf area development are beneficial, and management practices such as fertilization and use of higher population density will result in higher yields if the leaf area per plant, which is important in stalk weight formation, is not affected. Maximizing the contribution of LAI to cane yield demands careful consideration of tiller survival. It appears that canopy characteristics alleviating light distribution, such as short and erect leaf types, would be of significance.

Closed-system nitrogen balance studies in sugar cane utilizing 15-ammonium sulphate. A. P. Ruschel, E. Matsui, J. Orlando and V. C. de Bittencourt. *Proc. 16th Congr. ISSCT, 1977, 1539-1547.*—Pot experiments were made with 0, 100 and 200 kg.ha⁻¹ N equivalent in the form of (NH₄)₂SO₄ labelled with ¹⁵N. The results showed that the cane took up the equivalent of 21.04 and 24.82 kg.ha⁻¹, respectively, from the fertilizer, 2.2-2.6 times this amount being derived from soil and N fixation. With the higher level of added N, the proportion of fertilizer N in the green leaves was raised by about 40%, in dead leaves by 8% and in the stalks by 53%, although the weight of stalks was increased by 53.5% whereas the green and dead leaves weights were reduced by 10% and 6%, respectively.

Optimum plot size for testing yield in irrigated sugar cane. M. O. Abu-Zeid and M. G. Mansi. *Proc. 16th Congr. ISSCT, 1977, 1549-1555.*—A uniformity trial was carried out to determine the optimum size and shape of plots to use in cane yield testing. The area under trial was a 1.08 ha block of 1482 ultimate units, each of 2×1.2 m. Results showed that the coefficient of variation decreased with (1) an increase in plot size, (2) rectangular plots vs. square plots and (3) longer plots (i.e. in the direction of the furrow) vs. wider plots. Coefficients of variation lower than 1% were obtained with plots of 96 m² upwards, the minimum CV (0.04%) being obtained with a plot 40 m long by 12 m wide. With the smaller plots, large numbers of replications were required.

Modulation of ET (evapotranspiration) values of sugar cane because of high water table. G. Hunsigi and S. C. Srivastava. *Proc. 16th Congr. ISSCT, 1977, 1557-1564.*—An experiment conducted in a sandy loam with a high water table in India showed that irrigating at 75 mm cumulative pan evaporation reduced cane yield to 136 tonnes.ha⁻¹ against 164 tonnes.ha⁻¹ when irrigating at 19 mm CPE. The pol % juice was higher, however, at 21.20 vs. 19.99. Average evapotranspiration, measured gravimetrically, was 0.174 cm.day⁻¹ and would be used in calculating irrigation requirements; however, the high water table contributed a further 0.325 cm.day⁻¹, as determined by measuring the water deficit in a 60 cm depth of soil with and without a polyethylene barrier.

Effects of irrigation level and trash management on sugar cane. J. M. Gosnell and J. E. Lonsdale. *Proc. 16th Congr. ISSCT, 1977, 1565-1586.*—See *J.S.J.*, 1978, 80, 264-269, 299-303.

Action spectra for the assimilation of ¹⁴C into leaf sugar components of sugar cane. A. G. Alexander

and O. Biddulph. *Proc. 16th Congr. ISSCT, 1977, 1587-1592.*—Cane +1 leaves of a plant of PR 980 cane were subjected to radio-active CO₂ in a chamber irradiated for 10 minutes with monochromatic light which ranged in wavelength from 400 nm in the blue-violet to 710 nm in the far red. The leaf samples were then quick-frozen, lyophilized and extracted three times with boiling 95% ethanol. The extracts were centrifuged at 5000 g and the sugars identified by paper chromatography. Sucrose was the main recipient of the ¹⁴C at test wavelengths of 670 nm and below, with an essentially constant proportion of the radio-C entering. The contributions of the orange and near-red regions were greater for sucrose, smaller but important contributions coming from the blue region but a pronounced green depression. D-raffinose was the principal recipient of ¹⁴C at 710 nm.

Observations on cane ripening in the Iranian winter. D. P. Gowing and N. Baniabbassi. *Proc. 16th Congr. ISSCT, 1977, 1593-1597.*—Cane grown in the nearly rainless months from April to October is ripened by withholding irrigation water and by the falling temperatures. The rate of improvement in juice quality may be retarded by winter rains and reduced or temporarily halted as the temperatures fall near freezing, ripening resuming shortly after the return of more favourable conditions. In 1972/73 ripening did not resume for nearly seven weeks after a mild frost, but unexpectedly only after the first rains, in contrast to the usual effect of winter rains. There seems to be a parallel between the effects of mild and severe cold—promoting and inhibiting ripening, respectively, and causing mild and severe drying-off.

Leaf sheaths and the inhibition of germination of young axillary buds in sugar cane. G. T. A. Benda. *Proc. 16th Congr. ISSCT, 1977, 1599-1603.*—The younger parts of field-grown stalks of cane, with the spindle included but leaf blades trimmed back, were grown in distilled water in the dark. When sheaths were left intact, few buds germinated; axillary shoots developed only from mature nodes. When sheaths were removed, many more buds germinated and axillary buds developed from both older immature and mature nodes. The results, applied to normal stalk development, suggest that the sheath helps to control tillering. Germination of young buds could be inhibited by the sheath when it is tight as around upper cylindrical nodes but not when it is loose as around lower obconic nodes at the base of the stalk.

Sugar cane flowering control with "Polaris", a growth retardant. Z. A. Menshawi. *Proc. 16th Congr. ISSCT, 1977, 1631-1652.*—"Polaris" (N,N-bis-phosphonomethyl glycine) was applied three times at concentrations of 0.5-25 mg.cm⁻³ to the foliage of cane. At concentrations of 5 mg.cm⁻³ and higher, growth ceased and the plant displayed toxicity symptoms and died. At 1 mg.cm⁻³ and lower, there was, after about 10 days, a two-week period of conspicuous growth decline, followed by accelerated growth. At 0.5 mg.cm⁻³ the percentage of flowering was not affected but it was delayed, whereas at 1 mg.cm⁻³ flowering was reduced as well as delayed. All treatments caused an initial rise in the apical amino-acids and amides followed by their decrease.

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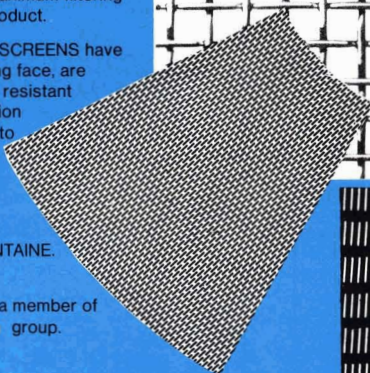
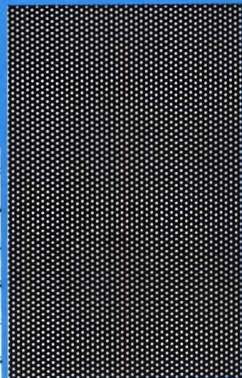
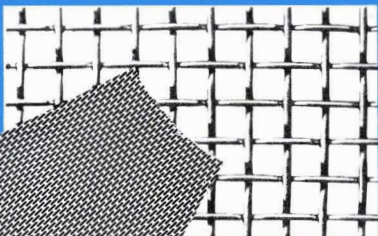
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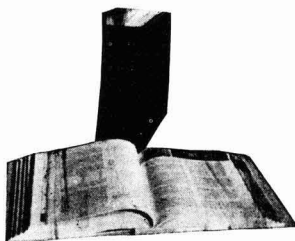
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CANE PESTS AND DISEASES

Control of smut disease of sugar cane through hot water treatment. M. R. Gupta. *Indian Sugar*, 1977, **27**, 385-386.—In tests, hot water treatment of 3-bud setts at 50°C for 2½ hours gave greatest reduction in smut incidence, but the best germination (51.7%) and yield (66.36 tonnes.ha⁻¹) were obtained with 2 hours' treatment, which gave almost the same reduction in disease incidence as did 2½ hours' treatment. Germination and yield of untreated cane were 37.3% and 58.32 tonnes.ha⁻¹, respectively.

Sugar cane smut in South Africa: current control recommendations. R. A. Bailey. *S. African Sugar J.*, 1977, **61**, 600-604.—See *I.S.J.*, 1978, **80**, 146.

Problems and progress in breeding sugar cane for mosaic resistance in Louisiana's sub-tropical environment. R. D. Breaux and H. Koike. *Proc. 16th Congr. ISSCT*, 1977, 425-432.—Strain H of sugar cane mosaic virus has been predominant during the past decade but Strain I, which injures some varieties more, appears to be increasing in incidence, particularly in the western part of the Louisiana cane belt. Since 1962, 15 additional interspecific hybrids with high mosaic resistance have been identified, most of which have a sucrose content higher than that of CP 48-103 so that it is now possible to include a high-sucrose, mosaic-resistant parent in most commercial crosses. Selection pressure in the greenhouse has been increased by going from sugar cane (POJ 234) to Rio sweet sorghum as virus source plants and in the field by growing the plants of early line trials and selected candidate varieties in areas of high mosaic spread. There has been, as a consequence of these factors, an increased number of releases of promising, mosaic-resistant, commercial-type varieties.

Detection of the RSD-associated bacterium by serologically specific electron microscopy. K. E. Damann, K. S. Derrick, A. G. Gillaspie, D. B. Fontenot and J. Kao. *Proc. 16th Congr. ISSCT*, 1977, 433-437. Serologically specific electron microscopy (SSEM) was used for detection and identification of the distinctive bacterium associated with RSD. Antiserum to the bacterium was adsorbed on "Parlodion"-coated carbon-fronted electron microscope grids. Floating these antiserum-coated grids on drops of juice or vascular extracts from RSD-infected plants resulted in the attachment of the bacterium to the grid surface by a specific antigen-antibody reaction. SSEM did not require concentration of the RSD bacterium as does the microprecipitin test for bacterial detection. The technique appears to be more powerful than quick-dip electron microscopy and was used to diagnose ratoon stunting disease.

Comparison of serological and inoculation methods for detecting latent infection of leaf scald. C. Ricaud, S. Sullivan, S. Félix and P. Ferré. *Proc. 16th Congr. ISSCT*, 1977, 439-448.—An antiserum against *Xanthomonas albilineans*, the causal organism of leaf scald disease, was prepared by serial intravenous injections in a rabbit and gave good serological reactions with pure culture whole-cell suspensions of the bacterium in tube agglutination, micro-agglutination and agar gel double diffusion tests. The antiserum had a high titre (1:2560) and was very specific. For diagnosis of the disease in cane stalks these were sliced and allowed to exude in water for two hours, the exudates strained through muslin and subjected to differential centrifugation at 20,000 g between two low-speed spins. The bacterium could be diagnosed in stalks showing disease symptoms by micro-agglutination tests with suspensions of the sediment but the technique did not work for stalks with latent infection. For the inoculation technique, the cane tissues were processed in the same way except that they were also homogenized and low-speed centrifugation was omitted. The sediment was used for inoculation of a susceptible variety. The method was more sensitive than the serological technique and allowed detection of latent infection. However, further improvements to increase its reliability are desirable.

