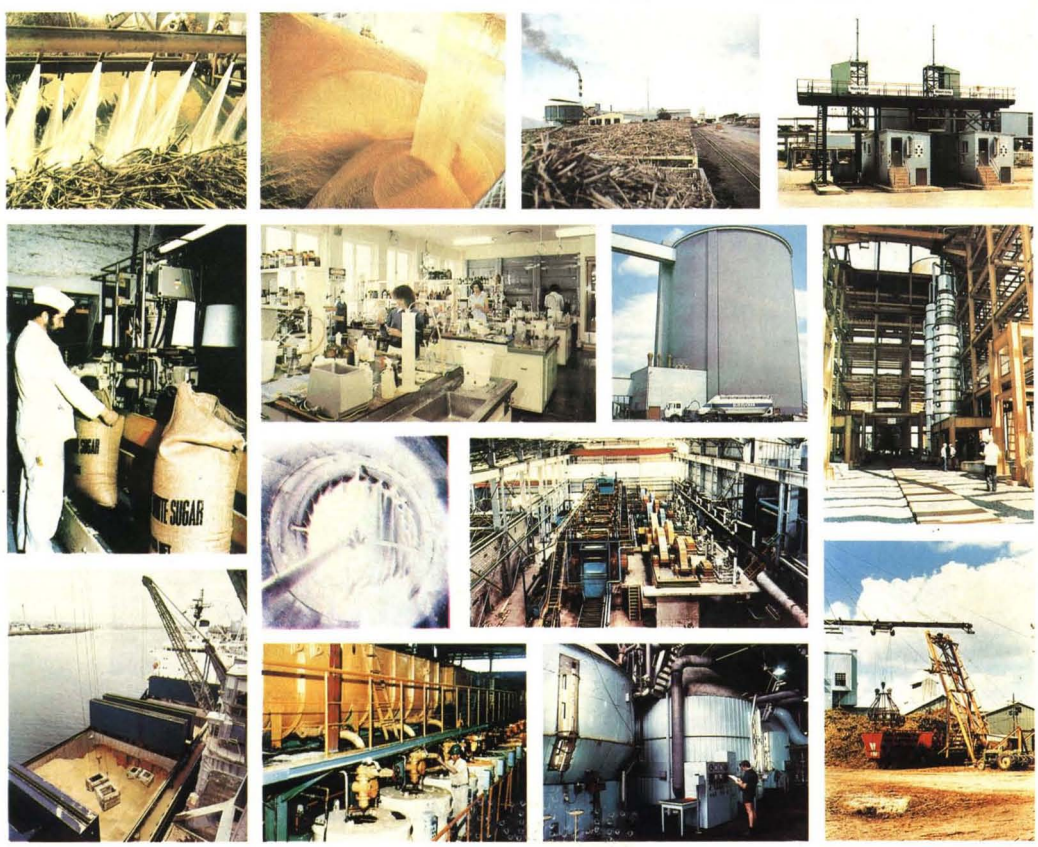
INTERNATIONAL SUGAR JOURNAL



VOLUME LXXXXII/ISSUE No. 1101 SEPTEMBER 1990

INTERNATIONAL SUGAR JOURNAL

UK ISSN 0020-8841
Volume 92
Issue No. 1101
September 1990

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Published by

International Media Ltd.

P.O. Box 26, Port Talbot, West Glamorgan SA13 1NX, U.K.
Telephone: +44-639-887498 *Telex:* 21792 REF 869 *Telefax:* +44-639-899830
US Office: 2790 Foster Avenue, Corning, CA 96021

Annual Subscription: £65.00 post free

Single Copies £6.50 post free

By Air: £32.00 extra

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News and views

World sugar prices

The London Daily Prices for both raw and white sugar rose sharply at the beginning of July when Cargill acquired most of the positions left open and Pakistan announced a tender for supply of 100,000 tonnes of white sugar. The LDP rose from $317.10 on July 2 to $327.10 on July 5, while the LDP(W) rose from $401.50 to $412 the next day but started to slide again almost immediately. The weakness was due to denials that the Cargill sales were for China or the USSR and also to selling by investment funds and F. O. Licht's estimate of an increased European beet sugar crop. Further reports of good coming crops and lack of purchases increased the weakness of market sentiment and the sugar prices continued to decline gently, to reach an LDP for raw sugar of $285.60 on July 31 and an LDP(W) of $374 per tonne.

E. D. & F. Man (Sugar) Ltd. comment[1] that: "An absence of appreciable buying interest other than routine offtake and the widespread opinion that both the 1989/90 and the 1990/91 seasons are expected to indicate a surplus of supply should keep prices in a lower range than of late. However, the overall statistical picture and stock position would not seem to indicate that market levels significantly lower than 10 cents/lb are warranted. It remains to be seen whether the recent drop will be sufficient to attract buyers back to the market and to eventually provoke a fall in production".

Philippines sugar expansion[2]

A sustained rise in sugar production is expected in the Philippines over the next two years. From 1.72 million tonnes estimated for 1989/90, output is expected to reach 1.90 million tonnes in the next season and 2.10 million tonnes in 1991/92, barring unforeseen natural disasters, which should allow the Philippines to regain a bigger share of the world market for its surplus. This projection by the Sugar Regulatory Administration is based on an expanded area of 311,000 hectares in 1989/90, up from 294,000 in 1988/89, and higher crop yields will help to boost output. Local consumption is expected to rise from 1,416,000 tonnes to 1,440,000 tonnes in 1990/91, while a government project of developing fuel alcohol from sugar also receives a share of 10,000 tonnes from the projected output.

Change in the USSR[3]

Agriculture accounts for 20% of the Soviet Union's GNP but, in spite of President Gorbachov's identification as a key area for reform, it performs dismally. Although, according to a report by *East Europe and China Agriculture and Food*, food processing and agricultural supplies swallow up 47.4% of the national budget, it yields an uninspiring rate of return. A significant improvement in the domestic supply of farm goods has been hampered by a general lack of technical and agricultural expertise as well as a drastic shortage of farming materials.

In the current year the area committed to beet is estimated at 3.29 million hectares, marking a decline of more than 400,000 ha over the past ten years. This decline has been offset to some extent by a slight improvement in yields. In the past few years, there has been increasing use of intensive cropping technology (ICT) - now estimated as applied to 90% of the beet area - which involves higher rates of input application and more intensive management to improve yields.

But Soviet farmers face a variety of problems; the period for planting and cultivation up to harvest is shorter than any other European country since severe winters result in a late spring and earlier winter. Despite some field mechanization the labour input remains high. Existing machinery is archaic compared with Western standards, sometimes with three machines to do the same work as a single Western harvester; such practices take their toll of the land. The machinery is difficult to maintain as there is a severe shortage of spare parts. Post-harvest losses arising from poor storage, processing and transportation methods have amounted to 11 - 12% of the crop in recent years. However, in spite of the large crop last season, losses in handling were claimed to be as low as 6%.

The process of converting beet into sugar is beset with problems at every stage. There is a severe shortage of trucks and railway rolling stock and, given the large distances which have to be covered, often on unsurfaced roads, it is not surprising that in most years there have been considerable delays in the delivery of beets to the factories as well as the distribution of sugar to consumers. Old equipment and working practices combine with severe winter weather to extend campaigns to 145-150 days. In the closing stages beets are processed from storage, where they deteriorate further in quality. It has been a long-term goal to reduce processing time but investment has tended to focus on upgrading capacity and has not resulted in increased productivity.

In 1988 the government launched a 5-year program to expand and re-equip the sugar industry's production base but there has been no improvement in the performance or durability of domestically produced machinery. Frequent servicing of equipment is commonplace owing to the large number of faulty components used. Few new designs of machinery are beyond the drawing board stage. At the beginning of this year the government ordered a study of sugar processing practices in order to reassess the industry's technological requirements.

As a means of encouraging higher farm production a system of hard currency payment was introduced last year; this does not apply to sugar beet, however, and farmers may well decide to switch out of beet to more financially attractive crops. Unless there is a more rapid improvement in crop yields and sugar recoveries this would add to import requirements by the USSR.

1 *The Sugar Situation*, 1990, (471), 1.
2 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 349.
3 *Czarnikow Sugar Review*, 1990, (1798), 91 - 93.

The Soviet food industry has, however, attracted some attention from Western businesses; a series of cooperation agreements has been concluded with foreign agro-industrial firms, one of which - Ferruzzi of Italy - has entered into agreements calling for an investment of some $550 million over the next three years. Sucden has negotiated to modernize sugar factories in the Ukraine as part of a $376 million agriculture cooperation scheme between the USSR and France. Foreign investors have been deterred by the USSR's shortage of hard currency stocks, insufficient and unreliable supplies of raw materials and, most importantly, by the uncertainties regarding repatriation of profits. As the economic system becomes more open and the control of key supply, distribution and marketing facilities is decentralized, Western industrialists are likely to respond in a more positive manner to the huge demand potential offered by the Soviet Union.

Brazil sugar and alcohol production plan, 1990/91[4]

Brazil has recently set its 1990/91 sugar and alcohol production targets. That for sugar production is 6,850,000 tonnes, tel quel, compared with a planned quantity of 6,987,000 tonnes and an actual production of 7,245,000 tonnes in 1989/90. Alcohol production has been set at 125.85 million hectolitres, compared with the 1989/90 target of 133.01 million hl and actual production of 119.61 million hl. The government estimates alcohol consumption at 136.5 million hl, leaving a deficit of more than 10 million hl which will have to be bridged by the import of ethyl and methyl alcohol.

Indonesia sugar expansion incentives[5]

Indonesia, consuming more sugar than it produces, has begun to offer incentives for cane growers and the sugar producers to boost output. The price paid to growers is being increased, while the factories will only have to sell 30% of their output to the national logistics agency at low domestic prices instead of the earlier 100%. The agency will have the option to buy a further 35% of the factories' output but will have to pay world market prices for it. Sugar not required by the agency may be exported. The head of the Indonesian Sugar Council expects a further 50,000 ha of land to be planted to cane as a result, bringing the cane area to 390,000 ha. New factories will be required to process the additional crops and domestic and foreign investors are invited to participate. At least two factories, one a joint venture with Taiwan, are expected to start construction in the eastern part of Indonesia this year.

European beet areas, 1990

Europe is probably on the way to an excellent crop, according to F. O. Licht GmbH[6], as conditions so far in the 1990 growing season have been almost ideal. If the trend holds, a lot more sugar will be coming out of Western Europe, while import requirements may shrink in the eastern part of the continent, especially with falling demand in these countries as economic reforms at least temporarily depress per caput consumption. East Germany, Hungary, Poland and Czechoslovakia will eventually overcome their economic problems caused by a shift from a centrally planned to a more market oriented economy, and sugar consumption should return to normal in a year or two. In the USSR, however, the Soviet economy is unlikely to improve while there are great divergencies of views on the path to reform.

The latest estimates of beet areas show a further small reduction from the 2nd estimate[7], from 7,039,000 to 7,009,000 ha. Most figures are virtually unchanged, with all variations being 5000 ha or less, apart from the Turkish figure which is set 20,000 ha lower.

Barring any unforeseen weather disaster, it seems that sugar production in Western Europe could easily rise by more than a million tonnes in 1990/91. The crop in Eastern Europe is still an open question but an increase here too is possible. This could permit consumption growth to return to normal while not being sufficiently large to herald another depression unless it were accompanied by sharp increases in other parts of the world where the extra sugar is not required for domestic consumption.

British Sugar results, 1989/90

In the Interim Statement by the parent company, Berisford International plc, it is reported that British Sugar produced just under 1.27 million tonnes of sugar from the 1989 crop and its contribution to the group's profit increased from £49.6 million in 1989 to £59.1 million. The outlook for the current season is again good; the majority of the crop is growing well although some germination problems caused by the dry weather during the spring have occurred in a small percentage of the crop in Northern England.

East German sugar industry structure changes[8]

Deutsche Ostzucker AG (DOZAG) was established on July 1 as the legal successor to the VE Kombinat Zucker. It will continue to have its headquarters in Halle/Saale and is in the process of spinning-off its constituent 21 companies. Beet growers in East Germany will get a majority share under the planned privatization, in which West German sugar companies are also showing interest.

DOZAG has developed a plan to make the East German sugar industry financially viable from 1993; a joint sales organization has been established with a western trade house to manage sugar distribution. In its preparations for the inclusion of East Germany in the European Community, the Commission has pencilled in an A-quota of 800,000 tonnes although the two German sugar industries had been hoping for 900,000 tonnes.

4 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 380.
5 *Reuters News*, June 11, 1990.
6 *Int. Sugar Rpt.*, 1990, **122**, 353 - 355.
7 *I.S.J.*, 1990, **92**, 106.
8 *Zuckerindustrie*, 1990, **115**, 534.

The Great Freeze of 1989

By Norman Rozeff
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Introduction

The mainland United States of America has commercial sugar cane operations in the states of Florida, Louisiana and Texas. The other North American (as distinct from Central American) cane-producing entity is Mexico. Cane growing states of the USA lie in the region generally categorized as sub-tropical while most, but not all, of Mexico's cane lies south of the Tropic of Cancer and hence is categorized as tropical. In reality, the climate of each region is not subject to latitudinal generalities as cane growers may attest.

Louisiana and Florida sugar cane is grown in the Humid East zone. Texas sugar cane is cultivated in the Great Plains, a continuous belt 485 - 645 kilometres wide extending from Mexico into Canada. It is the largest uninterrupted area with semi-arid climate in North America. All three states are influenced by both maritime and continental climates.

Continental air masses may be greatly chilled in winter and heated in summer before reaching the coast. Intervening periods of weather are tempered by air from the ocean. Other continental qualities of the climate are a rather abrupt change from winter to summer and the fairly marked development of summer thunderstorms with short, intense rains. The continental climate is characterized by rapid changes in temperatures, marked extremes and large temperature ranges both diurnal and annual[1].

Although largely dominated by tropical air masses from the Gulf of Mexico, the USA mainland cane-growing areas do not possess a truly maritime climate but rather more of a continental climate. Tropical maritime air masses are dominant throughout spring, summer and fall, but modified polar air masses frequently affect these areas in winter.

A marine-type climate is characterized by comparatively uniform temperature in all seasons with a small diurnal range; also, the progress of the seasons is retarded, winter lingering into spring, summer into fall. This gives a marine climate comparatively pleasant summers, mild winters, cool springs and warm autumns.

Mexico's cane is cultivated under a wide-ranging number of climates. Sinaloa state is much like Texas while Veracruz is more akin to Florida. The elevations above sea level combined with topographical features such as mountains and valleys produce varying micro-climates in other parts of Mexico.

The movement of large air masses of either cold or warm temperatures is termed a frontal passage. In winter, the USA and Northern Mexico cane may be subjected to the passage of cold air masses either of Pacific or Canadian origin. The latter is colder and more dangerous. Fronts form when air masses collide, for air masses do not mix unless they are very similar in temperature and moisture content. The colder air mass pushes under the warm one and lifts it. Cane-growers term these occurrences: fronts, cold fronts, "northers" and, when extreme cold is encountered, a "blue norther" or a "Siberian Express"[2]. In Table I is listed selected weather statistics for cane-growing areas of Florida, Louisiana and Texas[1].

Historical

Florida has seven processing mills, Louisiana 22, and Texas one. All the cane-growing areas of Louisiana and Texas are unprotected from fronts by any physical features. On the other hand, Florida is unique; it possesses Lake Okeechobee. This is the largest man-made lake in the United States. It is 1916 square kilometres in size. The water in the lake acts as a "heat-sink" which ameliorates cold air temperatures moving across it from the north and northwest. When Florida's industry was smaller, it encompassed the area adjacent to and directly south of Okeechobee. Now, cane expansion has pushed cultivation further south and west. As a result, some fields have lost the protection of the lake. Even with the lake's beneficial presence, however, a deep and lengthy freeze period will override the lake's latent heat.

In the decade of the 1980's, Florida's cane area has tended to increase inexorably. In Louisiana and Texas the area has fluctuated annually as influenced by the economics of sugar and other crops. In Table II is shown the pertinent production statistics for these areas[3].

Because Louisiana growers know that they will be subjected to an annual freeze, harvesting commences around October 1 and is usually completed by December 31. Rains may lengthen the normal harvest campaign thereby subjecting a greater area to the possibilities of a freeze. Florida and Texas have more extended seasons, normally running from mid-October through March and, again, possibly longer should wet weather interfere with mechanical harvesting operations. Florida and Texas, therefore, are more prone to freeze-damage of standing cane.

1 Sauer: "Climate and Man" (USDA, Washington), 1941, pp. 158, 894 - 1146.
2 Lehr: "Weather" (Golden Press, NY), 1964, pp. 77 - 95.
3 Anon: *USDA Sugar and Sweetener Rpt.*, March 1990, 54.

Table I. Selected weather statistics for cane-growing areas of Florida, Louisiana and Texas

State	Average January temperature, °C	Average date of first killing frost	April-September growing period rainfall, cm	Annual rainfall, cm
Florida	18.3	Killing frost liable only half the years	107	145
Louisiana	12.2	November 30	91	140
Texas	16.7	December 25	38	65

Table II. Production statistics for sugar cane in Florida, Louisiana and Texas, 10-year average and range 1980/89

State	Area harvested, ha	Crop yield, tonnes/ha	Sugar cane production, tonnes	Sugar production, tonnes	Yield % cane	Sugar yield, tonnes/ha
Florida:						
Average	150,643	71.8	10,825,000	1,216,000	11.22	8.05
Range	129,838	64.0	8,664,000	875,000	10.10	6.46
	- 166,802	- 79.5	- 11,809,000	- 1,424,000	- 12.27	- 8.71
Louisiana:						
Average	99,960	55.9	5,603,000	590,000	10.48	5.86
Range	82,996	49.4	4,100,000	446,000	9.07	4.76
	- 117,409	- 62.0	- 6,855,000	- 755,000	- 12.24	- 6.46
Texas:						
Average	13,482	67.7	914,000	80,000	8.84	5.98
Range	11,781	58.6	792,000	57,000	5.48	3.91
	- 14,818	- 74.8	- 1,049,000	- 100,000	- 10.45	- 7.59

Frontal systems, whether originating in Alaska or north of the Arctic circle in Canada, more often than not have a tendency to edge to the east as they move south. Texas meteorologists believe as a rule of thumb that a Canadian front with its centre passing to the east of Rapid City, South Dakota, is likely to by-pass Texas altogether. If it passes to the west of this city, it is likely to penetrate Texas. The broadness of a front determines whether it will hit all three regions. Rarely does a front have the broadness, direction, and depth to straddle the whole of the US-Mexico border. This situation did occur, however, in December 1962 and again in January 1971 when Los Mochis, Sinaloa, was struck.

In the Lower Rio Grande Valley of Texas the longest record of weather is 119 years for Brownsville. Located next to a river and close to the ocean, Brownsville temperatures are somewhat moderated. In Brownsville a serious freeze (defined as temperatures –3.3°C or lower for 4 hours or more for sugar cane) occurs on average once every 4.4 years. The lowest temperature ever recorded in Brownsville was –11.1°C on February 13, 1899. At Weslaco, Texas, 60 kilometres to the west of Brownsville, 64 years of data indicate a serious freeze occurs on average once every 3.6 years[4].

During the period January 9 - 13, 1962, Louisiana experienced the worst freeze since 1899. Temperatures dipped as low as –15.6°C. Sixty-five hours below –18.3°C were recorded. Soil froze to a depth of 10 cm in plant cane and 13.3 cm in ratoon cane[5].

On the morning of November 30, 1976, disaster struck Louisiana again. Temperatures as low as – 6.7°C were recorded in the cane belt. More than 40,000 hectares remained to be harvested. When December brought heavy rains, the problems were compounded. Eventually nearly 3000 hectares of cane were discarded. An estimated 46,000 tonnes of raw sugar were lost.

Industry people termed the campaign[6] as Louisiana's "worst harvest in its history". In that year Texas luckily experienced only a mild freeze, but unseasonal winter rains extended the harvest until June 15. Cane on 1143 hectares was abandoned and 2251 ha were carried over to the following season.

Memories were short when the December freeze of 1983 was termed "the freeze of the century". It wasn't quite as bad as 1962 for Louisiana but bad enough. In both cases it was the destruction of reviving ratoon vegetation which was of greatest import. In 1962 the sugar production was reduced by 27.4% from 1961. In 1984[7] it was reduced by 25.0% when 52 hours below freezing were registered and lows hit –10.3°C.

In 1983, when the Christmas Day freeze struck, just half of the Texas cane area had been harvested. After 32 days no more crystalline sugar production was possible. A large open pit was bulldozed to store surplus molasses production which was 2.6 times normal. More important, 33,000 tonnes of potential sugar production were lost.

Overriding the moderating effects of overcast skies, advectional conditions exacerbated the low temperatures. During the 8-day period, December 23 - 31, a cumulative total of 88.5 hours below zero were recorded with the nadir at –7.8°. In the latter stages clear skies and radiational cooling added to the woes of the western side of the Valley. Sixty-year old palm trees 30 metres in height were killed. Half of the 30,000 hectares of citrus trees were so badly hurt that they were ploughed out.

The arctic high pressure system associated with this freeze was very deep. At its peak, it registered 79.81 cm of mercury compared with 79.77 measured during the great 1962 freeze. The former was the highest pressure ever recorded in North America.

Florida received damage also. Areas to the east of the lake were worst-hit with – 6.1°C temperatures for 5.5 hours. Following this freeze production decreased 20% as it had done in Florida for one in the 1981/82 season[8].

4 Connolly: "Texas Sugarcane Growers Guide", 1975, Sec. 2100.
5 Abbott: *Sugar y Azúcar*, 1962, **57**, (3), 38.
6 Anon: *ibid.*, 1977, **72**, (3), 8.
7 Lauden: *Sugar Bull.*, 1985, **63**, (10), 4 - 6.
8 Miedema: *Florida Sugarcane League Press Release*, March 20, 1990.

The 1989 freeze

Five to seven days prior to the great freeze of 1989, meteorologists began to be concerned as the blocking ridge in Canada commenced to weaken, thereby signalling an outbreak event.

On December 19 the third of a series of highs was still centred just north of Alberta, Canada, but North Dakota temperatures had already plummeted to a daily low of –32.8°C. The system then moved rapidly southeast. In its wake 125 record lows were set for the date December 22 and 34 all-time record lows.

By the 23rd, an immense high pressure ridge extended from Kansas City all the way to Brownsville, a distance of 1500 kilometres. By the 25th the high was weakened somewhat. Its base had broadened to encompass Florida, and it now was centred in Northern Mexico.

In the middle of Texas's cane belt, temperatures were below zero for 55.0 hours and below –3.3°C for 29. The coldest fields dipped to a low of –9.4°C. Once again, an advection-type freeze occurred during the coldest period. Winds were 16 - 32 kilometres per hour. On the second night, however, radiation cooling combined with advectional cooling to plunge the Brownsville area to temperatures lower than it had experienced in 1983. At –8.9°C Brownsville experienced its coldest temperature of this century. Again, 50% of the citrus tree area was totally destroyed.

Mexico was hardest hit in the area of northern Veracruz, a location 775 kilometres south of Brownsville. Neighbouring cane areas in San Luis Potosí and Tamaulipas escaped more serious damage because fields were at higher elevations and cold air drained into the lower elevations. In all, eight mills were affected. Two were in Veracruz, four in San Luis Potosí and two in Tamaulipas.

In Louisiana, a low of –13.3°C was recorded in the cane belt. Between December 21 and 25, 101 cumulative hours were recorded below freezing. Although soil had been saturated with moisture from precipitation, the ground was frozen and packed down to 3.8 cm and a temperature of 0°C was measured at 10 cm[9].

The impact on Florida's cane was not as serious as the others but, with a larger area and higher prospective sugar content, it was hurt economically nonetheless. Temperatures dipped to – 4.4°C in the coldest locations but probably averaged –2.2°C elsewhere and were below freezing for 20 hours[7].

Nature of the damages

Table III categorizes the effects of freezing temperatures at various temperatures[10]. When the thermometer hit –7.2°C, even NCo 310, perhaps the world's most cold-tolerant commercial cultivar, exhibited rind-splitting and exudation of sap from top to bottom of all stalks. In Dr. Fors' categorization[11] Texas had suffered a Sixth Degree freeze while Florida was either in the Third or Fourth Degree range.

The quality effects of the freeze in Texas were rapid as temperatures rose above seasonal norms. By January 8, 1990, 18 days after the freeze, no additional crystalline sugar could be produced. The remaining 254,000 tonnes of cane on 5166 hectares went into molasses production. The storage pit built in 1983 was used once more. Instead of a normal campaign's production of 40,000 tonnes of molasses, 56,000 tonnes were produced. By the end of the season, and despite lower topping, cane dehydration resulted in a 15 to 20% loss of stalk weight.

Visiting Mexico, Dr. James Irvine, of the Texas Agricultural Experiment Station, Weslaco, made assessments of the freeze damage there. He reported[12] widely varying degrees of damage and amounts due to topographical influence. At two mills in northern Veracruz, approximately 15 to 25% of the fields had severely damaged cane. Another 25% had damage to the upper third of the stalks. 40 - 45% had limited damage and no more than 5% of the cane in the area was undamaged. A –3°C reading at El Higo mill was reported but may not be accurate.

Neighbouring states had Second and Third Degree freezes. These created conditions ranging from violent scorching of the leaves but without damage to

9 Richard: *Sugar Bull.*, 1990, **68**, (5), 10, 18.
10 Sund & Clements: *Hawaii Agric. Expt. Sta. Bull.*, 974, (160), 14 - 15.
11 *Sugar y Azúcar*, 1971, **66**, (7), 26 - 28.
12 Personal communication, February 27, 1990.

Table III. Low temperature effects on sugar cane

Temperature, °C	Effects	When noticeable
0.0 - 1.7	Purplish colour of leaf blades	2 - 3 weeks
– 1.1 - – 0.6	Slight leaf burn	1 - 2 weeks
	Banded chlorosis on emerging leaves	2 - 3 weeks
	Damage to growth terminal, brown to black discolouration of tissue	Within 24 hours
– 2.2	Complete leaf burn, photosynthetic activities end	Within 1 week
– 3.9 - – 2.2	Bud damage; deep brownish colour indicates damage. Slightly off-colour buds may be viable	1 week after occurrence
– 3.9	Percent recoverable sugar gradually declines	
– 6.1 - – 5.0	Cells destruction, stalk splitting; cells have translucent, water-soaked appearance. Recoverable sugar rapidly decreases	Within 24 hours

the terminal bud to damage to the terminal bud and possible extension of damage down the stalk starting from the top.

Dr. Silverio Flores, Director of IMPA, reported results[13] from the mills as of March 3, 1990. Cane tonnage for them averaged 21.45% below estimate. Sugar production was 36.35% below estimate.

Because growers are paid by the tonne in Mexico, most refused to discard deteriorated segments by topping low. As a result, mills dealt with low purities, sour cane, dextrans and conditions of which most had no experience. Seasonal sugar yield results up to March 3, 1990 for 8 mills averaged a low 7.06%. The yield for the week of February 25 to March 3, at 6.42%, indicated even more clearly the deteriorated state of the cane.

The consequences

The Great Freeze of 1989 had a severe immediate and future impact on North American sugar cane producers. In Texas, the reduction of 43,570 tonnes of sugar from a potential of 95,445 created an $18,600,392 shortfall[14]. Usually 20% of the cane area is replanted per annum. In 1990, this proportion was raised to 24% when it failed to ratoon satisfactorily.

In Florida, the 8% drop in production translated into a $50 million loss for area growers and processors. Florida citrus-growing areas north of Orlando have been hit by Freeze so often in the last 30 years it is likely that production will cease altogether in that region.

For Mexico, the dollar value was difficult to establish directly. The best evidence of the freeze's impact was from the world commodity market for sugar. Mexico, which was an exporter in recent years, "may have bought 600,000 tonnes and may need an additional 400,000 to meet domestic needs and export commitment"[15]. Mexico was quiet concerning losses and make-up requirements. As a potential buyer it did not want to generate a bullish trend on the world market.