Strains of streak virus infecting sugar cane. C. Ricaud and S. Félix. *Proc. 16th Congr. ISSCT*, 1977, 449-457.—Isolates of streak virus from naturally infected cane, from maize and from a grass, *Coix lacryma-jobi* Linn., were tested for infectivity by transmission with the leafhopper vector *Cicadulina mbila* Naude. The results demonstrated that different strains of the virus existed with different severity of effect on cane, with an intervening varietal susceptibility. The virus from cane grown in Mauritius was different from the strains infecting cane in certain African countries and did not infect five varieties susceptible to streak in South Africa. Agar gel immuno-diffusion tests using crude leaf sap or partially purified virus extracts showed no reaction between the Mauritius cane strain antigen and antiserum to the streak virus from Kenya.

Serological tests applied to leaf scald disease of sugar cane. A. R. Oliveira, T. Nakamura, H. P. Liu and M. H. Sugimori. *Proc. 16th Congr. ISSCT*, 1977, 459-468. Specific antisera to *Xanthomonas albilineans* (Ashby) Dowson, prepared by the Oliveira intra-lymph node injection technique¹, have shown positive microprecipitin and double diffusion serological reactions. The minimum and maximum antiserum titres varied to some extent. The antisera AS-Xa-187, AS-Xa-191 and AS-Xa-192 gave titres of 1:16, 1:4 and 1:2 on the fourth day after antigen injection. After 15 days the maximum titre was 256 (AS-Xa-191 and AS-Xa-192) and the minimum was 1:16 (AS-Xa-188). Using low-titre antisera it was possible to detect *X. albilineans* after 45 minutes in microprecipitin tests. *X. albilineans* exopolysaccharide gave a species-specific double diffusion reaction. The results indicate great possibilities for the application of serological tests in large-scale diagnosis of leaf scald disease of sugar cane.

Studies on smut disease (*Ustilago scitaminea* Syd.) of sugar cane. IV. Parasitism, germination, di-

¹ *Summa Phytopathologica*, 1976, **2**, 69-96.

karyotization and infection. K. C. Alexander and K. Ramakrishnan. *Proc. 16th Congr. ISSCT, 1977, 469-472.* Teliospores of the smut organism germinated mostly by producing promycelia bearing sporidia. Sometimes hyphae were produced instead of promycelium. The dikaryotic condition was attained through sporidial fusions, promycelial fusions and hyphal cell fusions.

Occurrence of pokkah boeng disease of sugar cane in Egypt. A. M. Higgy, A. A. Abd-Elrazik and M. H. Rushdi. *Proc. 16th Congr. ISSCT, 1977, 473-481.*—An epidemic of pokkah boeng in commercial cane plantations in Upper Egypt was found to be caused by *Fusarium moniliforme* Shield., *F. oxysporum* Schle. and *F. equiseti* (Corda) Sacc., the last two being recorded as causal agents for the first time. Reactions of varieties ranged from weak to severe. Symptoms started to appear in June 1974 with leaf infection which was followed by top rotting. Stalk weight and total juice solids were reduced but juice quality was unaffected. The first two microorganisms produced a number of enzymes *in vitro*, the amounts and proportions varying with the pathogenicity of the isolates.

The use of heat treatment for sugar cane disease control. G. T. A. Benda and C. Ricaud. *Proc. 16th Congr. ISSCT, 1977, 483-496.*—Heat treatment of sugar cane setts are applied (1) to reduce the incidence of one or more of a dozen diseases, able to pass systemically from one vegetative generation to the next, in order to increase yield or protect susceptible varieties from increasing inoculum pressure, (2) to increase the germination of seed cane so as to improve the stand and (3) to destroy pests in the seed cane. Heat treatments have not been shown to cause mutation in cane or cane pathogens. Aspects of heat treatment with air and water in different proportions are reviewed, with 59 references to the literature. It is considered that the aerated steam treatment offers the best combination of disease cure and sett survival.

Nematodes parasitizing sugar cane in Cuba. J. P. O'Reilly and J. R. Pérez M. *Proc. 16th Congr. ISSCT, 1977, 497-507.*—A survey has been carried out of 840 soil and root samples representing all the cane soils in Cuba. The 84 species of parasitic nematodes identified represented four superfamilies, seven families and 17 genera. The most important species were *Helicotylenchus dihystrera*, *H. erythrinae*, *H. retusus*, *Pratylenchus zeae*, *P. penetrans*, *P. sp.*, *Xiphinema diversicaudatum*, *X. americanum* and *Meloidogyne javanica*. Four new species parasitizing cane were reported as a result of the survey.

The role of varietal resistance in control of the sugar cane borer, *Diatraea saccharalis* (F.), in Louisiana. S. D. Hensley, H. P. Fanguy and M. J. Giamalva. *Proc. 16th Congr. ISSCT, 1977, 517-522.*—About 50% of the Louisiana sugar cane crop is planted to N:Co 310, CP 52-68 and L 62-96 which are much less susceptible than the other three major varieties (CP 48-103, CP 61-37 and L 60-25) to attack by *D. saccharalis*. Increased use of these varieties has reduced the need for application of "Azinphosmethyl" insecticide for control and so lessened mortality of birds, fish, etc. After 12 years of use there is no indication that resistance to "Azinphosmethyl" is developing in *D. saccharalis* populations.

A comparison of the reproductive strategies and certain other biological characteristics of *Apanteles* spp. and the tachinid parasites of *Diatraea saccharalis* (Fabr.). F. D. Bennett. *Proc. 16th Congr. ISSCT, 1977, 523-527.*—In a theoretical note it is suggested that (1) tachinid parasites of *Diatraea*, because of an extended pre-oviposition, are more vulnerable than *Apanteles* spp. to aerial applications of persistent insecticides, (2) where the effectiveness of the tachinids is reduced by hyperparasites the release of *Apanteles* spp. might be considered, and (3) following mass releases, *Apanteles* spp. may migrate less rapidly than the tachinids which in some instances should be advantageous.

Resistance of sugar cane varieties to *Argyroploce schistaceana* measured in the early growing stage of sugar cane. Y. S. Pan and S. L. Yang. *Proc. 16th Congr. ISSCT, 1977, 529-538.*—Ovipositional preference of the moth borer, *A. schistaceana*, larval establishment and the degree of larval injury on young plants of different varieties were investigated in laboratory experiments. Female adults tended to prefer F 168 variety for oviposition but the numbers of eggs deposited on 1-month old plants of nine varieties, or those collected from the varieties during the first four months after planting, did not differ significantly. More frequent oviposition was found on the +1, +2 and +3 leaves of young plants. Larval establishment on artificial diets containing powders of 5-months old plants of different varieties varied significantly. Rearing of the larvae on the sterilized young stems of 4-months old plants resulted in significant differences in the numbers of eggs laid by the females. Close correlation between the degrees of larval injury on young plants and maturing stalks suggests the feasibility of screening large numbers of new clones for resistance to *A. schistaceana* in early stages of development. A considerable degree of resistance was found in the variety F 171.

Larvipositional cycle of *Lixophaga diatraea* (Tachinid: Diptera). J. P. Roth and E. G. King. *Proc. 16th Congr. ISSCT, 1977, 539-543.*—Larviposition by the tachinid *L. diatraea* (Townsend) on methanol extracts of frass from *Diatraea saccharalis* (F.) larvae fed sugar cane began on the 7th day after female emergence from puparia and mating, peaked during the 8th-14th day and declined thereafter. Over 90% of the total number of maggots deposited were by the 15th day. Life span of the female flies ranged from 8 to 23 days and averaged 17.5; mortality was therefore not a significant factor in limiting larviposition. Flies 14 days or older behaved differently from younger flies depositing larvae more readily near frass or other dead flies and with smaller delays between depositions.

The nematodes, pests of sugar cane in Peru. E. E. Carbonell. *Proc. 16th Congr. ISSCT, 1977, 545-551.* Preliminary investigations have demonstrated 19 genera heavily infesting the cane crop in Peru, viz. *Tylenchus*, *Tylenchorhynchus*, *Psilenchus*, *Hoplolaimus*, *Rotylenchus*, *Helicotylenchus*, *Pratylenchus*, *Rodopholus*, *Meloidogyne*, *Cricanemoides*, *Hemicyodiophora*, *Dolichodoros*, *Belonolaimus*, *Aphelenchus*, *Aphelenchoides*, *Dorylaimus*, *Longidorus*, *Xiphinema* and *Trichodoros*. The occurrence and high population density of the nematodes suggest that they may be a contributor to the economic losses now facing some plantations.

Parasite-host size relationships: *Lixophaga diatraea* (Townsend) tachinidae reared on *Diatraea saccharalis* (F.) pyralidae. R. M. McPherson and S. D. Hensley. *Proc. 16th Congr. ISSCT, 1977, 553-559.*—A significant positive curvilinear relationship ($P < 0.01$) was detected between weights of host (*D. saccharalis*) and emerged parasite (*L. diatraea*) under laboratory conditions. Furthermore, the numbers of progeny per mated female parasite increased when the size of larvae used as hosts was increased. However, host size did not significantly influence parasite maggot development time.

Seasonal collections of alate sugar cane aphids in yellow pan water traps in Gula Perak Berhad plantation, Malaysia. G. T. Lim, Y. C. Pan and K. S. Pang. *Proc. 16th Congr. ISSCT, 1977, 561-564.*—Trap sampling of the aphids *Ceratovacuna lanigera* Zehnt. and *Longiunguis sacchari* (Zehnt.) showed that in 1974 the peak periods of flight activity of the latter were January, March and August and of the former March and August, while in 1975 the peak periods were January and January, March, May and September, respectively. The attractiveness to the aphids of the yellow pan water traps used¹ was proved.

The influence of rogesan on the recovery of the sugar cane plant. B. Wirioatmodjo and D. Samoedi. *Proc. 16th Congr. ISSCT, 1977, 565-568.*—"Rogesan" is the term used in Indonesia for regular cutting-out, over a wide area, of infested shoots just below the area containing borer larvae, a technique which, if carried out intensively, can reduce infestation by 80%. Trials showed that the rate of recovery of the cane plant was inversely proportional to the length of shoot removed, e.g. 68% for shoots cut 7.5 cm below the point of origin of leaf No. 1 but only 28% for shoots cut 22.5 cm lower. There was a highly significant positive correlation between this rate of recovery and rainfall.

Influence of the degree of attack by the stem borer *Diatraea saccharalis* Fabricius on some sugar cane yield constituents. R. Pérez G., R. Cardoso M. and A. Rosales L. *Proc. 16th Congr. ISSCT, 1977, 569-582.* Plant and ratoon cane of two varieties was grown on two kinds of soil and infestation by the stem borer measured in respect of the number of canes drilled, and the number and weight % of internodes drilled, as well as sugar losses. No significant differences were found for ratoons in respect of variety or soil, but infestation was higher with B 4362 cane on red ferralitic soil. There were significant correlations between numbers of canes drilled, numbers of internodes drilled and weight % of internodes drilled, as well as between sugar losses and infestation for all the ratoon cane and for plant cane of B 4362 on red ferralitic soil.