The Louisiana situation is likely the saddest of all. Although the 1989 crop was barely hurt, cold damage to stubble cane in the ground was immense. As of May 1 it was estimated that 50% of the cane area will be discarded either because it has not retillered at all or else very sparsely. The 50% which remains will have reduced yields upon harvest in 1990. In addition, this lower unit production will require the utilization of more area to supply seed cane. It is therefore estimated that Louisiana's tonnes harvested for yield may be 35% of a normal crop[16]. Louisiana normally supplies 12% of the total USA sugar production and 25% of its sugar cane-derived production.

Without question, the Great Freeze of 1989 will be remembered as the one adversely affecting the largest North American sugar cane area and, by any measure, having the most serious economic impact on all of its producers. Barring a truly phenomenal event in the last decade of the century, the Great Freeze of 1989 may truly be said to have been the "freeze of the century".

13 Personal communication, March 3, 1990.
14 Taylor: *Report of Texas Agric. Extension Service to Rio Grande Valley Sugarcane Growers*, March 26, 1990.
15 *Wall Street J.*, April 30, 1990.
16 Richards (American Sugar Cane League, Thibodaux): Personal communication, May 4, 1990.

Freeze damage cost for the Texas sugar industry

By Merritt J. Taylor
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Prior to the 1989/90 crushing season there had been a projection of 1,150,000 short tons of sugar cane to be processed in Texas with an expected yield of 105,000 tons of sugar. The actual tonnage was 902,422.37 tons of cane with 57,073 tons of sugar. At $430.362 per ton average price for sugar added to the sale of molasses, this was an $18.6 million shortfall.

The devastating freeze of 1989 affected every crop growing at the time the arctic air blasted from the North Pole across the Texas Plains, through the Rio Grande Valley and three-quarters of the way to Mexico City. Damage estimates to several of the annual vegetable crops have been developed while estimates regarding the perennial crops have been more difficult to ascertain. The revenues and losses from the sugar cane crop and the sugar factory owned by the Rio Grande Valley Sugar Growers Inc. have to be evaluated as a completely integrated industry owing to the total dependence of one segment on the other. The growers cannot sell their crop without the existence of the sugar factory and all of its infrastructure, which includes the harvesting and transportation, crushing, processing, concentrating and storage capital investment. The majority of the capital investment in the sugar factory cannot be utilized for alternative purposes. Since the Rio Grande Valley Sugar Growers Inc. is a wholly farmer-owned entity, the farmer's income is determined not only by the tonnage of cane cut and hauled from the farm but also by the earning of shares held in the sugar factory. The latter processes the raw cane from the fields into raw sugar to be sold for further processing into refined sugar as well as molasses which is sold mainly for animal feed. The costs of operating the sugar factory plus a retainer are subtracted from the revenue generated from the sale of raw sugar and molasses with the excess distributed to the member-owners.

Estimate of damage losses were

made immediately after the freeze with little knowledge of the extent of the sugar yield that would ultimately be derived from crushing and processing the sugar cane. Those early estimates grossly underestimated the total raw sugar quantity that would be produced. The actual total sugar production was only 54.4% of the original estimate.

A characteristic of sugar cane is that the sugar content begins to decline immediately upon the death of the plant. A rule of thumb is that sugar content declines by approximately 0.25% per day after the plant dies. In the case of a killing freeze such as that experienced in December 1989, all of the unharvested cane was killed at the same time, making the processing of the cane into sugar as soon as possible imperative to reduce the daily sugar loss as time passed. The sugar mill has the capability to process 450 tons field cane per hour or approximately 350 to 400 acres of 30 tons-per-acre cane per 24 hour period. At the time of the freeze there were 16,200 acres of cane unharvested. The crushing season had begun on October 10, 1989 and, following the freeze, by working around the clock at maximum safe speed, the sugar mill personnel were able to complete the cutting, hauling, crushing and processing of cane by February 12, 1990[1]. As expected, the last 10,000 acres of cane processed had a zero sugar content. The average sugar content for the season was 126.5 pounds of sugar per ton of cane harvested, which includes that from 17,550 acres of cane that was harvested prior to the freeze. As a comparison, during the 1988/89 harvest season the average sugar content of cane harvested was approximately 180 pounds per ton, or 5940 pounds of sugar per acre harvested, assuming 33 tons of cane per acre.

It had been estimated, prior to the crushing season, that the 1989/90 cane crop would average approximately the same as the previous year, with the selling price expected to be approximately the same as the previous year[2]. The actual average selling price for raw sugar during the 1989/90 crushing season was approximately $430.36 per ton or $0.215 per pound. The expected amount of molasses was 45,000 tons. The actual amount of molasses produced was 52% greater than the original prediction or 68,578 tons. This extra molasses was due to the change in properties in the cane that reduced the ability to convert the juice into sugar. The *expected* sugar yield times its selling price plus the expected molasses yield times its selling price was approximately $45,900,000. The *actual* revenue from sugar and molasses was $27,299,608. This was a $18,600,392 shortfall.

Expenses incurred by the farmers in the field are the costs of production which included land preparation, planting, weed control, insect control, multiple irrigations, land costs, etc. These are estimated at $745 per acre during the plant year and approximately $435 per acre during the subsequent ratoon years[3]. These costs were expended regardless of when the crop was harvested and regardless of the ultimately lower sugar content due to the freeze. At a payment yield of 45 tons of cane per acre and a price of $16.00 per ton the farmer can expect a gross income of $720 per acre in a "normal" year. It is estimated by the sugar factory that the average gross return to the farmers for the 1989/90 sugar cane crop will be approximately $6.35 per ton harvested or a reduction in gross income of $426 per acre under the above conditions. For the total 34,200 acres of cane this extrapolates to approximately $14,574,330 reduction of farmer income from growing the crop and selling it at a reduced revenue per acre. The field losses are only part of the story.

Reduced revenue for farmers and the sugar factory have a direct impact on the Rio Grande Valley. There are 720 people employed by the Rio Grande Valley Sugar Growers Inc. factory. The shorter crushing season means fewer jobs and less income for the Rio Grande Valley. A conservative estimate of the dollar turnover in the community or the number of times one dollar is spent in the Valley is $3.26 for every one dollar earned by the farmer[3]. Evaluating the lost revenue from cane production to the farmers produces a $47,512,315 reduced dollar impact or loss to the Rio Grande Valley just from freeze damage to the sugar cane industry.

An unknown factor that will not be determined until the 1990/91 harvest season is the impact of the freeze on the following and subsequent year's cane tonnage and sugar content. It has already been established that fields harvested in October and November, and which had strong regrowth at the time of the freeze, have been severely damaged. The plants had drawn heavily on nutrient reserves in the root system to start the regrowth after being harvested. The freeze killed all live vegetation above ground. When regrowth started for the second time there were less reserve nutrients for growth and the ability to adapt to other factors of stress such as insects, weed competition, salinity of the soil and water needs. Only time will tell how severely the damage will affect the next crop. Some farmers may even have to plough out the crop and replant.

Since the sugar factory and the growers are essentially one entity, all share in the benefits in good years and all share in the loss in a bad year. Those growers that had their cane harvested before the freeze will have to share the revenue generated from sugar produced from their fields with those farmers whose fields were killed by the freeze. All sugar cane growers will receive a much lower income this year owing to the freeze of 1989. As a result, the entire Rio Grande Valley will feel the impact of the reduced buying potential of everyone in the sugar industry.

1 *"Rio Grande Valley Sugar Growers Inc., 1989/90 crushing season final tonnage crushing and sugar production report"*, February 1990.

2 "Texas crop budgets, South Texas District"; "Crop Budgets C12.67 - Plant Cane, Irrigated and C12.69 - Ratoon Cane, Irrigated": *Texas Agricultural Extension Service Bulletin*, 1989, (B-1241).

3 Jones & Kao: "Economic impact of agricultural production in Texas: A handbook of state and regional estimates" (Department of Agricultural Economics, Texas Agricultural Experiment Station, Weslaco, TX, USA), *Departmental Tech. Rpt.*, 1985, (85).

Sugar consumption in Latin America*

In the last century Simón Bolivar dreamed of one country extending from the border of the United States of America to the border of Brazil. It was a dream which was not built purely on fantasy since even today modern social scientists are emphasizing the social and economic similarities amongst Latin American countries.

Sugar has been closely linked with the economic, social and political history of the region. It was one of the original crops grown when the plantation system was introduced, and the labour imported to produce sugar also became the principal domestic consumers. Economic and social development since the colonial period has continued to shape the pattern of sugar consumption.

Many countries of the region were colonies of Spain and Portugal for a long period after they were discovered by Europeans. During this period they specialized in the production of raw materials which were exported to Europe. Although some areas developed products which were directed to the domestic market, traditional exports were always at the centre of economic activities. Even in those regions producing for their own domestic market, the dynamics of the economy were determined by the foreign sector. During this period sugar was one of the main traditional exports for many of the Latin American countries.

Industrialization in Latin America

In the 20th century, the export of raw materials to Europe and the United States is still important for most Latin American countries. These have, however, industrialized by a process of substitution of imports. In this process those final consumption goods which were imported and for which there was a sizeable market began to be produced domestically. Substitution has not eased these countries' balance of payments position, however, since additional needs in intermediate and capital goods were created.

Industrialization in these countries also brought deep structural changes which demanded many new services which had not previously been required. This also increased the demand for imports. Exports, however, which were mainly of raw materials, were neglected because policies favouring industrialization frequently adversely affected traditional exports.

At the end of the European reconstruction after the war, a large amount of international capital was able to flow to Latin American countries. This postponed the consequences of the industrialization policies on their balance of payments. During industrialization, export competitiveness was not enforced since there was the possibility of financing development with the capital flow from developed countries. The first oil shock found the Latin American economies in a very fragile position Their balance of payments situation was very tight, because of the import of many inputs which were crucial to the functioning of the domestic economies. This reduced the capacity for adjustment without painful consequences for development. The demand for and production capacity of traditional exports were growing only very slowly. On the other hand there was the willingness of the international finance sector to lend, partly because of the need to recycle oil revenue.

To avoid the pain of the necessary adjustments these countries started borrowing. Banks and other sources of finance, on the other hand, misjudged their ability to repay the loans. At the end of the 1970's and beginning of the 1980's the instability of the situation produced the debt crisis. Because of this crisis Latin American countries were forced to impose tough adjustment measures which have restricted their economic growth. In most of the countries of the region, GDP per caput at the end of the last decade was much lower than at the beginning, which has led local economists to name the 1980's the "lost decade" for Latin America.

The social division

The traditional exports of raw materials had as one of their competitive advantages their reliance on cheap labour. Field workers in Latin America were mainly indigenous or the descendants of slaves brought from Africa. Both of these groups had a very low standard of living and their introduction to export-oriented primary production did not improve their standard of living and in fact decreased it.

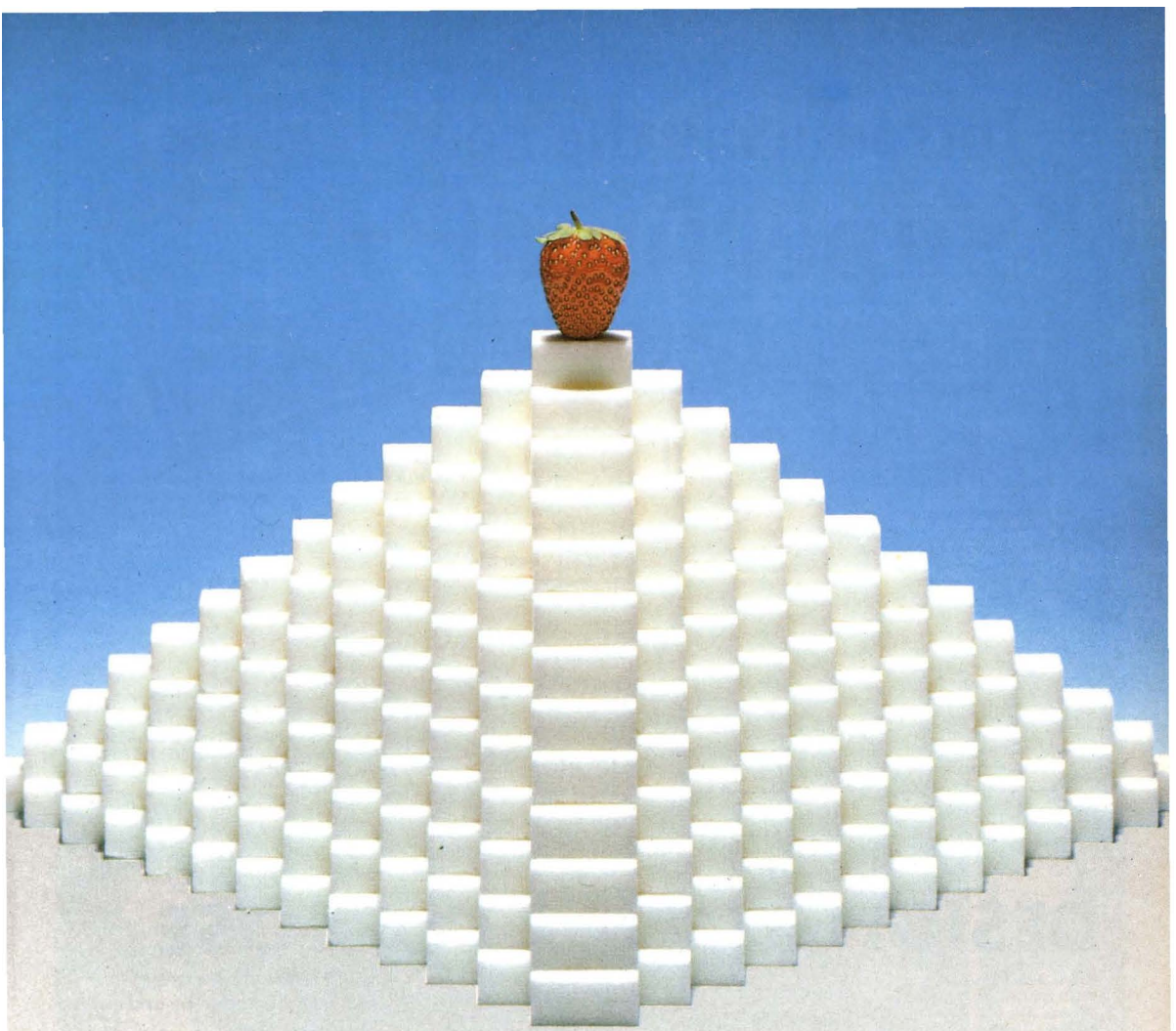
Moreover, their standard of living did not improve after the shift from slavery to wage-labour. The rapid increase of workers' standard of living during the process of industrialization in Europe and North America did not have a parallel in Latin America. Increases in income were largely confined to the middle class, widening income disparities in the region.