Parasites of *Elasmopalpus lignosellus* (Zeller) (Lepidoptera: Phycitidae) on a Jamaican sugar estate. T. Falloon. *Proc. 16th Congr. ISSCT, 1977, 583-591.*—*E. lignosellus*, the lesser cornstalk borer, is a pest of 1-6 weeks old ratoon cane under dry conditions. Studies in 1974 and 1975 identified an egg-larval parasite, *Chelonus elasmopalpi* McComb (Hymenoptera: Braconidae) and three larval parasites, *Stomatomyia* sp. (Diptera: Tachinidae), *Orgilus elasmopalpi* McComb (Hymenoptera: Braconidae) and *Eiphosoma dentator* (F.) (Hymenoptera: Ichneumonidae). *Stomatomyia* sp. attained the highest degree of parasitism (11.6% of borers collected in 1975), while *C. elasmopalpi* was least successful with less than

1% in both years. It is considered that parasites play a minor role in control of the lesser cornstalk borer at Monymusk.

A study of ovipositional preference of sugar cane moth borer *Tetramoera schistaceana* Snellen. G. T. Lim and Y. C. Pan. *Proc. 16th Congr. ISSCT, 1977, 593-602.*—A survey was made of oviposition on three cane varieties—N:Co 310, GPB 5 and GPB 24—in relation to plant structure. No relationship was found between ovipositional preference and the numbers of 1-celled hairs, 2-celled hairs, stomata or vascular bundles of the leaf blade, but the variety N:Co 310 was preferred to the others. The majority of eggs were laid on leaves +2 to +5 in all varieties, the highest actual number being on leaf +3. About half as many eggs were laid on the lower surface as on the upper and in this case the greatest numbers were on leaf +5. The tiller population was an important factor influencing ovipositional preference because of the shelter they provide for the moths.

Evolution of biological control of the sugar cane borer *Diatraea* spp. (Lepidoptera: Pyralidae) in Brazil. D. Gallo, E. Berti-Filho, G. J. de Moraes and H. J. Castilho. *Proc. 16th Congr. ISSCT, 1977, 603-615.*—A survey is presented of the present status of biological control of the *Diatraea* spp. borers in Brazil. The most efficient parasites are *Lixophaga diatraea* Town. (distributed in the Federal Territory of Amapá), *Paratheresia claripalpis* Wulp (distributed in the North-East, South and South-East of Brazil) and *Apanteles flavipes* C. (Hymenoptera: Braconidae) (distributed in the North-East) which can be reared on larvae of *Galleria mellonella* L. (Lepidoptera: Galleriidae) as well as on *Diatraea* larvae, and *Metagonistylum minense* Town. (Diptera: Tachinidae) (distributed in the North-East, South and South-East) which is reared on *Diatraea* larvae.

Biology of the cane leaf frog hopper *Mahanarva posticata* (Stal, 1855) (Hom.: Cercopidae), a pest of sugar cane in North-East Brazil. E. J. Marques. *Proc. 16th Congr. ISSCT, 1977, 657-662.*—A record is presented of a laboratory study of the biology of *M. posticata* under normal ambient temperature and relative humidity (26.1-28.5°C and 65.7-79.5% R.H.). Nymphs were collected from the field and reared on young cane plants. Descriptions are given of the stages of the life cycle of the frog hopper (which lasted 79.14 days on average), with details of incubation period, nymph development, adult emergence and mating and oviposition.

Studies of *Paratheresia claripalpis* (Diptera: Tachinidae). Effects of inbreeding on larva-adult viability. N. G. Saraceni and C. A. Mourão. *Proc. 16th Congr. ISSCT, 1977, 689-692.*—The effects of inbreeding on female fertility and larva-adult viability were studied in three generations of sibling crosses in *P. claripalpis*, a parasite used for biological control of moth borers. The results showed that viability decreases with increase in the degree of inbreeding, the percentages of adult flies being 13.3, 12.6 and 6.2%, respectively, for F_1 , F_2 and F_3 . By comparison, control crosses of unrelated flies produced 32.5% of adults.

¹ See Heathcote: *Ann. Appl. Biol.*, 1957, 45, 133-139.

CANE BREEDING AND VARIETIES

Polaroid photography: an aid to *Saccharum* chemotaxonomy. N. H. Paton, R. Shannon and P. Smith. *Proc. 16th Congr. ISSCT, 1977, 85-92.*—Leaf flavonoids are separated by two-dimensional paper chromatography or thin-layer chromatography but are only visible in u.v. light. Polaroid photography has been adapted to provide an instant visual record of the flavonoid pattern. The technique has been applied to chemotaxonomic studies of *Saccharum* and closely allied genera, and examples are given to illustrate the distinct visual differences between some genera and species of the *Saccharum* complex.

Single-stool variety selection in sugar cane (*Saccharum* spp. L.). P. M. Lyrene. *Proc. 16th Congr. ISSCT, 1977, 93-100.*—A total of 420 cane stools (20 genotypes replicated 21 times) were assessed by three people in grades designed to reflect commercial potential, in order to see if differences in apparent potential among single stools had a genetic basis and to determine what plant features (stalk diameter, length and number per stool) were most emphasized by selectors evaluating varietal potential. Grade differences among genotypes were fairly consistent, with some receiving high grades from all assessors in many replications and others seldom receiving a high grade. High potential was positively correlated with stalk diameter (0.635), stalk number (0.566) and stalk length (0.549). It was concluded that selection of varieties in unreplicated single stools is at least somewhat effective.

Synchronization of flowering to implement a proven cross breeding system in sugar cane. K. J. Nuss. *Proc. 16th Congr. ISSCT, 1977, 111-119.*—Parent varieties and crosses producing seedlings in the final selection stages were evaluated and a breeding programme based on the evaluation developed. Several proven parents do not flower freely under natural conditions but, by using floral induction treatments in a photoperiod house and a glasshouse, the flowering of varieties can be planned to coincide.

Sugar cane clonal selection research in Argentina. A review of experimental results. J. A. Mariotti. *Proc. 16th Congr. ISSCT, 1977, 121-136.*—The most important results from clonal selection experiments in Argentina over ten years are reported. Critical problems include very high selection pressures in the early stages, extremely subjective selection criteria, especially in the first stage, very narrow variability for important traits in original progenies, and a high frequency of genotype \times environmental interaction interferences. The degree of genetic determination appears to be acceptable for most traits from Stage II and on. A conditional environmental component of variation which affects the effi-

ency of the genetic parameters estimated was detected for diameter and number of stalks, with very definite trends. Association studies show that the number of stalks is the most conspicuous cane yield component. A non-linear type of association was detected between number of stalks and diameter which might explain some of the interactions found between this relationship and environments. Alternative or joint selection for cane yield and quality can readily be made without secondary effects. These characteristics were found to be independent under the conditions of the programme. From selection experiments carried out in varying environments it may be concluded that the environmental treatment strongly influences the selection of genotypes with specific adaptability which might affect the efficiency of the process.

Floral induction of sugar cane during the spring and summer months at Hawamdieh, Egypt. Z. A. Men-shawi. *Proc. 16th Congr. ISSCT, 1977, 137-145.*—Floral induction during the spring and summer months at Hawamdieh, at a latitude of 30° 02' N, has been achieved, so extending the period during which crossing may be made from November/January to June/January. It was achieved by regulation of daylength within the inductive margins of 12½ to 12 hours with excess darkness, at adjusted day and night-time air temperatures and humidity.

Identification of cold tolerance in *Saccharum* and related genera through refrigerated freeze screening. J. E. Irvine. *Proc. 16th Congr. ISSCT, 1977, 147-156.* Four commercial varieties, 28 *S. spontaneum* clones, two natural hybrids, six experimental hybrids and clones of *Ripidium*, *Miscanthus* and *Sclerostachya* were exposed to temperatures of 27°F (−2.8°C) for 12 hours and 24°F (−4.4°C) for three hours. These treatments caused complete freezing of the above-ground portions of many clones, including commercial ones, but clones which survived the treatments did so repeatedly and were clearly superior in cold tolerance. In addition to some thin-leaved, thin-stemmed clones of *S. spontaneum*, cold tolerance was also observed in *Ripidium* and *Miscanthus*. Although not a strict association, ratooning ability was generally related to cold tolerance.

Sugar cane pollen. M. Krishnamurthi. *Proc. 16th Congr. ISSCT, 1977, 157-164.*—Studies of sugar cane pollen show that a strong range of compatibilities exists among varieties of cane. The pollen is a specialized cell, highly sensitive to light, temperature and humidity. Germination of pollen is genetically determined and so is its ability to survive preservation and adverse conditions.

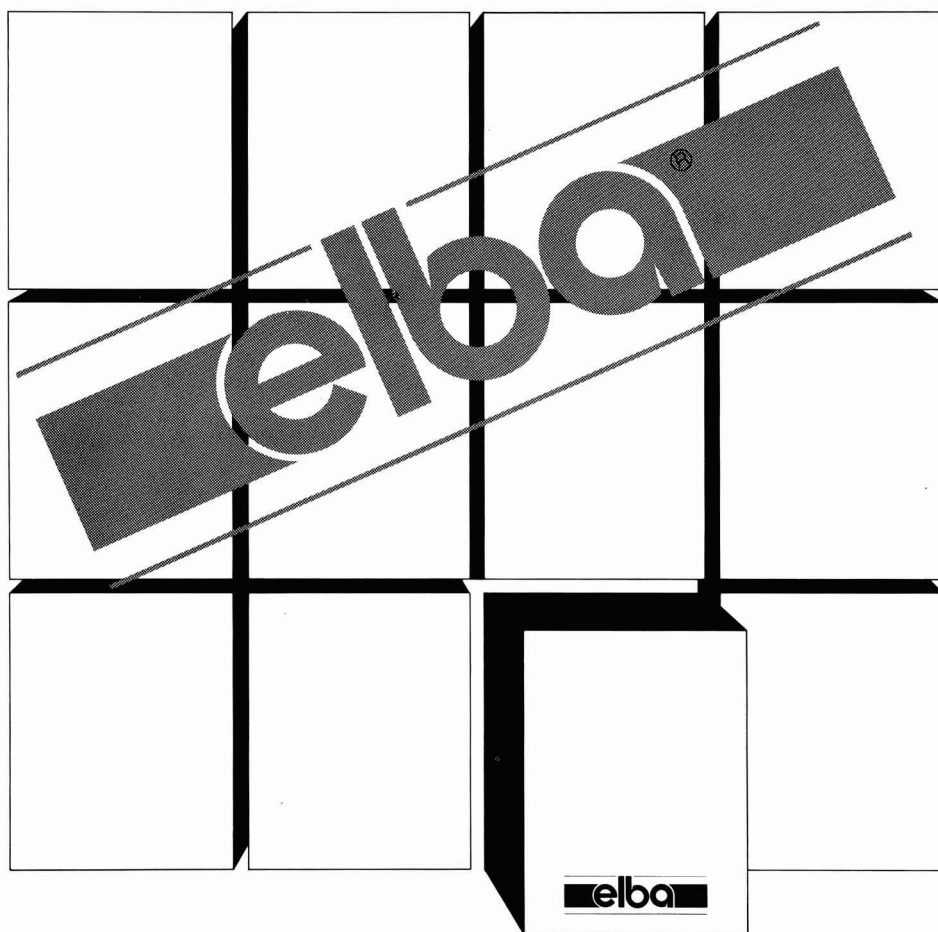
Production of sugar cane seedlings by the method of fuzz processing and early transplantation. W. M. da Silva. *Proc. 16th Congr. ISSCT, 1977, 165-176.*—A new system is proposed for production of cane seedlings which is called "Fuzz processing and early transplantation" (FPET). A machine has been developed with which the true seeds are separated from the hair tufts at the bases of the spikelets. A germination cabinet has also been designed and replaces the greenhouse for germination of the seeds which are transplanted as seedlings seven days after sowing, and re-transplanted into the field when 25 cm high. Details of the techniques are given, with a discussion of the effect of variation in some of the conditions, and a comparison is made with

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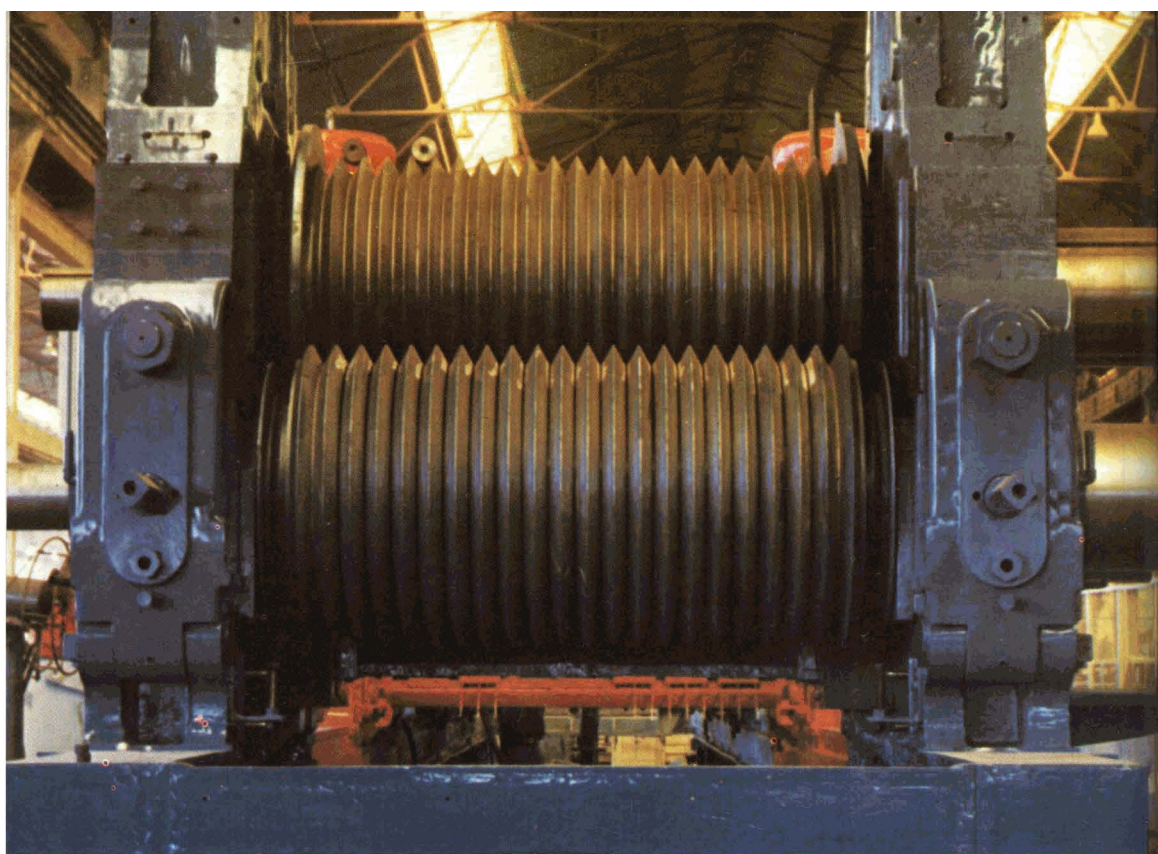
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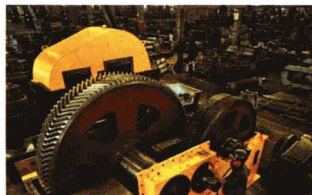
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the traditional method which is slower and involves greater losses.

Studies on the yield of sugar cane varieties with particular reference to the efficiency of the utilization of sunlight. III. The effects of the light extinction coefficient on some yield components in some sugar cane varieties. M. Shimabuku and K. Higa. *Proc. 16th Congr. ISSCT, 1977, 177-185.*—Field experiments were made to discover the relationship between the light extinction coefficient¹ K and the yields of sugar and cane and Brix in some cane varieties. A positive correlation was found between K and leaf area index (LAI) at an early stage of growth but a negative correlation was found between them at the period of rapid growth. A positive correlation was found between K and the percentage of dead stalks and a negative correlation between cane yield and K; varieties with smaller K values showed a higher cane yield because of the smaller proportion of dead stalks. A negative correlation was found between K and sugar yield. A positive correlation between weight per stalk and number of millable stalks will disappear if varieties with smaller K values and more stalks per unit area are chosen and selection continued for varieties with greater weight per stalk.

Interclonal competition in two sugar cane hybrid populations. A. M. Galvez and L. T. Empig. *Proc. 16th Congr. ISSCT, 1977, 187-202.*—Two types of competition were evaluated in different cane populations: homo-competition refers to the average performance of self-bordered clones, represented by the inner rows, while hetero-competition refers to the average performance of the half-bordered outer rows. Generally the characters considered suffered from insufficient compensation under the conditions of hetero-competition, as a result of the depressive effects of competition. Exceptions were the percentage of cane formation in both clonal populations studied, stalk length in one population and the number of millable stalks per stool in the other population, on which competition had no effect. Homo-competition produced higher mean values for most of the characters examined, which indicated that the effects of competition were less severe. Field evaluation of important economic characters should therefore be done in buffered rows of clonal plots to make selection more precise. Where this is impossible, as in seedling populations, it is suggested that selection criteria should be relaxed in order to avoid the possible loss of potentially superior genotypes. Correlation data and calculations of genetic variance of the different characters indicate that estimates of progress in selection may be exaggerated if heritability values in prediction are obtained from improperly bordered rows. This might also lead to the development of varieties which might subsequently prove inferior in homogeneous commercial populations.

Studies on *Saccharum spontaneum* L., *S. arundinaceum* Retz. and the related species *Miscanthus floridulus* (Labill.) Warb. in the Philippines. L. M. Engle, L. J. Escote and D. A. Ramirez. *Proc. 16th Congr. ISSCT, 1977, 203-209.*—Cytological examination of a collection of the title species from the Philippines showed a predominance of *S. spontaneum* clones having $2n = 80$, although clones with $2n = 72$ to 88 were also noted. *S. arundinaceum* clones had $2n = 60$ with others of up to $2n = 68$. *M. floridulus* clones had $2n = 38$. *S. spon-*

taneum and *M. floridulus* show normal meiosis while a considerable number of meiotic abnormalities are exhibited by *S. arundinaceum*. Some morphological and anatomical characters of the three species are also compared.

Studies on the inheritance of ligular process in the interspecific cross *Saccharum officinarum* var. Green Sport × *S. spontaneum* CBE. M. B. G. R. Batcha and K. Palanichamy. *Proc. 16th Congr. ISSCT, 1977, 227-231.* The pattern of inheritance of the character ligular process (auricles) was studied in the title interspecific cross. The presence of a ligular process was observed to be dominant over its absence, giving segregation ratios of 5:1 in F_1 , 15:1 in F_2 and 3:1 in BC_1 . By taking into account the genetic consequence of diploid gametes functioning in *S. officinarum*, it was concluded that ligular process is possibly governed by two duplicate non-allelic genes showing disomic inheritance.

Utilization of wild germplasm—*Saccharum spontaneum*—in breeding. P. Sankaranarayanan. *Proc. 16th Congr. ISSCT, 1977, 233-238.*—The results obtained in crossing various Puerto Rican (PR) and Hawaiian (H) clones with different *S. spontaneum* variants (SES) and in selfed progenies of a few *S. spontaneum* clones are given. Crosses between PR 1016, PR 1028, PR 1039, H 49-3533 and H 52-663, SES 13, SES 14, SES 147A and *S. spontaneum* Coimbatore are promising in yielding elite genotypes. Five *S. spontaneum* forms used in the breeding programme were selfed; of these SES 14 and SES 121A promise to segregate progeny of high sugar content. Six PR parents were crossed with a common pollen parent SES 84A; PR 1066 proved to be a promising parent for imparting vigour, girth and high Brix to the progeny.

Analysis of quantitative variation in sugar cane hybrid populations involving *Saccharum robustum*. T. C. R. Rao and J. T. Rao. *Proc. 16th Congr. ISSCT, 1977, 239-244.*—Patterns of variation of six quantitative characters (Brix, number of stalks, stalk weight, stalk diameter, stalk height and calculated yield) in sugar cane hybrid populations involving *S. robustum* are reported. Broad sense heritabilities estimated by two methods were high for all characters. Narrow sense heritabilities, estimated from the analysis of between- and within-family variances, were moderate to high, ranging from 47% for stalk height to 60% for stalk diameter. High and negative correlations between number of stalks and stalk diameter were noted. A need for further nobilization and selection for Brix and yield *per se* is suggested.

The inheritance of peduncle length in the hybrids of *Sclerostachya fusca* and *Narenga porphyrocoma*. P. A. Kandasami. *Proc. 16th Congr. ISSCT, 1977, 245-249.* The mode of inheritance of peduncle length was studied in the cross *S. fusca* × *N. porphyrocoma*. The additive type of gene action is indicated by the scaling test and also from the components of variance analysis. The effective number of factors governing this character was estimated to be about 5 or 6 gene pairs. The heritability was calculated to be 91-95% for this character.

¹ Monsi & Saeki: *Jap. J. Botany*, 1953, 14, 22-52.

CANE SUGAR MANUFACTURE

Solid bowl centrifuge performance in the treatment of cane mud. P. N. Stewart, A. G. Noble and G. A. Brotherton. *Proc. 16th Congr. ISSCT, 1977, 2289-2298.*—The machine settings and other operating variables influencing the recovery of sugar and mud solids retention obtained with a solid-bowl centrifuge handling clarifier mud are discussed. The use of flocculating agents, an improvement in bagacillo quality, and the provision of adequate retention time are three of the main factors which have led to the marked improvement in performance since installation. A comparison is also given between the performance of the centrifuge and that of rotary vacuum filters at present used in the treatment of cane mud; at present overall performance of the "MercoBowl 22L" machine is not as satisfactory as that of a well operated filter and it is not at present an attractive alternative. It is hoped that modifications in design to be carried out will further improve the performance of the centrifuge, when further study will be warranted.