Industrialization by import substitution did not solve the problem of income disparity, although it brought a very deep structural change for these primary export societies. The explanation might lie in the nature of the technologies or in the existence of unlimited labour or elsewhere; nevertheless, it is important to note the very unequal income distribution which resulted from this process of development. Because of this income distribution profile Latin American countries tend to have dual societies, where modern sectors with highly productive firms and sophisticated consumption patterns coexist with more backward structures having a a large informal sector, a low-productivity peasant economy and low standards of living. This "dualism" has important consequences for sugar consumption in most countries of the region, as did the economic crisis which hit the economy in the 1980's.

The nutritional role of sugar in Latin America

Most Latin American countries produce sugar and the region as a whole is a net exporter. The pattern of economic development and industrialization

* Adapted from a report to the Market Evaluation, Consumption and Statistics Committee of the International Sugar Organization.



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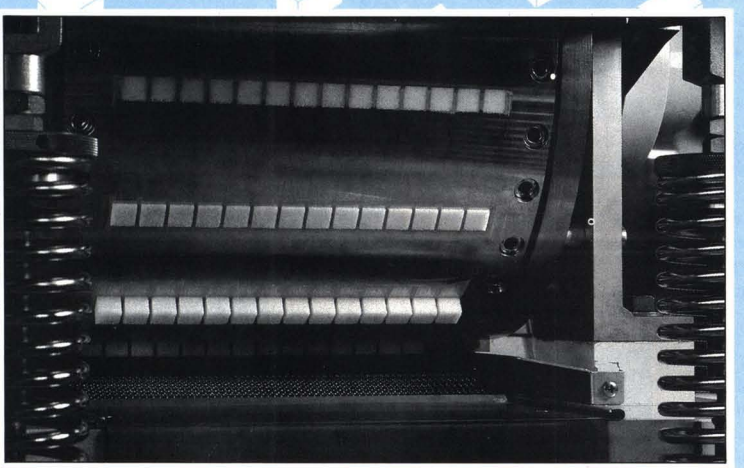

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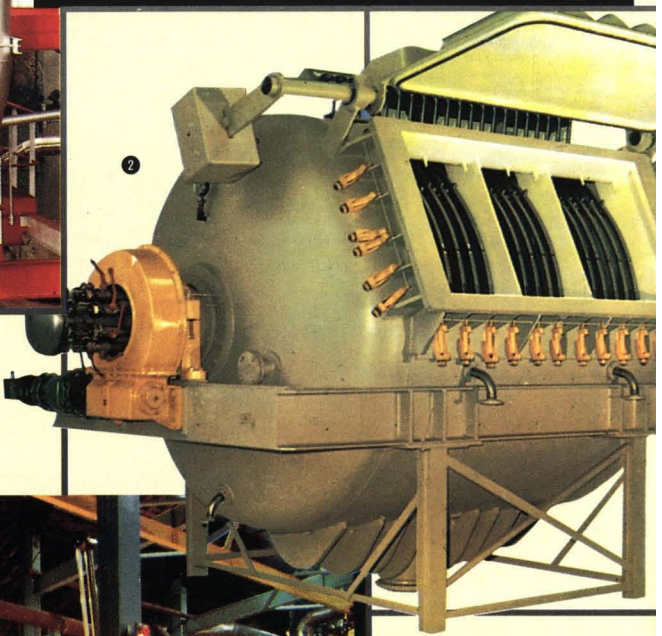

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after the second World War led to a smaller role for primary product exports in the economy. As a result, domestic sugar consumption grew more than production, from 40% of output in the late 1950's to around 60% in the late 1980's. The tradition of sugar production in the region makes it a very cheap source of calories. Given the inequality of income distribution, a large part of the Latin American population has a low standard of food consumption and for these people sugar is a very important source of calories. The average proportion of total calorie intake represented by centrifugal sugar, as an average for 1984/86, is shown in Table I which also includes comparative figures for other regions.

Table I

Argentina	10.64
Bolivia	13.77
Brazil	17.70
Chile	13.41
Colombia	14.35
Costa Rica	21.30
Cuba	25.78
Dominican Republic	18.33
Ecuador	17.35
Guatemala	15.24
Honduras	12.86
Mexico	13.94
Panama	14.87
Paraguay	8.09
Peru	15.57
Uruguay	11.34
Venezuela	16.70
World	7.62
Europe less USSR	12.66
Africa	6.41
Asia 4.32	

(Sources: "FAO Production Yearbook, 1988" and ISO)

The share of sugar in the total calorie intake is greater than in the rest of the world and suggests that prices of sugar are low in Latin America, at least by comparison with other calorie sources. The high proportion could lead to invalid conclusions, however, since it is not related to total calorie intake and in fact, daily calorie intake in the countries of Latin America as an average for 1984/86 ranged from 2058 to 3191 or 61 to 94% of the average calorie intake for Europe.

World sugar prices and consumption

The world sugar price has been found to be a relevant variable in domestic per caput consumption in only seven of 18 Latin American countries and even here very low elasticities were found. In the case of Brazil it was found that domestic consumption rose with world prices, and the only plausible explanation is that, as a big producer and consumer, Brazil reduces its supply to the world market, thereby raising the price, when its domestic consumption increases; this is a reverse of the normal direction of causality.

It is considered that there is still potential for growth in the region but this will depend on an improvement in income distribution. With the current distribution, growth of income will still have some positive effect on sugar consumption, but it could be small.

US sugar policy

The two houses of Congress have their own Agriculture Committees operating independently of each other and of the Administration. The House of Representatives and the Senate have passed their own versions of the US Farm Bill and these are sufficiently different for there to be a need for a special House/Senate conference committee to reconcile the two. Eventually a jointly approved bill will be sent to the President for signature and the Administration will be endeavouring in the meantime to have its own views on farm policy to be taken into account.

There are a huge number of interests which will be affected by a Bill concerned with a wide range of crops and even in the case of sugar alone, the interests of domestic and foreign suppliers, not forgetting the corn sweetener companies, provide a fertile ground for dispute. The domestic suppliers, benefiting from a high support price, praise the present system as providing stable prices to the US consumer. Corn sweetener companies are also in favour; they have been able to expand production under the shelter of this support price and have taken over a large share of the US market with HFS having virtually excluded sucrose from the soft drinks market.

This loss of market has affected the US refiners and the overseas raw sugar producers who supply them. Imports of sugar into the US have been reduced drastically and a considerable part of the refining industry has had to be closed with the remainder often working at well below capacity. The refiners and sugar users point out that the stable price is much higher than it need be if traditional suppliers in Latin America, the Caribbean and the Philippines were able to export freely to the US as in the past. They also point out that limiting exports by quotas reduces the wherewithal of the sugar exporters to buy goods from US manufacturers.

The Australian Bureau of Agricultural and Research Economics (ABARE) has published a discussion paper, "1990 and US sugar policy reform" intended to provide an objective (although not disinterested) assessment of the economic effects of US sugar policy, both internally and externally. This paper has been summarized by F. O. Licht GmbH in their *International Sugar Report*[1]. ABARE points out that the true costs of the policies adopted by the USA have not been well understood while the use of import quotas tends to obscure the transfers of funds to producer groups. According to its calculations, the policies impose on US consumers a cost of around $2.60 for every $1.00 transferred to domestic producers, while it also costs the world economy up to $0.54.

They estimate that, as a consequence of US policy, imports in 1988 were between 2.5 and 5 million tonnes lower than they would have been in the absence of the policy. They calculate that the adverse effect on the world sugar price was between 3.6 and 7.84

1 1990, **122**, 301 - 304.

cents/lb (27 - 45%) while over the period 1982/88 the policies were responsible for depressing the world price by 21 - 33%. The total cost to US consumers during this period is estimated at between $2300 and $2900 million a year in 1988 values, which far exceeds the estimated benefits to domestic producers, calculated to be between $900 and $1000 million a year for sugar producers and between $600 and $1000 million for HFS producers. The cost to US sugar stock holders roughly balances transfers to the government so that the net loss to the US economy is assessed to have amounted to just short of $800 million a year during 1982/88.

Losses suffered by sugar exporters

Exporters, whether to the world market only or to both the world and US markets, have suffered as a consequence of US policy, the EEC losing most, with an average of between $172 and $394 million a year in the years from 1982 to 1988. Comparative figures for Australia were $87 to $232 million, whilst Brazil lost between $42 and $179 million a year. Net importers, on the other hand, gained as a result, with Japan benefiting on average to the extent of between $81 and $172 million a year, while the USSR and China were also major beneficiaries.

It is suggested by ABARE that, if US policies are not reformed, either unilaterallly or as part of multillateral trade policy decisions, the country could develop new corn and chemical sweeteners and eventually become a major sweetener exporter. Not only would this tend to perpetuate current inefficient policies but it would raise the cost of the program and also establish a new set of unintended beneficiaries. The US has accepted that it has an obligation to adjust its current quota arrangements so as to comply with the findings of a GATT disputes panel. Sugar is included in the 1990 Farm Bill and this provides an opportunity to reform policies. According to ABARE, failure to seize this reform opportunity will tend to create even greater problems for the world sugar exporters than those which exist at present.

Possible future policy approaches

Several possible approaches are discussed, ranging from completely free trade arrangements with domestic producers receiving world market prices, to a continuation of current policies. It is suggested that, in the interest of US producers of both sugar and HFCS, as well as for US taxpayers and the overall US economy, the most advantageous method would be the simultaneous reform of policies in the EEC and Japan as well as the USA. This would apear to be in conformity with the current GATT Uruguay Round which is scheduled to be concluded this year.

In its representations to the GATT, the USA has constantly called for tariffication of all existing forms of fiscal instruments so that the relative benefits and impositions can be measured and subsequently reduced. ABARE has suggested that this might be an appropriate measure for the USA to use itself when giving support to its domestic sugar producers. It would enable the domestic price to be raised above the world market price; at the same time it would be consistent with the USA's obligations under the GATT. This program would introduce several new elements, however, including the fact that it would no longer be possible to stabilize the price of sugar in the USA within a reasonably narrow band. Instead the domestic price would remain at a constant premium to the world market price. Also, although they might be able to sell more sugar than under the present quota system, suppliers would lose the preferential level of prices they presently enjoy. Without this preference, the US would become just another part of the world market and in times of shortage there would be no certainty that the needs of the US consumer would be given preferential treatment.

If a country decides to support any one interest group, for example sugar producers, there is a strong argument that it should do so in such a way that it would be at the lowest possible cost to other groups. ABARE considers that during the past decade the methods adopted in the US have been both costly and inefficient. They have differed from arrangments made to support other commodity programs – and especially grain – and even differ from arrangements adopted under previous sugar programs. It is suggested that there is in the US a lack of clear understanding of the cost of the policies and that inefficiency is ascribed to several aspects of the US political process including the role of sub-committees, the practice of vote trading and coalition building. In addition ABARE cites the use of sugar policies to achieve political objectives. The fact that these arrangements have been found to be inconsistent with the requirements under the GATT provides the motive for reform. The opportunity presents itself under the 1990 Farm Bill.

Brazil's alcohol program

A scant few weeks ago, the sugar press was publishing articles concerning the crisis in Brazil's alcohol-from-cane industry. The cause was two-fold; the program of motor vehicle construction which used alcohol fuel had been too successful so that the demand for alcohol was greater than could be met by the domestic distilleries, and the cost of alcohol manufacture was much higher than the equivalent petrol fuel. It was reported that garages were converting the alcohol cars to petrol while distilleries were closing and the cane was being used for manufacture of the more lucrative sugar. Production of alcohol-powered cars was said to have all but ceased.

The alcohol program was in deep trouble but, because Brazil has been so committed to it for so long, it was inconceivable that it would just collapse. The consensus seemed to be that the program would be cut back but would continue, so long as the oil price did not

continued on page 191

ISJ Abstracts

Cane sugar manufacture

Optimum crushing season

E. Martínez M. and R. C. Rodríguez. *ATAC*, 1987, **46**, (4), 2 - 8 *(Spanish)*.

A computer was used to calculate the optimum start and length of the crushing season as a function of cane pol content at a Cuban sugar factory. A number of recommendations are made on the basis of the results obtained.

Critical surface tension and relative interface concentrations of sucrose treated with surfactants. Effect of temperature

R. González Q. and J. Lodos F. *ATAC*, 1987, **46**, (4), 35 - 45 *(Spanish)*.

In a study of the effect of temperature (60° and 100°C) on the behaviour of sugar solutions of 30, 40, 50 and 60°Bx treated with 50, 100 and 150 ppm Espumol K and Espumol H surfactants, there was considerable adsorption of Espumol K at the solid-liquid interface which increased with dosage rate, concentration and temperature, although the presence of other surfactants reduced the positive effect of temperature. Poor adsorption of Espumol H at the solid-liquid interface contrasted with perfect concentration of the same surfactant at the liquid-vapour interface.

Usina Pumaty S.A.

Anon. *STAB*, 1987, **6**, (1), 52, 54 *(Portuguese)*.

A short and less detailed account is given of the title 8000 t.c.d. factory/distillery in Pernambuco which concentrates on the equipment used for cane processing and organization.

Usina Cruangi S.A.

Anon. *STAB*, 1987, **6**, (1), 55 - 56 *(Portuguese)*.

By contrast with the above, this account of the title company is almost all concerned with agricultural details. The 6000 t.c.d. plant in Pernambuco produces 300 tonnes of sugar – half white sugar and half raws – as well as 2000 hl of alcohol and 1.5 tonnes of dried yeast. Of the cane supply two-thirds is provided by growers, and details are given of the varieties and practices adopted in the company's land for soil preparation, planting, cultivation and harvest.

Usina Central Olho D'Agua S/A.

Anon. *STAB*, 1987, **6**, (1), 58 - 60, 62 - 64 *(Portuguese)*.

The title factory/distillery in Pernambuco crushes 8800 t.c.d. to produce 800 tonnes of sugar and 2000 hl of alcohol. The article provides details of the executives, agricultural conditions and methods as well as industrial equipment and techniques used and a table of results from the 1986/87 season.