Basic energy and its utilization in the cane sugar industry. W. Leibig. *Proc. 16th Congr. ISSCT, 1977, 2299-2311.*—Consumption of mechanical or electrical power in the industry is continually increasing because of the application of more sophisticated production processes and the application of more environmental protection. Because of recent developments in energy costs there is a need for re-evaluation of energy management and heat economy even in the sugar industry. It is presupposed that heat economy is optimized, with production of heat with a high energy potential, thus allowing the transformation of more primary energy into mechanical or electrical power and influencing favourably the subsequent thermo-physical processes. The advantages of the application of high-pressure steam and rearrangements for power plants are shown to balance out the high demand for mechanical or electrical power with lower process heat consumption and, further, to make surplus energy available for sale.

Effluent treatment in the South African sugar industry. J. Bruijn. *Proc. 16th Congr. ISSCT, 1977, 2313-2327.*—Laboratory results of experiments on treatment of sugar factory waste water by an activated sludge process and by biological filtration are reported. Performance figures are given from a full-scale biological filtration plant which has operated for three years. Modifications to the plant and their effect during the period of operation are discussed. In a similar way, data are reported on a full-scale activated sludge plant operating for a number of years at a sugar factory.

Approaching the ultimate in thermal economy in sugar manufacturing plants. P. N. R. Rao and S. K. Ghosh. *Proc. 16th Congr. ISSCT, 1977, 2329-2346.*—With

conventional methods, the law of diminishing returns tends to preclude any further intensification of thermal efficiency measures as economically non-viable. But an increase in the value of bagasse in the future as a raw material for paper manufacture may change the economics of heat economy measures. The present paper identifies the chimney and condensers as the main areas for investigation and discusses the feasibility of measures based on the simultaneous use of an economizer, air preheater and bagasse drying to maximize waste heat recovery and the elimination of the evaporator condenser for maximum process heat economy, together with other unconventional measures for reducing power as well as heat load in direct consumption white sugar manufacture.

The development of the S.R.I. light duty feeder. D. S. Shann. *Proc. 16th Congr. ISSCT, 1977, 2347-2361.* The development of the theory of pressure distributions on mill feed chutes is discussed and practical experimentation described. The further theory of the action of a pair of feeding rolls directing feed into a closed chute linking feeder and mill proper is discussed, and various equations for forces and torques are developed. The emergence of an effective low-cost feeding device is described and some practical operating data given.

Bagasse drying—a comparison with other methods of waste heat utilization. S. K. Ghosh. *Proc. 16th Congr. ISSCT, 1977, 2363-2373.*—Suggestions have been made for the drying of bagasse using heat from boiler flue gas, the object being to reduce the heat loss inherent in the presence of moisture in the bagasse. It is a reduction of sensible loss rather than of condensation loss that occurs in such drying of bagasse which must therefore stand comparison with other methods of waste heat recovery, viz. the use of economizers and air preheaters. An attempt is made in the paper to analyse carefully the thermal gain by each of the relevant methods so as to place bagasse drying in proper perspective, and it is concluded that, unless warranted by specific conditions or exigencies, bagasse drying is less economical than the other two measures.

Continuous thickening and rotary vacuum filtration of first carbonated cane juice in India. N. N. Joshi, S. K. Goel and R. M. Rahul. *Proc. 16th Congr. ISSCT, 1977, 2389-2400.*—A semi-commercial scale continuous thickening and filtration plant was installed at Mawana Sugar Works and, on the basis of its successful operation, equipment suitable for 2500 t.c.d. was installed in 1972 at Mawana and also at Daurala Sugar Works. The installations comprised two "RapiDorr 444" thickeners and three Dorr-Oliver rotary vacuum filters of 3 m dia. and 4.3 m length. Operational experience with the equipment is described and the benefits discussed.

Heater designs for the cane sugar industry. A. Valdés D. *Proc. 16th Congr. ISSCT, 1977, 2401-2413.* Comparisons were made between six types of juice heater in respect of heat transfer coefficient, juice pressure drop, space occupied, area subject to radiation losses and cost of construction. Of the tube heaters evaluated, the multiple horizontal two-pass design proved to be best for heating mixed juice because it offers the highest heat transfer coefficient during operation with the lowest pressure drop while taking up a fairly small horizontal space with no great amount of

surface subject to radiation losses and low construction cost. From a technical standpoint, however, a vertical direct-contact design offers better results than any of the tube heaters because it has the highest heat efficiency, no pressure drop through the equipment, the least surface for radiation and lowest construction costs. It also occupies less floor space and needs no control station; nevertheless, use of this type of heater is conditional upon the capacity of the evaporator station.

Introduction of basic automation in a traditional sugar mill. Some ideas and suggestions. V. A. F. I. Isoldi. *Proc. 16th Congr. ISSCT, 1977, 2415-2417.*—Because of the inter-relationships between performance of different stations in a cane sugar factory it is suggested that automation should be introduced at the very beginning of operation, i.e. for cane feeding, and gradually extended to other stations through the process. A system employing sensing fingers to control carrier speed, and the use of a number of mass-sensing devices is briefly outlined.

Effect of larger-sized grooves and of imbibition on the extraction of juice. F. Serna S. *Proc. 16th Congr. ISSCT, 1977, 2419-2425.*—An increase in extraction obtained at Ingenio Tamazula during the 1975/76 season is attributed mainly to improved cane preparation, increase in mill roller diameter, increase in the pitch of the grooves and changed included angle, use of welding in the mill rollers, application of hydraulics to the mills to improve flotation of the rollers, increase in the compound imbibition, improvements in the intermediate carriers, adequate adjustment of the mill rollers and turnplates, and adequate hydraulic pressures and loading on the mills.

True continuous crystallization. I. Design stages. II. Industrial application. F. Langreny. *Proc. 16th Congr. ISSCT, 1977, 2427-2443.*—The development of the Langreny continuous pan¹ and the trials at Beau Champ and Stella sugar factories are described and the impact of continuous boiling on cane sugar processing is discussed. Continuous boiling requires a smaller pan volume and reduces the amount of auxiliaries such as pumps, storage tanks, receivers, etc., although control equipment is essential (but is normally available in modern factories with conventional pans) and a perfectly stable supply voltage must be ensured. The specific crystallization rate is higher and a harder crystal is formed in a continuous pan, which can also operate with low-temperature heating steam and so produce less melassigenic substances, to give better molasses exhaustion and improved sugar recovery. With good circulation and optimum supersaturation levels throughout the pan, crystallization rates are very high, with better quality sugar and higher recovery. A system for a three-stage boiling scheme using continuous pans is illustrated and the advantages outlined.

A new continuous clarifier. L. A. R. Pinto. *Proc. 16th Congr. ISSCT, 1977, 2445-2457.*—An account is given of the development of a new continuous clarifier which, installed at Usina Santa Lydia in Brazil, operated during the last 65 days of the 1976 season and gave

brighter juice with less flocculant use than with conventional multi-tray clarifiers while demonstrating a doubled capacity, halved retention time and a greater time during which juice could remain without the need for liquidation when milling was interrupted. The only disadvantage was a lower mud density than with a multi-tray clarifier. The new design includes three concentric zones; in the first and innermost, juice flows downwards and foam and bagacillo are separated by flotation while sand and heavy particles sink to the bottom of the housing. In the second zone the juice flows upwards and small mud particles are agglomerated with larger, downward-moving particles, sinking with them to the sump. The outermost zone surrounds the upper part of the second zone and is provided with a number of slightly-dished annular trays; juice flows horizontally between these and exits through draw-off points at the top of the clarifier and just beneath the tray circumferences. Particles settle on the trays and slide inwardly towards the second zone into which they fall. The mud and sand is removed from the sump while bagacillo, etc. passes into an overflow chamber connected to a second discharge pipe.

Separation of fly ash and other solid wastes from factory effluents by combined decanting and sieving over a precoated screen. S. Marie-Jeanne. *Proc. 16th Congr. ISSCT, 1977, 2459-2467.*—Separation of solids from wet flue-gas scrubber effluent and filter cloth washings is achieved by means of a subsider and a DSM screen. Waste water at the rate of $9.0 \text{ m}^3 \cdot \text{hr}^{-1}$ is handled per m^2 of settling area and yields a supernatant containing $0.4 \text{ mg} \cdot \text{cm}^{-3}$ undissolved solids. Precoating of the DSM screen enables the subsider underflow to be dewatered, to yield a disposable cake containing 81-83% moisture.

Effect of green and dry trash on cane and milling qualities. S. El-N. A. Hemaida, G. El-K. Sayed and A. A. El-Badawi. *Proc. 16th Congr. ISSCT, 1977, 2485-2492.*—Samples of 30 kg of clean trashed cane, with and without added green or dry trash up to 7.5% on net cane, were crushed in a small three-roller mill and the effects of the trash examined. Green cane up to 7.5% had no ill effect on either mixed juice or sugar extraction, although dry trash significantly reduced both. Both green and dry trash increased the final bagasse % cane, dry trash having the greater effect, and slightly lowered sugar % final bagasse. The sugar loss in bagasse % net cane increased significantly in linear relationship to the added trash. Dry trash markedly increased the Brix, sucrose content and glucose ratio in mixed juice, while both kinds of trash significantly lowered the mixed juice purity in linear proportion to the amount of trash. Both also increased the total non-sugar soluble solids and ash content of the mixed juice with dry trash having a greater effect, while green trash raised the total N content of the mixed juice. The presence of trash significantly increased the sugar loss in molasses, the effect being much higher with dry trash. Every 13.4 kg of dry trash or 36.9 kg of green trash milled with one tonne of net cane caused an estimated loss of 1 kg of sugar.

¹ *J.S.J.*, 1977, 79, 310-314.

Treatment of sugar mill waste waters. R. R. Bathgate, J. S. Keniry and A. W. Strong. *Proc. 16th Congr. ISSCT, 1977, 2509-2517.*—The system installed at Victoria Mill, Australia, for the treatment of waste waters is described and the design concepts and operating procedures are discussed. The system involves two-stage treatment of wastes, in well-mixed ponds, each with sludge recycle. The first or primary stage is equipped with two small surface aerators and operates in a mainly anaerobic condition with pH control and nutrient addition. The second stage is an aerobic activated sludge system. A third pond is provided for pre-treatment of strong wastes prior to discharge to the primary pond. Retention time in the primary pond is approximately 24 hours and slightly longer in the secondary pond. Suspended solids concentrations in each pond are controlled at about 2.5 mg.cm^{-3} with excess sludge disposed of on surrounding grazing land. In the 1975 season the system handled an average daily volume of 3598 m^3 of waste containing on average 0.949 mg.cm^{-3} and yielded final effluent containing on average 0.026 mg.cm^{-3} BOD and 0.058 mg.cm^{-3} suspended solids.

Cooling and reheating C-masseccutes with extended suface elements. E. E. A. Rouillard. *Proc. 16th Congr. ISSCT, 1977, 2519-2536.*—Equations for predicting the power consumption and overall heat transfer coefficients in crystallizers stirred with finned tubes with their axes parallel to the axis of rotation are presented. These equations, which take into account the physical properties of the masseccute as well as the geometry of the crystallizer, were developed from experiments carried out using a pilot plant size apparatus. Similar equations are presented for the friction loss and overall heat transfer coefficient in reheaters equipped with finned tubes. These equations were developed from measurements taken on industrial installations. It is shown that a staggered tube configuration gives a higher overall heat transfer coefficient than an in-line arrangement.

Some problems and consequences of the evaluation of the transfer efficiency of cane diffusers. G. V. Genie. *Proc. 16th Congr. ISSCT, 1977, 2537-2547.* See *I.S.J.*, 1978, **80**, 259-263.

Effect of preharvest burning on cane and milling qualities with elapse of time after burning and/or cutting. G. El-K. Sayed, S. El-N. A. Hemaida and A. A. El-Badawi. *Proc. 16th Congr. ISSCT, 1977, 2549-2562.*—Burnt standing cane gained in weight with elapse of time after burning whereas both burnt and unburnt cut cane suffered weight losses, the former to a greater extent. Burnt standing cane showed the best milling qualities. In both burnt and unburnt cut cane, both juice and sugar extraction decreased while final bagasse % cane and the amount of sugar lost in bagasse increased. Mixed juice quality showed no change in burnt cut cane, while in unburnt cut cane a drastic decrease took place after two days. Burnt standing cane showed a continuous drop in Brix and sugar % mixed juice with constant non-sucrose soluble solids % Brix. In unburnt cut cane both Brix and non-sucrose solids increased while sucrose % juice decreased. The Brix and sucrose increased substantially but non-sucrose solids increased slightly in the burnt cut cane. The sugar % cane and theoretical sugar yield showed a continuous marked drop after the first day of burning in

the burnt standing cane. In the unburnt cut cane the decrease was clear after two days while the burnt cut cane exhibited a continuous marked increase until the end of the test period (8 days). The theoretical sugar yield in tonnes per feddan (4200 m^2) decreased by 0.1, 0.44 and 1.64 tonnes in the burnt standing, burnt and unburnt cut cane, respectively, after 8 days from burning and/or cutting. The unburnt cut cane deteriorated much more rapidly than the burnt cane whereas the burnt standing cane suffered the least deterioration losses.

The application of a lithium tracer method to residence time studies in a sugar factory. P. G. Wright and R. Broadfoot. *Proc. 16th Congr. ISSCT, 1977, 2569-2580.*—The use of a lithium salt as a tracer in residence time studies on sugar factory equipment is described, and its application to evaporators, continuous vacuum pans and continuous cooling crystallizers is discussed. The method has several significant advantages over other tracer methods, as long as a good quality flame emission photometer is available for the rapid analysis of the output samples. Some examples of the application of the method to continuous pans and crystallizers are given, and some techniques for the reduction and interpretation of the results of tests are described.

The behaviour of moisture migration and sugar caking. C. J. Lu, E. H. Hsu and H. C. Tseng. *Proc. 16th Congr. ISSCT, 1977, 2599-2611.*—A statistical analysis was undertaken to gain better understanding of the interrelationship between equilibrium relative humidity, non-sugar content and crystal size, etc. and caking of sugar. Moisture migration was identified as the most important factor in conducting caking. Loss of water on a change to a lower equilibrium moisture level is linearly related to the degree of caking and this loss should be limited to less than 0.3% for raw sugar or 0.06% for white sugar if caking is to be avoided. An empirical formula and nomograph are presented to display the behaviour of the equilibrium moisture content of raw and white sugar in relation to temperature, atmospheric relative humidity and reducing sugars content. From the amount of water loss, which can be directly located in the nomograph, it can be predicted whether conditions are suitable for storage without caking. Ways of maintaining good keeping quality of sugar in storage are recommended.

Continuous low grade masseccute boiling studies. R. Broadfoot and J. R. Allen. *Proc. 16th Congr. ISSCT, 1977, 2667-2677.*—The progress of studies on continuous boiling at the Sugar Research Institute, Mackay, is described both on a theoretical basis and using a single-cell unit built by Evans, Deakin Industries. These have shown that a considerable improvement in production rate per unit of installed volume is possible in a continuous unit but at the cost of an inevitable wider spread of crystal sizes. Use of a batch seed material would allow a good quality masseccute to be produced, however. A mathematical model of continuous crystallization has been used to provide a better understanding of the process and the influence of the operating and design variables on the performance of such a unit.

The occurrence of lactic acid and associated microorganisms in cane sugar processing. L. McMaster and A. B. Ravnö. *Proc. 16th Congr. ISSCT, 1977, 2679-2693.*—Results obtained from a three-year survey of the

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lactic acid and associated bacterial levels at various sugar factories in Natal are presented. Preliminary research involved establishing a suitable method for the qualitative and quantitative determination of lactic acid in various process streams. The relationship between sucrose lost and lactic acid produced was investigated and an average weight ratio of 2:1 is postulated. It was also confirmed that lactic acid is the principal organic acid formed on the fermentation of sucrose by thermophilic bacteria. The results from the surveys at the various factories indicate that, while lactic acid is absent from freshly harvested cane, it is usually to be found in the incoming cane by the time it reaches the mill. Further lactic acid is formed by bacterial fermentation at the expense of sucrose during juice extraction, especially in the case of diffusion processes. Various methods for inhibiting the production of lactic acid are discussed. Quantitative lactic acid balances indicate that most of the lactic acid present in mixed juice ends up in the final molasses, presumably as calcium lactate.

Use of an enzyme from barley malt for the removal of starch in sugar house products. S. Bose, K. C. Mukherjee and L. Singh. *Proc. 16th Congr. ISSCT, 1977, 2695-2700.*—Studies have been made of the effect on the starch content of cane juice, raw sugar and sweet sorghum juice of an α -amylase prepared from barley malt. Up to 77% removal was effected in cane juice, up to 44.2% with raw sugar syrup and up to 96.9% with sorghum juice, the degree of removal depending on both the initial starch content and the amount of enzyme employed.

Some aspects of cane quality affecting mill processing. P. C. Ivin and D. H. Foster. *Proc. 16th Congr. ISSCT, 1977, 2701-2710.*—The work carried out in Australia on the factors affecting cane deterioration and causing difficulties in processing is surveyed and recent work on the deterioration rates and dextran contents of short (<250 mm) and long (>250 mm) billets in chopper-harvested burnt cane and green cane is reported. They confirm earlier work and the authors conclude that the present emphasis in Australia on producing long sound billets, free of extraneous matter and quickly transported to the factory, is well placed. Green cane harvesting appears to have a potential for further reducing the effects of *Leuconostoc* infection, especially where there is danger of delays due to mill breakdown or to weather conditions. However, further investigations will be necessary to examine the nature of the deterioration process in green cane as compared with burnt cane.

Development of a continuous centrifugal for white sugars. D. Hoks. *Proc. 16th Congr. ISSCT, 1977, 2711-2727.*—In continuous centrifugals currently employed, crystals are damaged by movement over each other during passage along the conical or drum basket and by striking the wall of the housing when discharged. Stork-Werkspoor Sugar B.V. have patented a continuous centrifugal for white sugar which retains the benefits of continuous operation (lower maintenance and power cost, absence of power peaks, less noise, etc.) but also has beneficial aspects of batch operation (crystals motionless during spinning, and sequential separation, washing, drying and discharge). This is achieved by use of a conical basket with an internal feed, wash and discharge system rotating at a different speed from the basket (arranged by means of a planetary gearbox). The new machine has been tested in a sugar refinery with a comparable automatic batch centrifugal. The ash content of the sugar produced was virtually identical

while colour was slightly less and moisture content only 0.23% vs. 1.00%. Crystal breakage was less than 2%, while the run-off Brix and purity were 77.5° and 92.4 against 75.0° and 91.8 for the batch machine. Power consumption of the continuous centrifugal was 2.7 kWh per tonne of sugar.

Use of ion exchange in cane sugar processing. F. X. Pollio and F. X. McGarvey. *Proc. 16th Congr. ISSCT, 1977, 2729-2742.*—It is shown how the Gryllus process, developed for the beet sugar industry, could be applied in cane sugar processing, and a cost balance is drawn up. Decolorization of sugar liquors by a combination of gross decolorizing resins and polishing resins is discussed, and the application of resins in the direct production of liquid sugars is mentioned.

Mill sanitation—a fresh approach to biocide evaluation. R. H. Tilbury, B. S. Hollingsworth, S. D. Graham and P. Pottage. *Proc. 16th Congr. ISSCT, 1977, 2749-2768.* In laboratory tests using a synthetic cane juice, 14 biocides were compared for control of sugar factory micro-organisms, while factory trials were carried out in Trinidad, South Africa and Kenya on four of the biocides. Quaternary ammonium compounds were the most effective in the laboratory trials and it was shown that the rate of sugar loss in naturally contaminated real mixed juice could be reduced by up to 58%. Addition of slime from the mill substantially increased sucrose loss. The proportions of the total loss due to chemical inversion, enzymic inversion and microbial growth were 13%, 25% and 62%, respectively. The trials in Trinidad were at Brechin Castle factory which has two identical tandems. Normal "good housekeeping" operated on both, but one tandem received shock doses of biocide, 25% on the bed of prepared cane and 75% added to juice under the 3rd mill. A polymeric biguanide at 5 ppm resulted in sugar savings of 0.74 kg.tonne⁻¹ of cane whereas a quaternary ammonium compound saved 0.34 kg.tonne⁻¹. Statistical analysis showed that results were significant using changes in reducing sugars % Brix as the criterion, less significant using true purity and not significant using apparent purity. To avoid some of the difficulties associated with assessment of factory trials, experiments were made with a model mill fed with real juice. Biocides were tested in the model at dose rates of 20 ppm on juice. Savings of up to 60% of sugar loss could be demonstrated. It was concluded that biocide addition is of significant benefit in cane mills but choice of the best chemical remains inconclusive.

Maximizing the elements of incentive and equity in a general cane payment system. E. J. Buchanan. *Proc. 16th Congr. ISSCT, 1977, 2769-2786.*—This paper states the basic requirements for an efficient cane payment system based on experience in South Africa. Alternative systems for applying incentives to individual growers and millers are analysed and a novel system proposed for applying strong but equitable incentives to growers is proposed. This aims severe penalties at cane which has excessively high fibre:pol and non-pol:pol ratios which are characteristic of cane having high extraneous matter and deteriorated cane. Alternative formulae for relative cane payment are compared mathematically, reasons being given for adopting the system recently applied in South Africa. Changes in the cash flow pattern to growers under relative payment are described.

TRADE NOTICES

Cane carrier durability improvement. Ewart Chain-belt Co. Ltd., Derby, England DE3 8LX.

One solution to the gruelling treatment of the cane carrier during a complete season is the use of a heavy-duty overlapping apron conveyor with large diameter rollers mounted outboard of the conveyor's side plates, clear of possible spillage and immediately accessible for maintenance. Such a "Cobra" installation is employed at Monymusk sugar factory in Jamaica where, operating at 120 ft centres, the carrier consists of a horizontal and an inclined section and received hand-cut cane direct from the washers, carries it under a set of knives and elevates it to a further conveyor which feeds the mill. Working round the clock, $6\frac{1}{2}$ days a week through most of the harvesting season from December to early September, the 84-inch wide carrier runs at an average speed of 60 ft.min⁻¹. This speed varies continually, however, to control the flow of cane to the mill, creating additional operating stresses. The National Sugar Company's technical services division considers that the "Cobra" system could last indefinitely under normal conditions at other Group-owned mills; even where washing of cane is necessary, as at Monymusk, greatly increasing problems of abrasion and corrosion, only chain pins have needed replacing over several seasons' operation.