Characteristics of sucrose crystals-mother liquor systems. II. Mother liquor supersaturation

J. Buriánek and A. C. Hernández. *CubaAzúcar*, 1987, (July/Sept.), 3 - 8 *(Spanish)*.

The authors demonstrate how algorithms developed for calculation of the composition of a sugar crystal-mother liquor mixture may be used to find the supersaturation of the mother liquor at a given temperature and to solve various process problems. The results may be used to optimize boiling and crystallizer operation. While tabulated data are of help in manual calculations, empirical equations (such as one for calculation of the soluble solids content in saturated solutions as a function of purity and temperature) are more suitable for computer calculations.

Friction wear of stainless steels in the sugar industry

G. Rodríguez V., R. Castañeda S. and F. Martínez P. *CubaAzúcar*, 1987, (July/Sept.), 30 - 34 *(Spanish)*.

Abrasive wear of nine grades of stainless steel used for different purposes in cane sugar factory plant and equipment was investigated and showed that resistance to wet or dry friction was greatest in steels having a martensite-bainite-troostite structure and increased with their carbon content. In the presence of juice, no correlation was found between the mechanical properties of the steels and their wear resistance.

The Termoazúcar 2 computer database for sugar factory thermoenergy systems

M. Marques G. and H. P. de Alejo V. *CubaAzúcar*, 1987, (July/Sept.), 35 - 40 *(Spanish)*.

Details are given of the development of the Termoazúcar 2 database for use in thermal calculations. A mathematical model of a juice heater is used as an example of the subroutines included.

Influence of fibre and pol in cane and of juice purity on the sugar and alcohol manufacturing process

L. A. C. Gonçalves. *Brasil Açuc.*, 1987, **105**, (4/6), 49 - 64 *(Portuguese)*.

Data from 17 industrial units were used to examine the influence of fibre, pol and purity on sugar and alcohol production and various relationships are illustrated by equations and graphs by means of which the effect of other parameters can be projected. Particular influences discussed include that of foreign matter represented by high levels of fibre and also the influence of juice purity. Causes, consequences and control measures are tabulated for losses in sugar and alcohol manufacture. A number of conclusions are drawn.

Are thermoplastic valves better than metal ones in the extraction area?

P. J. Galego and R. Caro. *CubaAzúcar*, 1987, (Oct./Dec.), 20 - 25 *(Spanish)*.

The effect of juice on corrosion and deterioration of metal gate valves used in mill juice pipelines was examined. Results showed that oxygen and a reduced pH were the main causes. Steel had greater resistance than cast iron, while

experience with thermoplastic valves for up to five seasons showed that these are a suitable replacement for metal ones.

Computer analysis of sugar factory thermal energy systems

A. M. Marqués G. and H. P. de Alejo V. *CubaAzúcar*, 1987, (Oct./Dec.), 26 - 30 *(Spanish)*.

The development and structure of a subprogram for analysis of steam and of the performances of juice heaters, evaporators, vacuum pans, turbogenerators and mill turbines are described.

Application of contact heaters in different evaporation schemes

C. Vázquez, M. Salermo and O. Santana. *CubaAzúcar*, 1987, (Oct./Dec.), 39 - 44 *(Spanish)*.

The advantages and disadvantages of contact heaters are discussed and their use in place of traditional tubular heaters for primary and secondary juice treatment analysed on the basis of experiments in which the system of vapour bleeding and feeding to the heaters was varied. It was concluded that the contact heaters were less efficient than the tubular types.

Two-stage process for the production of biogas and stabilization of sugar factory effluents

A. A. Guillermo N. and D. Cuevas D. *CubaAzúcar*, 1987, (Oct./Dec.), 52 - 56 *(Spanish)*.

Laboratory trials are reported in which 1 part of fresh filter cake was added to 4 parts of waste water to give a total solids content of about 6% and the mixture treated in a semi-continuous 2-stage system, agitation being used in the 1st stage. Results showed a 94% reduction in COD and a biogas production which increased over 30 days to 563 dm^3/kg of volatile solids at a treatment temperature of 35 - 37°C and a pH of 6 - 7.

Method of calculation for the design of a pilot plant for juice purification with calcium sucrocarbonate

M. León C., N. Alvarez C., P. A. Pérez and J. Buriánek. *ATAC*, 1987, 46, (5/6), 32 - 37 *(Spanish)*.

The calcium sucrocarbonate process for juice purification is described with a flow diagram of a pilot plant designed to operate at a juice temperature of 90°C with the pH increasing by stages to a final 7 - 8. Residence time in each of 3 stages is 5 min.

Usina Costa Pinto S.A. Açúcar e Alcool

Anon. *STAB*, 1988, **6**, (3), 4 - 8 *(Portuguese)*.

The title company, located in São Paulo, has a crushing capacity of 24,000 t.c.d. and receives its supplies from 26,100 ha of growers land and 20,510 ha of its own. The article provides information on the company organization, edapho-climatic conditions, varieties, soil preparation, planting, cultivation, fertilization, weed and pest control, harvesting, vinasse distribution, cane transport, weighing and reception, washing, preparation and milling, juice treatment whether for the distillery or for sugar manufacture, evaporation, boiling, centrifugalling, drying and storage of sugar, fermentation and distillation of alcohol, steam and power generation, water treatment, the industrial and microbiological laboratories, and use of residues.

Experience at Usina da Barra in the use of welding for the protection and repair of machines and components - General applications

A. Capozzi and A. G. de Silveira. *STAB*, 1988, **6**, (3), 38 - 43 *(Portuguese)*.

Details are given of practices at the title sugar factory in respect of the equipment which has been welded as well as details of electrodes used, etc. Most of the details refer to centrifugal pumps and valves.

Some thoughts on the operational efficiency of steam generators in sugar factories of Villa Clara (Cuba)

R. Espinosa P., M. J. Carrillo A., S. Machado B. and A. R. Alamo.*Centro Azúcar*, 1988, **15**, (1), 11 - 13 *(Spanish)*.

The operational parameters and the steam-raising performances of boilers at 12 sugar factories are presented and discussed.

Some thoughts on the use of condensates in sugar factories

S. Machado B., R. Espinosa P., M. J. Carrillo A. and A. R. Alamo. *Centro Azúcar*, 1988, **15**, (1), 14 - 16 *(Spanish)*.

Examination of the situation in 12 sugar factories showed that the amount of condensate available was insufficient to meet all the boiler requirements, so that chemically treated make-up water was needed (raising the chemicals consumption above acceptable levels). Failure to make use of the flue gases to heat this water resulted in a relatively low feed temperature, while the energy in the condensates was not completely utilized for flash evaporator or juice preheating.

Study of some characteristics of lime-sodium carbonate mixtures for liming

E. González G., M. Villalonga G. and E. Valdés B. *Centro Azúcar*, 1988, **15**, (1), 39 - 44 *(Spanish)*.

Some of the properties of juice liming mixtures prepared from CaO and 0 - 100% Na carbonate are examined, including pH, partial and total alkalinity, available CaO, Ca^{++} concentration, volume of mixture needed to provide a pH of 8 in the case of 50 ml of juice and clear juice absorbance. The available CaO level in mixtures containing 10% or 20% Na carbonate was comparable to that in a lime suspension, and it is recommended to use a mixture containing no more than 10% Na carbonate. Alkalinity was considered more suitable than pH for characterizing a liming mixture.

Evaluation of syrup clarification in the manufacture of white sugar

A. Egido M. and L. Carrazana R. *Centro Azúcar*, 1988, **15**, (1), 53 - 57 *(Spanish)*.

In laboratory tests on colour and polysaccharide removal from syrup, trisodium phosphate, phosphoric acid and a detergent were added in varying proportions to 300 g of syrup which was then heated to 85°C, an anionic flocculant and quaternary amine added and the contents stood for 30 minutes. Results showed up to 25.70% decolorization with 100, 100, 10, 10 and 30 ppm phosphoric acid, trisodium phosphate, detergent, flocculant and quaternary amine, respectively, while up to 97.51% polysaccharide was removed with 200, 200, 30, 10 and 20 ppm of the same additives in the order above.

Material balance of a three-massecuite boiling scheme

O. Gozá L. *ATAC*, 1988, **47**, (1), 29 - 33 *(Spanish)*.

A method of calculating the material balance of a 3-massecuite scheme that does not involve use of the Cobenze diagram is described.

Evaluation of a lagooning system for treatment of sugar factory waste water

M. C. Obaya A., M. A. Sandar V., J. Ramos A., E. Valdés J. and O. L. León P. *ATAC*, 1988, **47**, (1), 34 - 39 *(Spanish)*.

The performances of an anaerobic and an anaerobic facultative lagoon at a Cuban sugar factory during two seasons are discussed with the aid of tabulated data.

Lubrication of massecuite after its discharge from the pan

A. C. Hernández M., J. Buriánek and A. Herrera M. *ATAC*, 1988, **47**, (1), 40 - 54 *(Spanish)*.

A mathematical method is described for calculation of the amount of syrup of a required Brix to be added as lubricant to provide a massecuite of 1.05 - 1.08 supersaturation before purging in the centrifugals.

Method for establishment of the optimum season length and programming

A. E. Morales P. *ATAC*, 1988, **47**, (2), 2 - 8 *(Spanish)*.

A method is described for calculation of the optimum start and length of the crushing season to end on a date between April 30 and May 30 in Cuba. The sugar yield % for a season length in the range 120 - 160 days is indicated.

How to salvage damaged knives at reception centres

J. Varona M. *ATAC*, 1988, **47**, (2), 36 - 39 *(Spanish)*.

Reprocessing knives that become worn and damaged after use on the cane tables at reception centres is discussed. Since grinding of the blades shortens the knife, a means had to be found for adjusting the cane cutter to allow for this; this is briefly described with the aid of a diagram.

Study of bulk ebullition of sugar solutions and factory juices

D. Clerch A., R. González Q., O. Herrera M. and J. M. Roller A. *ATAC*, 1988, **47**, (2), 40 - 47 *(Spanish)*.

A laboratory evaporator is described that was used in a study of the processes that take place during ebullition of sugar solutions and juices of varying Brix as well as distilled water. Results for the overall heat transfer coefficient *vs.* temperature difference and density of heat flux are given in graph form and demonstrate the suitability of the unit and of the method of calculation used for investigation of heat transfer in evaporation.

Usina Nova America S.A.

Anon. *STAB.*, 1988, **6**, (4/5), 4 - 9 *(Portuguese)*.

The title sugar factory/distillery in São Paulo state was founded in 1947 and currently has a crushing capacity of 15,000 t.c.d. from which it produces 600 tonnes of sugar and 11,050 hl of alcohol. Details are provided of the executives of the company and its history, as well as agricultural and industrial information. This includes cane supply, edaphoclimatic conditions, varieties, soil preparation, cane planting and cultivation, fertilization, weed and pest control, harvesting, loading and transport, cane weighing and reception, unloading, washing and preparation, milling, juice screening and clarification, evaporation, boiling, centrifugalling, drying, conditioning and storage, fermentation and distillation, electricity and steam generation, the control laboratory and by-products disposal. A table is given of results from the 1987/88 season.

Processing of cane without topping. Experience at Açucareira Quatá

C. O. Belodi. *STAB*, 1988, **6**, (4/5), 41 - 42, 44 - 45, 49 *(Portuguese)*.

The results of trials at the title factory on the processing of cane with and without topping showed that a major factor was wear of equipment due to an increase in the content of mineral impurities while the cane payment system on a sucrose basis did not detect or allow for the cost of excessive impurities. The presence of extraneous matter did not affect feeding of the mills but increased power requirements by 3%. While there was little difference in juice quality apart from a slight increase in reducing sugars, the clarifier mud quantity increased. No variations in evaporation, crystallization or centrifugation could be attributed to untopped cane, but there was some additional corrosion in the condensate piping, probably due to an increase in natural acids in the cane. The fermentation and manufacture of alcohol were not significantly affected when using a must of juice and molasses but when using raw juice the content of solids,

mainly earth, caused some abrasion of the equipment and an increase of the bottoms.

Techno-economic results of use of a vibro-fluidized bed cooler to prevent sugar deterioration in storage

J. Lodos, D. Esson, M. Canales and A. Zaborsin. *CubaAzucár*, 1988, (Apr./June), 3 - 9 *(Spanish)*.

Causes of raw sugar deterioration in bulk storage are discussed. It is stated that some 100,000 tonnes of sugar are liable to storage deterioration in Cuba and requires reprocessing, resulting in an estimated loss of 5000 tonnes of sugar and 16 tonnes of equivalent fuel, including 4.1 million kWh; the consumption of power, fuel and steam is indicated for each operation from transportation and melting to centrifugalling and storage. A vibro-fluidized bed cooler is described that reduces the temperature of pre-storage sugar from 50° to <35°C at a throughpout of 50 tonnes/hr and thus allows the sugar to be stored for 7 - 10 months without deterioration, as confirmed by large-scale industrial tests. The economics of such pre-storage cooling are discussed and show a payback period of less than 1 year.

Oil economy in the industry by use of magnetic anti-scale treatment

R. D. Catellanos and R. C. Morera. *CubaAzúcar*, 1988, (Apr./June), 10 - 17 *(Spanish)*.

Investigations on magnetic treatment to prevent scale formation in evaporators led to construction of a horizontal flow-through unit (an Antiemit-1) in which passed at 45 m^3/hr through a field of 1200 gauss before entering a sextuple-effect evaporator. The result was a 19% reduction in the formation of sulphate and silica compounds from the 2nd effect onwards, and the brittle crystalline layer of scale was easily removable with much less HCl and NaOH than previously.

A computerized system for daily management of the sugar season. II

M. S. Gutiérrez. *CubaAzúcar*, 1988, (Apr./June), 18 - 28 *(Spanish)*.

The main features of the POOZ system (Plan for Optimum Operation of the Sugar Season) are described, including the major inputs and the type of decisions that have to be made when fluctuations occur, e.g. concerning a reduction in the cane mill throughput, changeover to mechanical harvesting and storage of process sugar. The scheme aims to maximize sugar yield and reduce agricultural losses.

Influence of calcium on boiling of commercial strikes

J. A. Urrutia F., E. L. Ramos S. and R. A. Linares C. *CubaAzúcar*, 1988, (Apr./June), 36 - 45 *(Spanish)*.

Treatment of syrup with calcium hydroxide to improve sugar storage properties was found to have no observable effect on boiling of *A*- and *B*-strikes nor on the properties of the massecuites.