New pH control system. Tate & Lyle Process Technology Ltd., 55 Liddon Road, Bromley, Kent, England.

The new Duplex juice pH control system is the result of extensive field trials and, while it is applicable to any industrial process requiring pH measurement, in the case of cane sugar manufacture is intended to provide brilliant juice from the clarifier by maintenance of a steady selected pH value, obtained by automatically dosing lime slurry to the main juice stream. The addition of lime is made via a splitter box assembly, which is especially designed to give freedom from blockage, into a stirred reaction tank which discharges into the limed juice tank. A small proportion of the output flow from the reaction tank is recirculated through a pH measuring unit which comprises a dual set of dip-type electrodes mounted in a stainless steel weir assembly. The high flow through the electrode assembly ensures that the electrodes remain clean.

A major development has been the fitting of a head amplifier to the electrodes which eliminates noise and moisture problems on cabling, making possible the separation of the system's free-standing console from the pH weir box assembly without the risk of false readings through interference. The pH signal obtained is fed to a measuring system housed in the console, while compensation is automatically applied for flow rate changes in the juice supply so that over-liming cannot occur in the event of mill stoppage. The console consists of a number of plug-in modules to give twin measuring systems, and a single electric actuator

control. These units are linked so that whilst one is controlling the process the second (standby) system is automatically adjusted and tracks the controlling system. Thus the changeover between systems can be made without disturbance to the process under control, guaranteeing very high reliability.

A chart recorder gives continuous pH read-out and high and low alarms are provided, whilst a digital panel meter gives an instantaneous indication of juice pH. Control of the lime splitter box is made by the electric actuator positioning module, while limit switches on the splitter are interlocked to the central alarm system. It is intended to develop an in-line measurement system to replace the weir assembly.

PUBLICATIONS RECEIVED

MHEA pocket guide. Mechanical Handling Engineers' Association, 16 Dartmouth Street, London, England SW1H 9BL.

The Guide is a directory of the Association, which provides names, addresses, telephone and telex numbers of members of this body, with fold-out tables showing which designers and contractors offer particular products and services from a total of 80, ranging from aerial ropeways to warehousing and distribution systems.

United Erectors. United Erectors, Laxmi Park Colony, Pune, India 411 030.

This booklet is an illustrated record of the production capabilities of this Indian company which is built on its experience, originally in Uganda but since the 1972 coup back in India, and is now able to plan, erect and commission high pressure steam generators, electrical control systems, cane mills, multi-storeyed buildings, vacuum pans, centrifugals and water pipelines, as well as the "Saturne" cane diffuser fabricated under licence from Sucatlan Engineering of France.

Fletcher and Stewart diversification.—A new activity has been added to those of Fletcher and Stewart Ltd. by creation of the Process Systems Division. The new division is actively engaged in the design, manufacture and installation of machines and unit equipment for a variety of industries within the materials processing field, including sampling systems; fine grinding, batching and blending of materials; and lime hydration plant. The Division is also able to offer complete plant and systems for automated cashew nut decortification.

Renold Group centenary.—The Renold Group of companies celebrates its centenary in 1979. In one hundred years, Renold has grown from a back street workshop in Salford into a world-wide group of 26 companies, employing some 13,000 people in 28 factories spread across four continents and backed by a network of over 400 distribution centres in more than 100 countries. Renold is a recognised world leader across the whole field of power transmission engineering and claims the distinction of having become the world's largest single group specializing in products for power transmission and mechanical handling, with important interests in other branches of engineering—making sophisticated machine tools, pharmaceutical machinery and specialized equipment for the metal industries. The company was founded by Hans Renold, a young Swiss engineer whose brilliant engineering in his chosen field of precision chain manufacture, anticipation of trends in the mechanization of industry, and confident handling of his business opportunities laid the foundations on which the Renold group was built. 1979 is also an important milestone in the history of power transmission engineering, significant for the way in which the leading company in transmission by precision chain developed into the present Group through mergers with other pioneers and leaders in Britain's development of gears, couplings, clutches and other devices for precision power transmission in industry. Renold is now looking to a future in which many industrial drives will be increasingly subject to remote or automatic control, with parallel advances in the demand for precise and continuous speed monitoring and drive synchronization and it is in these new fields that the Group expects its future advances to take place.

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

UK 29th National Sugar Beet Spring Demonstration

TWELVE precision drills and a record number of twenty-four tractor hoes have been entered for this year's Sugar Beet Spring Demonstration to be held at Brome, near Eye, Suffolk, on Wednesday, May 24.

The operating machinery includes several newcomers—two drills and eight tractor hoes ranging from five to 15-row models. Drill performance assessments are being carried out as in previous years.

Sowing of the 70 hectare crop (173 acres) was completed on April 5 using a 15-row drill. Despite cold wet weather before and after drilling, seedling emergence prospects are good.

As well as the herbicide programme conducted by the commercial companies, plots have been prepared to illustrate and cost some of the many other combinations of chemicals available to the sugar beet grower in his attempt to achieve weed control throughout the growing season.

A wide range of other field trials and demonstration plots will be on view including sugar beet varieties, time and method of applying nitrogen, pest and disease control and wind damage prevention. In addition, plots simulating weed beet infestation have been prepared in order to draw more attention to this potential menace to sugar beet growing.

The weed beet problem is also highlighted in research and advisory exhibits which, together with chemical and machinery stands, total more than 100.

Visitors will be able to see the results of the field plots at Brome at the Autumn demonstration on October 25, when the main theme will be sugar beet tops saving.

Australian cane agriculture journal changes¹.—From March 1979 the magazine *Producers' Review* has ceased production by Strand Publishing Pty. Ltd., of Brisbane. The Editor, Mr. Bill Kerr, has joined the staff of the Queensland Cane Growers Council and will manage a new monthly magazine to be called the *Australian Cane Grower* and to be published by a Council subsidiary, QCGC Publications Pty. Ltd. The new magazine, of slightly larger format than the *Review*, will become the official journal of the Australian cane growing industry.

US upholds EEC sugar dumping allegation².—The US Treasury Department announced in early February that it found that sugar from Belgium, France and West Germany had been sold to US importers at less than fair value. A spokesman said that the case stemmed from an anti-dumping petition filed by Florida cane sugar producers and involved shipments totalling about 83,000 short tons during May-July 1978. The case will now be referred to the US International Trade Commission for a three-month investigation to determine if injury resulted to the domestic industry, he said. If injury is found, duties could be assessed on sugar shipments to the US from the three countries, starting February 12.

Afghanistan sugar factory.—Further details of the Afghanistan sugar factory contract for Fives-Cail Babcock announced earlier³ have been received. The factory will be at Baghlan, 30 km north of Kabul, and the turn-key plant will have a daily beet slicing capacity of 2000 tonnes with the possibility of later expansion to 3000 tonnes. The preliminary study and international tender were carried out by the Afghan Ministry of Mines and Industry with the collaboration of Tate & Lyle Technical Services Ltd. who as consultants will supervise the execution of the contract, and the factory is to go into operation in the autumn of 1980, covering a third of the country's sugar demand. Beets will be supplied from an area which is an extension of that for the present small factory at Baghlan.

Taiwan sugar exports, 1978⁴

| | 1978 | 1977 | 1976 |
|-----------------------|-------------------|---------|---------|
| | tonnes, raw value | | |
| Guam | 0 | 327 | 411 |
| Hong Kong | 1,909 | 6,407 | 7,569 |
| Indonesia | 10,870 | 11,957 | 0 |
| Japan | 165,635 | 296,746 | 225,242 |
| Korea, South | 136,534 | 160,478 | 107,871 |
| Malaysia | 0 | 31,464 | 0 |
| Morocco | 0 | 0 | 14,705 |
| Portugal | 0 | 0 | 12,969 |
| Saudi Arabia..... | 10,870 | 65,981 | 52,176 |
| Sri Lanka | 0 | 9,264 | 9,264 |
| USA..... | 51,476 | 78,227 | 78,882 |
| Other countries | 678 | 0 | 0 |
| | <hr/> | <hr/> | <hr/> |
| | 377,972 | 660,851 | 509,089 |

Brazil sugar technologists association meetings. STAB-SUL, the Southern Region of the Sociedade dos Técnicos Açucareiros do Brasil, held a Symposium in Ribeirão Preto in September 1978 on "Cane industrialization for production of sugar and alcohol" and it is intended to publish abstracts of the papers presented in due course. The Region will be holding further meetings during 1979, including one on May 18 concerned with the manufacture of aguardiente or cane brandy, at Sertãozinho, another on sugar and alcohol manufacture on July 27 at Barra Bonita, and a third in the form of a seminar organized by manufacturers of equipment and engineering companies which will be held at São Pedro, near Piracicaba, on October 18-19. The first national Congress of the STAB was held at the beginning of the year and 84 papers were presented covering both field and factory topics to the approximately 800 members attending.

Canada beet sugar campaign, 1978/79⁵.—A total of 117,340 tonnes of sugar were produced in the 1978/79 campaign in Alberta, Manitoba and Quebec, as against 127,790 tonnes in 1977/78. The beet area had been reduced from 63,059 acres in 1977/78 to 60,535 acres in 1978/79.

Levulose and levan production from sucrose⁶.—A new process for manufacture of high-levulose syrups from sucrose has been announced by CPC International. A fructosyl transferase enzyme obtained from *Pullularia pullulans* is used for the transfructosylation of sucrose to give a levulose (fructose) polymer-containing substrate which is particularly suitable for the production of syrups containing more than 55% of levulose. The enzyme acts on the sucrose in solution at pH 5.5 and 58°C and some of the dextrose formed is isomerized to levulose at the same time, using an enzyme derived from *Streptomyces olivochromogenes*, immobilized on porous alumina. The levulose polymer may be hydrolysed to its monosaccharide components by enzymatic means or by acid hydrolysis if required, to give a high-fructose syrup (about 60% levulose, 36-38% dextrose and the remainder oligo- and polysaccharides). Alternatively the polymer may be separated from the syrup and hydrolysed to give a very high fructose syrup of preferably above 90% levulose content.

Alcohol from bagasse in the US⁷.—The US Dept. of Agriculture has approved a loan for a joint venture by subsidiaries of US Sugar Corporation and Savannah Foods Corporation to build a plant in Clewiston, Florida, to convert bagasse into alcohols for industrial purpose. The project will involve initial pilot and engineering work at Purdue University, followed by construction of a commercial-scale plant at Clewiston.

¹ *Producers' Review*, 1979, 69, (1), 13.

² *Public Ledger*, February 10, 1979.

³ *I.S.J.*, 1979, 81, 99.

⁴ F. O. Licht, *International Sugar Rpt.*, 1979, 111, S33.

⁵ C. Czarnikow Ltd., *Sugar Review*, 1979, (1427), 32.

⁶ F. O. Licht, *International Sugar Rpt.*, 1979, 111, 83.

⁷ *Westway Newsletter*, 1979, (63), 16.

U.K. sugar imports and exports¹

| IMPORTS | 1978 | 1977 | 1976 |
|--------------------------|-------------------------|------------------|------------------|
| | tonnes, <i>tel quel</i> | | |
| Australia | 28,601 | 49,485 | 135,720 |
| Barbados | 39,612 | 21,814 | 0 |
| Belgium/Luxembourg | 696 | 1,520 | 16,258 |
| Belize | 41,894 | 47,090 | 44,092 |
| Brazil | 9,390 | 67,724 | 89,938 |
| Congo | 5,047 | 0 | 0 |
| Costa Rica | 0 | 56 | 0 |
| Cuba | 0 | 0 | 133,228 |
| Cyprus | 0 | 4,625 | 640 |
| Czechoslovakia | 0 | 10 | 558 |
| Denmark | 90,523 | 91,466 | 87,643 |
| Dominican Republic | 0 | 0 | 12,192 |
| Fiji | 169,896 | 194,419 | 132,666 |
| France | 58,518 | 109,231 | 103,512 |
| Germany, West | 36,640 | 52,830 | 45,731 |
| Guyana | 178,244 | 161,825 | 192,281 |
| Holland | 37,411 | 19,801 | 10,171 |
| India | 23,791 | 27,469 | 09,193 |
| Ireland | 26,586 | 47,241 | 27,860 |
| Jamaica | 138,887 | 131,420 | 148,175 |
| Kenya | 0 | 64 | 3,159 |
| Leeward Is. | 17,589 | 15,172 | 15,703 |
| Malawi | 15,510 | 20,456 | 11,099 |
| Mauritius | 461,191 | 495,965 | 497,467 |
| Mozambique | 0 | 0 | 61,959 |
| Philippines | 0 | 0 | 32,354 |
| Réunion | 37,411 | 84,725 | 19,333 |
| South Africa | 41,801 | 2 | 12,751 |
| Surinam | 1,611 | 427 | 0 |
| Swaziland | 126,540 | 99,199 | 99,554 |
| Switzerland | 9 | 16 | 4,515 |
| Tanzania | 20,430 | 10,603 | 10,292 |
| Thailand | 0 | 0 | 13,584 |
| Trinidad & Tobago | 56,888 | 90,427 | 75,325 |
| Uganda | 2,415 | 3,162 | 0 |
| USA | 16 | 229 | 18 |
| Other countries | 2,391 | 330 | 65 |
| | 1,669,539 | 1,848,803 | 2,078,036 |

EXPORTS

| | | | |
|----------------------------|---------------|----------------|----------------|
| Algeria | 0 | 0 | 3,992 |
| Cyprus | 1,024 | 3,494 | 6,363 |
| Germany, West | 780 | 890 | 269 |
| Ghana | 999 | 131 | 2,894 |
| Greece | 10 | 2 | 5 |
| Hong Kong | 0 | 1 | 1,762 |
| Iceland | 62 | 448 | 676 |
| Iran | 182 | 887 | 154 |
| Iraq | 0 | 0 | 12,000 |
| Ireland | 2,464 | 3,160 | 14,552 |
| Israel | 246 | 7,951 | 16,969 |
| Ivory Coast | 19 | 31 | 1,987 |
| Jamaica | 1 | 7 | 5,141 |
| Jordan | 17 | 63 | 4,229 |
| Kenya | 1 | 83 | 22,988 |
| Kuwait | 3 | 53 | 2,472 |
| Lebanon | 3 | 14,864 | 6 |
| Leeward Is. | 300 | 458 | 0 |
| Malta | 1,156 | 634 | 1,865 |
| Morocco | 0 | 1,046 | 0 |
| Nigeria | 23,463 | 21,390 | 21,512 |
| Norway | 38,818 | 32,889 | 49,840 |
| São Tomé—Príncipe | 1,500 | 301 | 400 |
| Saudi Arabia | 1,024 | 972 | 18,033 |
| Sierra Leone | 1,403 | 611 | 3,150 |
| Switzerland | 836 | 34,746 | 17,418 |
| Tunisia | 5,340 | 23,914 | 32,255 |
| United Arab Emirates... .. | 933 | 1,716 | 0 |
| Venezuela | 0 | 0 | 5,700 |
| Windward Is. | 1,076 | 1,437 | 2,315 |
| Yemen, North | 0 | 6,600 | 1 |
| Yemen, South | 1 | 1 | 5,688 |
| Other countries | 3,966 | 5,124 | 7,502 |
| | 85,627 | 163,904 | 262,139 |

BREVITIES

US beet sugar factories for sale².—U & I Inc., formerly Utah-Idaho Sugar Co., announced on November 20, 1978, that its sugar factories (at Garland and Idaho Falls, Idaho, and Toppenish and Moses Lake, Washington) and terminal facilities are for sale. As with other US beet sugar producers, the company has been losing money on its sugar manufacturing operations for some two years and, in the absence of stable conditions offered by new sugar legislation, has decided to give more emphasis to its other activities. Agreement in principle was reached on February 28, 1979, for sale of the two Washington factories to Washington Sugar Company, a newly-formed growers cooperative³, at a price of \$14.5 million but it was later announced⁴ that the deal had fallen through.

New rust disease of Queensland cane⁵.—The Director of the Bureau of Sugar Experiment Stations, Mr. Owen Sturgess, has confirmed that the outbreak of rust in late 1978 in North Queensland is not the common form of the disease which has been known in Queensland for a very long time but appears to be identical with a second rust disease present in Asia and Africa. Efforts are being made to identify the pathogen, which was probably brought to Australia in the form of wind-borne spores carried at high level from another continent. The symptoms are short linear brown spots on the leaves. They take on a pustular appearance on the underside of the leaf and the pustules burst open to release the powdery mass of brown spores which are dispersed by wind. Where large numbers of rust pustules occur on the leaves, the plant takes on a brown to reddish-brown colour. These rust-affected patches have been found in advanced young plant and ratoon crops but in relatively few blocks so far; mature crops have shown virtually no symptoms. Varieties on which the disease has been identified include Q82, Q90, Q91, Q99, Q105, Q106 and Q107. However, it is not possible to rate them for resistance because of the few valid comparisons available.

Mauritius distillery⁶.—A new distillery is to be built at Beau Plan, to begin operating at the end of 1979, increasing the production capacity of the Mauritius OK distillery company from 7000 to 20,000 litres per day. Animal fodder will be produced from the recovered yeast.

US beet area reduction⁷.—US beet growers in 14 major producing states which accounted for about 95% of the 1978 output, said they intend to reduce their 1979 acreage by about 11% from last year, according to the US Dept. of Agriculture. In a report on farmers' intentions as at January 1, the Department said that most states surveyed expect a decrease in this year's sowings; however, California, the second leading producing state in 1978, expects the beet area to increase by 4% to 215,000 acres. The area planted to beet in all states last year amounted to 1,312,000 acres, of which 1,273,500 acres was eventually harvested, yielding a crop of nearly 25.9 million short tons. The Department said that several beet sugar plants have announced that they are closing and will not receive 1979 crop beets. This is expected to result in a decline in beet area in Idaho, Oregon and Utah, while the beet crop in Washington state is in question because both factories in the state have indicated that they do not plan to operate in 1979.

¹ C. Czarnikow Ltd., *Sugar Review*, 1979, (1427), 34.

² *Sugar J.*, 1979, 41, (8), 7.

³ *Lamborn*, 1979, 57, 39, 44.

⁴ *ibid.*, 52.

⁵ *Australian Sugar J.*, 1978, 70, 438.

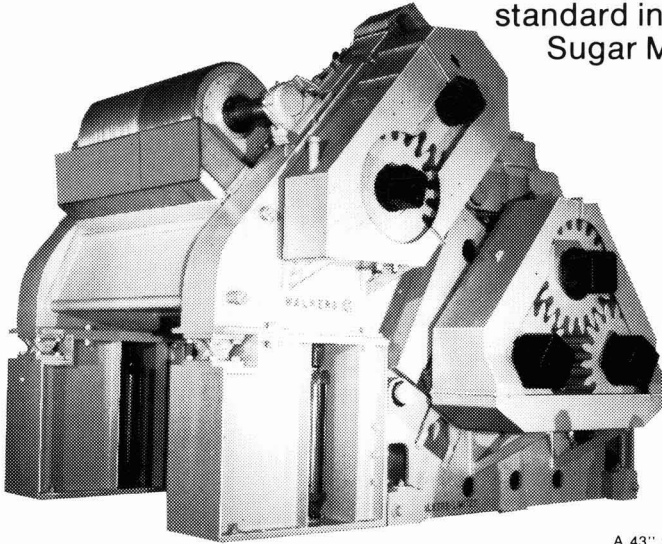
⁶ *Westway Newsletter*, 1979, (63), 16.

⁷ *Public Ledger*, January 24, 1979.

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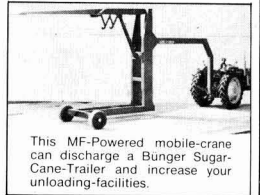


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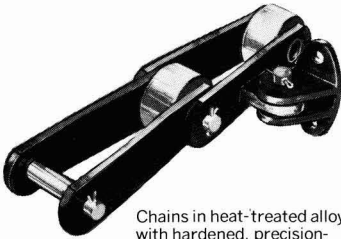
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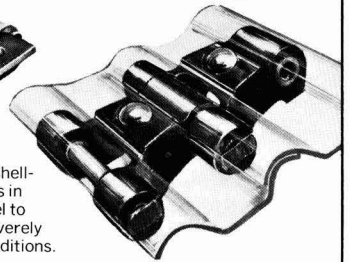
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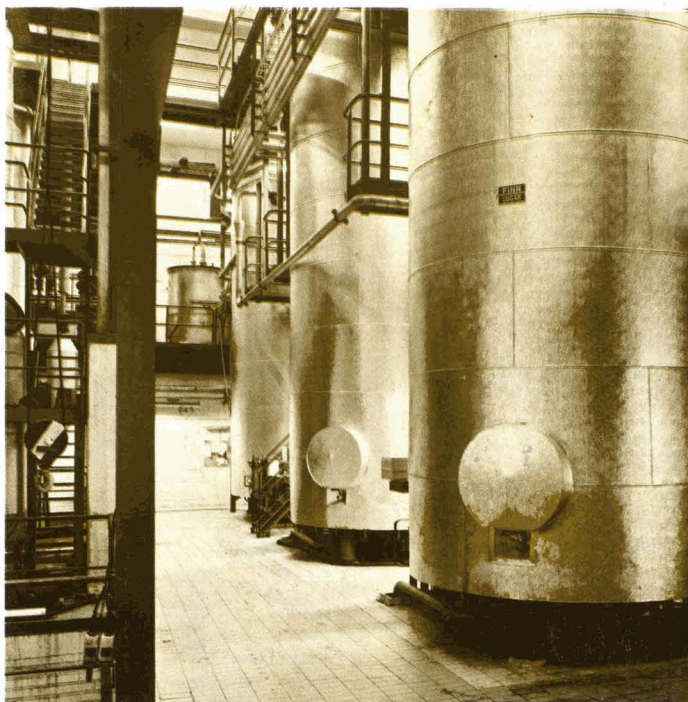
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