Analysis of the economic benefits of using enzymes in the production of Cuban export sugar

I. Namer, J. R. Pérez and H. Dávila. *ATAC*, 1988, **47**, (3), 34 - 38 *(Spanish)*.

The advantages of treating cane juice with dextranase and alpha-amylase so as to reduce the polysaccharide content and increase the refining quality and hence monetary value of the raw sugar are discussed.

Comparative techno-economic assessment of the different types of drive used in automatic centrifugals

E. Crespo I. and M. Balseiro E. *ATAC*, 1988, **47**, (3), 39 - 43 *(Spanish)*.

Comparison between A.C. and D.C. drives for automatic centrifugals showed that the D.C. drive has a number of advantages, including greater flexibility and efficiency (resulting in a final product that is more uniform and of higher quality), reduced maintenance, less noise and vibration, and lower energy consumption and costs of operation; however, it has two major disadvantages: (i) a high reactive energy consumption and hence low power factor and (ii) harmonics caused in the system by the non-linearity of the converter.

08 Kp steel for bearing plates in evaporators

Y. S. Novigrod and T. G. Porva. *ATAC*, 1988, **47**, (3), 48 - 53 *(Spanish)*.

Comparative tests on St-3 and 08 Kp steels have shown that the latter type has greater corrosion resistance than the former and meets requirements for weldability and machinability, so that it is suitable as a replacement for St-3 in evaporator bearing plates.

Investigation of design parameters of equipment for heating cane juice with direct vapour

N. Martínez, P. Nemirovich, P. Fabregat, A. P. Nikolaev, L. D. Bobrovnik, I. Ricardo, L. Casado and W. Burgos. *Centro Azúcar*, 1988, **15**, (2), 9 - 16 *(Spanish)*.

Clarification of mixed juice was improved after the juice had been treated in a direct-contact heater with high pressure vapour which promoted adhesion of coagulants to impurities. Clear juice colour, colloid and insolubles content was lower and its purity and settling rate higher than without heating. The best vapour:juice weight ratio was found to be 0.008, corresponding to a temperature difference of 6°C.

Inadequate topping and its effect on the sugar factory process

E. Valdes B., W. Burgos G., L. Crespo Z., N. González P. and J. Blanco G. *Centro Azúcar*, 1988, **15**, (2), 27 - 30 *(Spanish)*.

Although mechanically harvested cane supplied directly from Cuban fields

contained more extraneous matter than that from reception centres, the proportion of tops was lower. The inefficient topping at reception centres and the resulting adverse effect of the greater amount of water and undesirable solids introduced in the factory on processing are discussed.

Integral thermoenergy balance of Candido González sugar factory

A. Fontes H., P. de la Cruz, R. Tendai and R. González. *Centro Azúcar*, 1988, **15**, (2), 31 - 34 *(Spanish)*.

An integral heat energy balance was drawn up in order to determine the amount of live and exhaust steam consumed by individual pieces of equipment at a sugar factory faced with serious energy problems and to find a more rational way of utilizing bagasse. It was found that the turbogenerators and vacuum pans consumed excessive amounts of steam, with significant flue losses because of the absence of recovery means.

Adsorption of model colorants with ion exchange resins

J. B. de León B., M. Muro M. and I. Machado L. *Centro Azúcar*, 1988, **15**, (2), 35 - 42 *(Spanish)*.

In experimental decolorization of model caramel, melanoidin and alkaline degradation solutions using Kastel A-501-D strongly basic anion exchange resin in Cl^- form, the resin showed greatest affinity with alkaline degradation products and removed up to 94% of this colorant. The contact period was the major factor in removal of melanoidin and alkaline degradation products, while the initial colour concentration governed the removal of caramel. Optimum conditions included a temperature of 80°C, a minimum contact time of 15 minutes and a resin usage of 0.5% of the initial colour concentration.

Evaporation schemes simulation and comparison of calculated results with data measured in the factory

L. Hernández C. and P. Kadlec. *ATAC*, 1988, **47**, (4), 18 - 22 *(Spanish)*.

A mathematical model of evaporation was developed and a simulation program used to calculate process parameters in a quintuple-effect system. Comparison with true results indicated: (i) a calculated initial Brix in each effect that was greater than the true value except in the final effect (where the values were identical), with the difference falling with each stage after the 2nd effect (where there was greatest discrepancy); (ii) a calculated steam pressure that was below the measured value in the first three effects but was greater than it in the fourth, while the values coincided in the 5th effect; and (iii) considerable fluctuation in the differences between calculated heat surface area requirements and the factory data.

Determination of the coefficient of efficiency of a centrifugal (entrainment) separator

R. González G., R. T. Sánchez, A. Fontes H., E. Martínez C. and R. Pérez H. *Centro Azúcar*, 1988, **15**, (3), 12 - 14 *(Spanish)*.

The performance of a centrifugal separator in a pilot-plant vessel operating as 2nd effect in a quadruple-effect evaporator was assessed by determining the sugar content in the condensate using the sodium citrate-sulphuric acid method. The results showed a separation efficiency of 99.97 - 99.99% in all 30 samples.

Development of a mixture for steel corrosion inhibition in 5% HCl

O. Cortijo J. and V. Berberena G. *Centro Azúcar*, 1988, **15**, (3), 22 - 38 *(Spanish)*.

A mixture of distillery wort and 2-(2-nitrovinyl) furan acted as an effective corrosion inhibitor in laboratory experiments with a low-carbon steel and in factory evaporator cleaning tests where HCl was used as descaler. Optimum results were obtained with 1.2% HCl and a mixture containing 35 ppm wort and 8 ppm of the furan derivative.

Analytical review of direct-consumption white sugar manufacture

C. Pérez B., I. Machado L. and S. Marrero A. *Centro Azúcar*, 1988, **15**, (3), 39 - 48 *(Spanish)*.

A review with 42 references is presented of the literature on manufacture of direct-consumption white sugar, including the design and performance of sulphur burners, syrup clarification methods, boiling and sugar storage.

Insoluble solids balance in the purification station at Carlos Baliño sugar factory

L. Carrazana R. and O. López P. *Centro Azúcar*, 1988, **15**, (3), 49 - 56 *(Spanish)*.

A balance of insoluble solids (including proteins, polysaccharides and wax) in juice showed that a parabolic screen for mixed juice was unstable in operation and performed poorly (possibly a result of the high proportion of very fine particulate material) as did clear juice and evaporator syrup screens; however, removal of the insoluble solids in clarification was fairly good. It was found that about 50% of the solids entering the clarifier emanated from filtered juice and a large proportion underwent changes during evaporation.

Analysis of the viscosity behaviour of sugar solutions in the presence of impurities

L. Z. de Cárdenas, C. Ruíz C. and J. Guerra D. *Centro Azúcar*, 1988, **15**, (3), 57 - 66 *(Spanish)*.

The influence of sucrose concentration (20, 40 and 60%), temperature (25, 40 and 60°C) and glucose, fructose and a 1:1 mixture of these on viscosity was examined at purities of 85, 90 and 95. Results showed a fall in viscosity with temperature rise and an increase in viscosity with concentration; at constant

sucrose concentration and temperature, viscosity rose in the presence of the monosaccharides, but the 1:1 mixture caused temperature and purity to have a smaller effect on viscosity than the individual hexoses. Temperature had less effect than purity.

Isolation and characterization of micro-organisms that produce dextranase

B. Guilarte, R. Cuervo, J. Rodríguez and N. Pacheco. *CubaAzúcar*, 1988 (July/Sept.), 13 - 19 *(Spanish)*.

Out of 200 different strains of micro-organism determined for their dextranase productivity, seven gave positive results, with *Penicillium funiculosum* HI-4 having the highest enzymatic activity. Details are given of the isolation and purification of the culture which is intended for use in hydrolysis of cane juice dextran.

Study of the effect of temperature and process time on progressive liming

J. C. Bango B., R. Fernández E. and J. Galindo G. *CubaAzúcar*, 1988 (July/Sept.), 25 - 29 *(Spanish)*.

A laboratory study of liming at 40 and 80°C for 6 and 10 min showed that 6 min at 80°C gave best separation of insoluble matter, colloids, phosphates and colouring matter as well as a higher settling rate and good filter cake compaction.

Temperature field in a Reto (CV-25-18) boiler

P. Beatón S. and E. Olivares G. *Ing. Energ.*, 1988, **9**, (3), 219 - 222 *(Spanish)*.

Results are discussed of an investigation of the temperature field in the furnace of a Reto No.2 (CV-25-18) bagasse boiler of 25 tonnes/hr steam output at a Cuban sugar factory, and causes of poor flame distribution are examined.

Features of the bagasse pelleting process

E. Silva L. and S. M. Shestakov. *Ing. Energ.*, 1988, **9**, (3), 261 - 266 *(Spanish)*.

Bagasse pelleting as a function of pressure (78.5 - 628.9 MPa), temperature (20 - 200°C) and residence time (20 - 60 sec) was investigated and empirical equations derived for calculation of pellet density. For a pellet size of 10 - 20 mm, the density should be 100 - 1300 kg/m^3 so as to guarantee long-term storage.

Increase in the wear resistance of grey iron

T. Porva and Y. S. Novigrod. *ATAC*, 1988, **47**, (5), 3 - 7 *(Spanish)*.

Normalization was applied to different types of grey iron (as used in the construction of sugar factory equipment) so as to increase its durability. It was found that the optimum normalizing temperature should coincide with the optimum temperature of tempering for the different types of iron. Normalization is recommended for couplings, trashplate and other components susceptible to abrasive wear.

Sucrose losses by hydrolysis. Development of equations for kinetic calculations of losses during bulk storage

J. A. Urrutia F. and E. L. Ramos S. *ATAC*, 1988, **47**, (5), 29 - 35 *(Spanish)*.

Equations were developed for calculation of losses in stored sugar as a function of pH, temperature, time, purity and moisture content. Experiments in which sugar of 98.0 and 97.5°S was stored for up to 150 days at 40°C demonstrated the validity of the equations and the reduction in losses brought about by syrup liming. It was also found that the rate of increase in colour content of sugar at constant purity and temperature was governed by the impurities content (particularly amino-acids) and pH.

Evaluation of the corrosive effects of sulphitation juice

L. A. López C. *ATAC*, 1988, **47**, (5), 43 - 52 *(Spanish)*.

The corrosion resistance of bronze and three grades of steel used in the manufacture of sulphitation equipment was determined in laboratory and factory tests. The microstructure of each steel is illustrated. X18HI0T proved to be the best steel, closely followed by a stainless steel, Type 410, while ST-3 had no corrosion resistance. Bronze used in juice pumps showed very good resistance and is recommended for this purpose.

Operating strategy for the pan station at Manuel Martínez Prieto sugar factory

L. Hormaza M., L. Toledo G., G. R. González, I. Riera G., I. Rasua A. and H. Pérez de A. *ATAC*, 1988, **47**, (5), 53 - 56 *(Spanish)*.

Analysis of pan boiling at the title factory using a number of computer programs indicated considerable losses of time, representing 45% of the total available per cycle; half of the time loss was due to shortage of feed material, while the other known causes included unavailability of facilities to receive massecuite at dropping, lack of steam and vacuum and failure to have the pan ready for the start of the cycle.

Velocity profile of corrosion of steel plates in sugar industry evaporators

O. Cortijo J., V. Berberena G. and D. Izada R. *Centro Azúcar*, 1988, **15**, (4), 3 - 10 *(Spanish)*.

Tests on corrosion inhibition in simulated evaporators provided with low-carbon steel tubes showed that G-O inhibitor at 40 ppm applied with 2.5% HCl as descaler gave best results in terms of weight loss (which was about one-third of that when no inhibitor was used), followed by 334 ppm Anticor-208. In all cases, corrosion increased with acid cleaning time and with distance from the evaporator wall.

Beet sugar manufacture

Present-day limitations to reduction in energy consumption in the sugar industry

P. Christodoulou. *Cukoripar*, 1990, **43**, 27 - 40 *(Hungarian)*.

See *I.S.J.*, 1989, **91**, 136.

Dependence of the minimum viscosity of sugar solutions on their supersaturation coefficient and purity

A. I. Gromkovskii and F. Hammud. *Dokl. Voronezh. Tekhnol. Inst.*, 1989, 10 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (6), Abs. 6 R1643.

The viscosities of pure and factory sugar solutions were calculated at varying temperatures and concentrations. Relationships were established between their optimum temperature (at which their viscosity was minimum), supersaturation and purity and proposed equations are presented. It was found that increase in supersaturation was accompanied by a shift in minimum viscosity to a region of higher temperatures.

Intensification of raw juice purification using activated polyacrylamide in preliming

V. A. Loseva, N. G. Kul'neva and N. V. Govorunov. *Dokl. Voronezh. Tekhnol. Inst.*, 1989, 7 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (6), Abs. 6 R1644.

A method has been developed for raising non-sugars removal efficiency in preliming by means of activated polyacrylamide. Optimum process conditions were determined as: activation by addition of ammonium sulphate at 0.005 - 0.015% by weight of flocculant solution followed by adjustment of pH to 11.4 - 11.6 with NaOH and introduction of the activated polyacrylamide to preliming at a juice pH of 7.8 - 8.5. The structure of the mud and the settling properties of the juice were examined when different preliming methods were used, and the colloid removal and purification efficiencies determined when activated polyacrylamide was used. The effectiveness and practicality of the process with polyacrylamide were confirmed in factory tests at Ramon sugar factory.

Ways of reducing sugar losses in filter cake

Yu. V. Anikeev, E. I. Vorob'ev, V. M. Samoletov, P. M. Barabanov and V. P. Ivakhno. *VNII Inf. Tekhn.-Ekon. Issled. Agroprom. Kompleksa, NII Inf. Tekhn.-Ekon. Issled. Pishch. Prom. (Obz. Inf. Ser. 23)*, 1989, (12), 1 - 27; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (6), Abs. 6 R1645.

Recommendations are made on methods of improving filter cake sweetening-off, and reduction in sugar losses in sweetening-off and drying is examined theoretically. New types of equipment and methods for sugar loss reduction in 1st and 2nd carbonatation juice filtration are described.

Modernization of ACWW-1000 continuous centrifugals

S. Banczak. *Gaz. Cukr.*, 1990, **98**, 1 - 5 *(Polish)*.

Changes that are being made to Polish ACWW-1000 continuous centrifugals for use in affination and *B*- and *C*-masscuite treatment are described, including alterations to the basket construction, changes to the drives and increase in the maximum speed, and modifications to the washing mechanism.

A second campaign of waste water treatment at Wroclaw sugar factory

B. Bielas and K. Kaminski. *Gaz. Cukr.*, 1990, **98**, 5 - 6 *(Polish)*.

The UASB (Upflow Anaerobic Sludge Blanket) system used at Wroclaw reduced the BOD_5 by 85.5 - 96.8% from initial levels of 8986 - 11,883 kg/day (the overall reduction in both the anaerobic and a subsequent activated sludge stage being 99.5 - 99.8% to 20 - 30 mg O_2/dm^3). The daily throughput was 2336 - 2498 m^3, energy consumption was 0.31 kWh/kg BOD_5 and 0.623 - 0.670 m^3 of biogas was produced per kg BOD_5.

Technological properties of wilted beets

V. A. Knyazev, S. N. Kalina, E. G. Tomilenko and L. N. Verbitskaya. *Sakhar. Svekla*, 1990, (2), 48 - 51 *(Russian)*.

Beets lose moisture not only during their growth period, harvesting and transport from the field but also during storage at the factory; solar radiation at low R.H. may cause intensive drying of beets to a depth of 0.5 - 0.6 m from the pile surface with considerable losses in weight and sugar. A method based on turgor restoration by sample immersion in water was found to be satisfactorily accurate at a wilting rate of 6 - 15%; at <6% wilting, it gave exaggerated values and at >15% the values were too low, although at 15 - 19% satisfactory results were obtainable by increasing the residence time from 2 to 4 hr or by introducing a correction for the 2-hr immersion. Tests showed that beets exhibiting up to 6% wilting absorbed the lost water within 24 hr, whereas even 144 hr immersion restored only 90 - 93% of the initial moisture in beets of 20 - 30% wilting rate. At an air temperature of 20°C and a R.H. of 50%, the beets in four weight fractions from 150 to 750 g lost the same percentage of weight (approx. 5%) in day 1, after which the wilting rate was greater in the smaller beets. The relative wilting rate (ratio between the mean hourly weight losses after 4 days and 1 day) increased with fall in the initial beets size and rose significantly with 50% R.H. as against 36%. A sharp fall in weight was accompanied by a considerable fall in sugar content and an increase in reducing sugars; in many cases there was also increase in the α-amino-N and alkali content (particularly Na) in beet extract, although no overall increase in the conductimetric ash content was found. Any weight loss was accompanied by increase in molasses sugar and a fall in purified juice purity and sugar

yield. Statistical analysis of experimental results showed that change in the major indices of beet processing quality as a result of wilting was exponential and $y = 0.00215\ x^2$, where y = total sugar loss and x = weight loss. Although the root lost moisture to a greater extent than the defoliated crown, wilting caused much greater sucrose degradation and non-sugars formation in the crown as a consequent of marked respiration.

The AVZ air cooler

V. N. Gorokh, A. I. Sorokin, B. F. Us and K. O. Shtangeev. *Sakhar. Svekla*, 1990, (2), 58 - 61 *(Russian)*.

An air cooler with a 90 kW, 5 m horizontal fan, rotating at 250 rpm, and six rectangular heat exchange sections (housing horizontal tubes) located at 60° relative to each other in a line above the fan was used in tests to condense pan and evaporator vapour and to cool incondensable gases. Results showed that the unit was not suitable for treatment of the incondensable gases (for which a supplementary cooler had to be used) and did cause some supercooling (because of the horizontal tube arrangement and condensate stagnation at deflections in the tubes), but the temperature of the pan vapour was reduced from 56 - 66°C by 23 - 56°C at a condensate output of 4 - 5 tonnes/hr. This allowed a reduction in fresh water consumption from 180 - 250 to 75 - 90 m^3/hr. Altering the angle of deflection of the fan blades from 5° to 24° increased the hourly air output from 250,000 to 600,000 m^3. The possible average annual monetary savings are calculated for a factory having an average daily beet slice of 3000 tonnes; these would result from simplification and reduction in costs of the water supply and waste water treatment and use of the condensate as diffusion water.

Two-phase continuous centrifugals in the sugar manufacturing process

B. Socha. *Gaz. Cukr.*, 1990, **98**, 21 - 24 *(Polish)*.

The design and operational features of CWA-1000 and SW-1000 A continuous centrifugals (bottom- and top-driven, respectively) for use as affination machines, with simultaneous molasses separation and crystal washing, are described with the aid of diagrams. The 30° sloping baskets have a maximum diameter of 1000 mm and spin at a maximum speed of 2050 rpm. Throughput of low-grade massecuite is 8 - 12 tonnes/hr. In tests in the USSR and Cuba the machines have handled 90 - 92°Bx magma of high purity without any difficulty. Details are also given of CWK-1000 and SW-1000 K continuous centrifugals designed to spin *B*-massecuites and simultaneously dissolve the separated crystals in thin juice to give a remelt liquor of 63 - 65°Bx. Massecuite throughput is 10 - 16 tonnes/hr and basket speed is 1860 rpm. The machines have performed to their design requirements in tests and have provided a colour reduction of the order of 60%.

Raw juice purification with the use of calcined filter cake

V. V. Mank, T. A. Mikhailik, L. G. Vorona and V. P. Leshchenko. *Izv. Vuzov, Pishch. Tekh.*, 1989, (4), 19 - 21 *(Russian)*.

Filter cake regenerated at 900°C was added in powder form at 0.6 - 1.6% by weight to raw juice that had been preheated to 85°C and fed into a mixer rotating at 30 rpm. During mixing for 1 - 10 min, samples were taken and their pH, filtration coefficient and colour determined as a function of mixing time and amount of filter aid. The lowest value of F_k was obtained after 1 min mixing which was sufficient to dissolve the CaO in the surface layer on the carbonate particles and aggregates and to coagulate the colloids and allow the carbonate to adsorb them. Increase in the mixing time reduced filtration, evidently because the adsorbed colloids passed back into the juice. Increase in the amount of powder caused a fall in F_k and colour to minima at 1.1 - 1.2% after which there was a steady rise while the pH continued to rise. In further tests, 1.1% regenerated filter cake was mixed with the juice for 1 min followed by liming for 20 min with 0.3 - 1.5% CaO and 1st and 2nd carbonatation. As a control, juice was prelimed at 85°C for 8 min with 0.3% CaO, then limed for 20 min at 90°C followed by 1st and 2nd carbonatation, and total lime consumption wa 2.8% CaO by weight; under these conditions, the colour content was reduced to 34.3 optical density units, the pH rose to 8.95, the lime salts fell to 0.48%, purity rose to 89.65 and a purification efficiency of 37.1% was achieved. By contrast, 0.85 - 1.0% CaO plus the filter cake gave approximately the same results while 1.5% CaO improved on them to give a purity of 90.85, a colour content of 36%, a lime salts content of 0.35% and a purification efficiency of 45.4%; the final pH was 9.05.

A mathematical model of a single-pass evaporator as object of operational control

A. N. Chagarov, F. V. Negoda and A. P. Ladanyuk. *Izv. Vuzov, Pishch. Tekh.*, 1990, (4), 64 - 66 *(Russian)*.

By elevating the steam temperature to a higher level than in a Robert evaporator, a film evaporator used as 1st effect benefits the units in a multiple-effect system and allows maintenance of a required Brix under stable conditions without vapour loss to the condenser. However, known stabilization schemes are unreliable for operational and quality control of evaporation under non-steady conditions. A mathematical model in the form of an orthogonal algorithm with control parameters derived from simulation results is particularly suited to a film evaporator of high unit capacity and allows maintenance of thermal and hydrodynamic conditions; for optimum operational control, economic efficiency is used as criterion in the form of a variable profit factor with allowance made for technological limitations. The validity of the model has been checked against actual conditions at a sugar factory.

Sugar refining

Design of a system for decolorization of clarified liquors with ozone on an industrial scale

L. A. Fernández, M. O. Bataller, G. D. Iglesias, R. Pérez, M. Gómez and R. Ramos. *CubaAzúcar*, 1987, (Apr./June), 36 - 40 *(Spanish)*.

On the basis of successful application of ozone to liquor decolorization on a laboratory and pilot-plant scale, a computer program was developed for the design of a full-scale plant for a refinery producing 300 tonnes of sugar per day. Values are given of design, operational and processing parameters and of required clarified liquor properties to provide best results.

Economic aspects of liquor decolorization with ozone

J. R. Pérez R. *CubaAzúcar*, 1987, (Oct./Dec.), 45 - 51 *(Spanish)*.

The economics of liquor decolorization using ozone in refineries of varying capacity are analysed and compared with those of other systems. It is shown that the use of ozone would allow a reduction or elimination of active carbon imports.

Indirect liquor carbonatation with calcium sucrocarbonates. Secondary effects

N. Alvarez, P. Perera and J. Buriánek. *ATAC*, 1988, **47**, (2), 30 - 35 *(Spanish)*.

A 20% aqueous sugar solution and a lime paste were mixed together in a 100:7 ratio to give a product containing 8% CaO, 18% sugar and 74% water. This was dried in a spray dryer with air at 304°C and a pressure of 137 kPa to yield a white non-hygroscopic sucrocarbonate powder resembling starch. When this was added to 60°Bx raw sugar liquor at 1% it reduced its colour by up to 45%. Treatment of raw sugar with sucrocarbonate at the factory reduced its hygroscopicity and thus improved its keeping properties during transport and storage; the treatment also helped to adjust the pH to a required level.

Study of the microbial content in Cuban refined sugars

M. López and M. T. Hernández N. *Centro Azúcar*, 1988, **15**, (2), 3 - 8 *(Spanish)*.

The bacterial counts were determined in samples from the different Cuban refineries over a 5-year period and the results tabulated for moulds, mesophiles and total and acid-forming thermophiles (no gas-forming thermophiles were found). The levels conformed to international standards.

The significance of the molecular weight of colouring matter in regard to its removal

A. Fariñas B. and E. González R. *Centro Azúcar*, 1988, **15**, (2), 17 - 21 *(Spanish)*.

High molecular weight colorants of the type usually found in refinery liquor (caramels, melanoidins and reducing sugar alkaline degradation matter) were found to be more easily removed by phosphatation than by active carbon treatment which removed more low molecular weight matter. This was the result of an investigation which demonstrated that molecular weight and not the nature of the colorant was the crucial factor governing its removal.

Analysis of the characteristics of different coagulants in regard to refinery effluent

Z. Herrera R., N. Alba D., I. Morell F. and M. Contreras M. *Centro Azúcar*, 1988, **15**, (2), 22 - 26 *(Spanish)*.

Laboratory experiments showed that bentonite reduced the suspended solids content and COD of the effluent of a sugar factory refinery section to a greater degree than an unconventional coagulant, Agent A, while alumina gave the poorest results. However, Agent A gave almost as good a performance as bentonite and has an economic advantage in that it is a Cuban waste product.

Experimental refinery: a necessity for the development of the Cuban sugar industry

R. Rodríguez E. *ATAC*, 1988, **47**, (3), 44 - 47 *(Spanish)*.

The major difficulties in refining are discussed and the benefits indicated of setting up a small-scale experimental refinery in the vicinity of Pablo Noriega sugar factory which would supply the raw sugar.

Experimental determination of the intraparticle diffusion coefficient for granular carbon

A. Curbelo S. and M. Muro M. *Centro Azúcar*, 1988, **15**, (3), 15 - 21 *(Spanish)*.

The intraparticle diffusion coefficient was determined for granular carbon used at varying volumes (0.16 - 0.50 litres) to decolorize 0.25 litres of 50°Bx liquor during a contact time of 30 min. Results showed the coefficient to have a value of the order of 10^{-7}/cm²/sec. Application of this value to the calculation of parameters for an industrial column gave a carbon service life of 22 days.

Application of static mixers and the addition of phosphoric acid to liquors on raw sugar refining

T. Prieto F., E. Hernández L., A. Márquez S., M. Martínez L. and D. Silveira C. *Centro Azúcar*, 1988, **15**, (3), 67 - 70 *(Spanish)*.

From a study of static pipeline mixing, an equation was derived for calculation of the length of pipeline (0.8 m) needed for adequate mixing of phosphoric acid and remelt liquor instead of tank mixing with which difficulties have been encountered at a named refinery. The advantages and economic effect of pipeline mixing are discussed.

Economic evaluation of the manufacture of quaternary amines for use in the sugar industry

J. R. Pérez. *CubaAzúcar*, 1988 (July/Sept.), 9 - 12 *(Spanish)*.

Techno-economic aspects of producing

quaternary amines were examined on a laboratory scale. While 500 ppm octadecyl ammonium acetate was expected to give a remelt liquor decolorization of 45% and thus comparable to the same dosage of Talofloc but at a much lower cost, 500 ppm of a 1:1 mixture with benzyloctadecyldimethyl ammonium chloride would give 55% decolorization; the chloride on its own at 500 ppm would give 63% decolorization but would cost more than the mixture.

Decolorization of refinery liquors with hydrogen peroxide

M. Posada, A. Macia and A. Cemillan. *CubaAzúcar*, 1988 (July/Sept.), 37 - 41 *(Spanish)*.

Regression equations are developed which relate to liquor decolorization as a function of hydrogen peroxide and phosphoric acid concentration in the presence and absence of a quaternary amine. Satisfactory agreement was found between calculated and experimental values obtained on an industrial scale, indicating the suitability of the equations for use in regulating the dosage rates. It was found that 1 kg of 35% hydrogen peroxide could replace 1.4 kg of active carbon when quaternary amine is not used or could replace 1.8 kg carbon when the amine is included, representing a substantial monetary saving. The peroxide-phosphoric acid process was also found to be more economical than phosflotation.

Evaluation of refined sugar boiling systems

T. Cruz C., A. Delgado R. and J. L. Sierra M. *ATAC*, 1988, **47**, (5), 23 - 28 *(Spanish)*.

A 7-massecuite system is described in which each boiling yields a marketable sugar and the run-off is used for the next boiling in the sequence. The *A*-sugar is boiled from a liquor of 98.98 purity and 75°Bx, and the sugar purities range from 98.25 to 82.92. The scheme has the advantage over the conventional 4-massecuite system used in Cuba of reduced syrup recycle, an increase in purity drop and a greater amount of total sugar produced. While the colour is adequate (ranging from 0.33 to 1.83%), it is necessary to ensure that the decolorization efficiencies for the last three sugars are >90% for *E*-sugar, >93% for *F*-sugar and >94% for *G*-sugar, since an efficiency below 90% may present difficulties in mingling.

Techno-economic considerations relating to liquor decolorization

J. Castañeda P. *ATAC*, 1988, **47**, (5), 36 - 42 *(Spanish)*.

Comparative tests showed that treatment of liquor with ozone removed the same quantity of colouring matter (85%) as did active carbon, while "colactivita" (using a bagasse pith product) removed 83%. The "colactivita" process is considered a suitable replacement for defecophosflotation and carbon treatment. The ozone process requires a liquor of 65°Bx while a Brix of 60° is adequate for "colactivita" treatment, with the advantage of thermotechnical stability and a saving in fuel; both processes are recommended for a refinery having a daily capacity of 200 tonnes. Ozone treatment does not produce any contaminating or corrosive waste, while used "colactivita" may be used for preparation of moulds and as a fertilizer additive.

Integral thermoenergy balance for a sugar factory/refinery

M. Napoles G., A. Fuego, M. González, M. Nyakurukwa and J. Junquera. *Centro Azúcar*, 1988, **15**, (4), 47 - 50 *(Spanish)*.

The thermoenergy balance of a cane sugar factory/refinery is analysed and a number of recommendations made.

The effectiveness of using VPK electrolyte in sugar solution purification

L. G. Vorona, V. V. Mank, V. F. Chernenko and T. A. Mikhailik. *Dokl. Kiev. Tekhnol. Inst. Pishch. Prom.*, 1989, 12 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (5), Abs. 5 R1486.

The effect of a cationic polyelectrolyte on raw sugar remelt purification was investigated and optimum process parameters determined. A method was developed for remelt treatment with VPK-101 polyelectrolyte and a reduced amount of lime. Simple evaluation of the optimum dosage rate of the polyelectrolyte using a proposed equation for continuous monitoring of the colour of remelts to be treated allows stabilization of their quality and hence the quality of the resultant consumption sugar with variation in the quality of the raw sugar intended for processing.

Automation of the control of sugar syrup turbidity at Mantulin refinery, Krasnopresnensk

Yu. A. Dmitriev, Zh. V. Stepanenko and B. S. Armer. *Mater. Vsesoyuz. Konf. Izmerit. Vychisl. Tekhn. Upr. Proizv. Protsess. APK*, 1988, (1), 119 - 120; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (5), Abs. 5 1494.

Experimental operation of a NIL-1 turbidity meter showed that supplying filter stations with a number of the instruments would allow automation of the filtration process, reduce the effect of the subjective factor and increase the period before regeneration of an ion exchange station for syrup treatment.

Investigation of the effect of temperature on purification of syrup from 2nd refined sugar with active aluminium oxide

V. V. Zueva, V. A. Loseva and E. N. Voitova. *Dokl. Voronezh. Tekhnol. Inst.*, 1989, 5 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (6), Abs. 6 R1647.

The effect of temperature on refinery syrup treatment with aluminium oxide was investigated under stationary conditions. The experimental data showed a rise in purity of the syrup as a result of decolorization by 0.32 units (a purification efficiency of 25.84%) at 40°C rising to 0.78 units at 80°C after which it fell to 0.73 units at 90°C.

Laboratory studies

Boundary electrical conductivity of certain ions in aqueous sucrose solutions

R. Alvarez B. and E. Martínez C. *Centro Azúcar*, 1987, **14**, (1), 8 - 11 *(Spanish)*.

Conductimetric measurements of alkali metal ions in 10% and 20% sucrose solutions showed that in all cases sucrose caused a fall in conductivity, with the effect of sucrose differing between ions. In no case did the fall correspond to an increase in viscosity and so did not conform to the de Walden rule. The conductivity increased in the order $Ca^{++} < Na^{+} < K^{+}$.

The formation of melanoidins

V. V. Chopik, A. Fariñas and E. González. *Centro Azúcar*, 1987, **14**, (1), 66 - 73 *(Spanish)*.

Melanoidins were synthesized by reacting glucose with an amino-acid and the model solution then fractionated by gel filtration. Ultraviolet and infrared spectra obtained for each of the three fractions are discussed. The fraction representing molecular weights in the range 5000 - 30,000 is the dominant one causing coloration in factory products.

Application of membrane filters to determination of the microbial quality of intermediate products in the refinery

M. E. Pérez R., M. T. Hernández N., N. Herrera C. and A. Portal P. *Centro Azúcar*, 1987, **14**, (2), 16 - 22 *(Spanish)*.

Results of microbiological studies on syrups, liquors and sweetwater demonstrated the suitability of membrane filtration with a membrane pore size of 0.45 mμ. Optimum sample concentration was 1% by volume, and best results were given by the McCleskey-Faville agar at an incubation temperature of 37°C during 24 hours.

Effect of dilution on refractometric Brix

L. Carrazana, C. Pérez and M. Mazorra. *Centro Azúcar*, 1987, **14**, (2), 23 - 29 *(Spanish)*.

A method is presented by which the true Brix of 1:1 diluted final molasses is calculated from the Brix of the original undiluted molasses.

Preliminary study on non-toxic clarifying agents for pol determination in raw sugar

F. H. Pérez S. and Z. Hernández B. *ATAC*, 1987, **46**, (3), 26 - 31 *(Spanish)*.

Aluminium sulphate, zinc sulphate and Carrez II reagent were tested as clarifying agents in place of lead subacetate for raw sugar polarimetry. Results showed that aluminum sulphate solution at a concentration of 0.70M gave pol values closest to those obtained with lead subacetate provided 0.80M NaOH solution was used to adjust the pH to 7.2 immediately after addition of the sulphate.

Use of the Fajardo formula with the core sampler or mechanical probe at Ingenio Central Castilla

O. Ospina L. *Mem. 2o. Congr. Soc. Colombiana Técn. Caña Azúc.*, 1987, (2), 667 - 671 *(Spanish)*.

According to the Fajardo formula used to calculate cane payment, sugar yield = (cane sucrose content - 0.03 Brix). Tests were conducted on use of the formula in conjunction with a core sampler, disintegrator and hydraulic press. Correlation between results for yield, pol, Brix and payment factor and values obtained by analysing 1st expressed juice was sufficiently high that the formula is considered suitable without any correction factor.

Role of carbohydrate degradation reactions in the stability of sugar industry products

E. L. Ramos S., J. A. Urrutia F. and R. G. González Z. *CubaAzúcar*, 1987 (July/Sept.), 9 - 15 *(Spanish)*.

A molasses sample was heated under reflux at 90°C and samples taken daily for measurement of the sucrose, reducing sugars, total sugars and amino-acid contents, pH after 1:1 dilution with distilled water and absorption at 460 nm of NaOH-diluted fractions after separation on Sephadex G-50. The polymer contents in the fractions were determined by weighing the precipitate obtained in an acid medium, while their infrared spectra were determined after mixing the solid fractions with KBr. A model molasses was prepared from sucrose, glucose, fructose, glycine and water in the same proportions as found experimentally and the pH adjusted to 6.5 with NaOH before heating under reflux at 80°C with occasional mixing. Colour, pH, amino-acids and carbonylic and Amadori rearrangement compounds were determined. Results, which are discussed, showed that neutralization and alkaline treatment were effective in decreasing sucrose losses during processing and caused an appreciable reduction in the risk of degradation during storage of sugars and molasses.

Comparative study of culture media used for the determination of fungi

M. López and M. T. Hernández. *Centro Azúcar*, 1988, **15**, (1), 69 - 72 *(Spanish)*.

Four culture media were compared for determination of moulds in refined sugar. No significant differences were found between them in the counts obtained, but Czapek agar was the cheapest and so preferred to potato-dextrose agar, Sabouraud agar and malt agar.

Comparative study of analytical techniques for determination of soluble calcium oxide

I. Alegret and J. Rodríguez. *ATAC*, 1988, **47**, (2), 48 - 52 *(Spanish)*.

Three methods were compared for determining the amount of CaO dissolved in juice: (i) in which 50% sucrose solution is added to a water-diluted sample followed by filtration and titration with sulphuric acid using phenolphthalein as indicator, (ii) involving addition of 35 -

40°Bx refined sugar solution to a water-diluted sample, the mixture agitated for 30 min, filtered and titrated with HCl with phenolphthalein as indicator, (iii) where 5% phenol is reacted with the sample which is filtered and titrated with HCl using methyl orange as indicator, and (iv) an iodometric method. Results showed no significant difference be tween the values obtained with the different methods and their repeatability was similar, but the iodometric method was the most rapid. The choice of method will depend on reagent availability and analysis time.

Mineral impurities - weight in the balance *versus* weight in the cost of sugar cane

J. A. B. Costa and H. J. S. Crespo. *Brasil Açuc.*, 1987, **105**, (4/6), 65 - 73 *(Portuguese)*.

Part of the function of the sugar factory laboratory is determination of the quality of the incoming raw material. Foreign matter in cane can have a considerable effect on the process and a survey of the effects of mineral impurities on cane fibre, pol, etc. is presented with the aim of provoking greater study of how cane payment in terms of quality as well as weight can be made more accurate.

Method proposed for determination of dextran in raw sugar

A. Rodríguez A., F. Fernández A. and R. González Z. *CubaAzúcar*, 1988, (Apr./June), 29 - 35 *(Spanish)*.

Comparison of the CSR modification of the Nicholson & Horsley method with that of Roberts for dextran determination in raw sugar showed that the former was more suitable as a control method in Cuba since it gave a higher recovery (100% as against 75 - 85%), a repeatability of 20 ppm by comparison with 155 ppm and was less laborious. Both methods are described and experimental results analysed.

Evaluation of two colorimetric methods for determination of phosphorus in cane juice

M. L. Rodríguez, L. Martínez and J. A. Quintana. *ATAC*, 1988, **47**, (4), 35 - 41*(Spanish)*.

The P_2O_5 content in cane juice was determined by two colorimetric methods: (i) based on addition of ammonium metavanadate as reducing agent and measurement of the resultant yellow colour, and (ii) based on formation of a complex between phosphomolybdic acid and malachite green. No significant difference was found between the results of the two methods and neither their precision nor their accuracy was affected by the presence of Ca, Mg and Si. However, method (ii) is preferred as it is more rapid and less expensive.

Study on the fate of reducing sugars during raw sugar manufacture

E. L. Ramos, J. Rodríguez and S. Karamurza. *ATAC*, 1988, **47**, (4), 42 - 47 *(Spanish)*.

A zonal adsorption method of separation is described for determination of reducing sugars conversion to polymeric colorants (alkaline degradation products) in which the colorants are adsorbed on Sephadex G-10 with diluted 0.1N formic acid used as buffer; those substances not adsorbed are eluted with acid and the retained colorants then eluted with 0.1N ammonium hydroxide. The proportion of glucose degraded can be found using ^{14}C-labelled glucose. Some results obtained are discussed. Amino-acids had no catalytic effect on hexose degradation during clarification.

Surface structure of the sucrose crystal

M. Saska. *Zuckerind.*, 1990, **115**, 118 - 120.

The relative growth rates and habit of a crystal are governed by internal factors (related to the crystal structure of each face) and external factors involving the solvent and impurity effects. In a study of the solvent effects in crystal growth, the individual faces of the sucrose crystal were characterized by determining the accessibility of the van der Waals-sized surface atoms to a spherical probe representing the solvent molecule. The smooth surface generated by rolling the probe along the crystal surface consists of (i) solvent-accessible parts where the probe touches only one atom at a time and (ii) re-entrant parts where two or three atoms are touched simultaneously. Details of the radii and positions of the individual C, O and H atoms obtained by rolling the probe over the 90 atoms located at the surface (the other atoms serving as blockers to provide solid neighbours) were fed into a "supercomputer" for calculation of the accessibility of the five major crystal faces (a, c, d, p and p') to solvent molecules of varying sizes, thus yielding values of the solvent-accessible areas (SAA) of the individual atoms as well as their derivatives with respect to the radius of the solvent molecule. It is intended to use these two factors to provide better solvent-effect correction factors for previous theoretical predictions of the growth habit of the sucrose crystal.

Evaluation and determination of the recoverable sugar in sugar cane

J. E. Larrahondo A. and J. S. Torres A. *GEPLACEA Bull.*, 1990, **7**, (3), 5 pp.

Factors influencing the determination of recoverable sugar are listed and methods described, including a brief mention of those based on primary juice analysis and direct analytical procedures using the dry and wet methods. Disadvantages of the methods based on primary juice are the dependence of Brix, purity and pol on the percentage of juice extracted (mill pressure) and failure to allow for the effect of fibre content. The benefits of using a hydraulic press as in the dry method are indicated, although wet disintegration is a suitable alternative where a press is not available. The importance of good sampling, whereby trash and deterioration of the juice are eliminated, is mentioned.

By-products

Organic residues of the cane agro-industry. 1. Physical and chemical characteristics

C. C. Cerri, A. Polo, F. Andreux, M. C. Lobo and B. P. Eduardo. *STAB*, 1988, **6**, (3), 34 - 37 *(Portuguese)*.

A comparison is made between the physical and chemical characteristics of bagasse, filter-cake and vinasse. The vinasse has the greatest content of organic nitrogen, nutrients and ash, bagasse the least and filter-cake between the two. Organic matter extracted by alkaline reagents are of a humic nature similar to those found in the soil except that fulvic acids predominate over humic acids.

Economic effect of depithing alternatives in the production of paperboard

E. González S. and R. García J. *Centro Azúcar*, 1988, **15**, (1), 73 - 78 *(Spanish)*.

Bagasse wet depithing was compared with screening and use of the Horkel swing hammer mill in economic terms. The Horkel system is not recommended, whereas a combination of screens and a small-scale wet depithing system would be economically suitable and be adequately efficient.

Glucose from sucrose. Study of operational parameters

E. Duarte P., G. Lago M. and A. Fariñas B. *Centro Azúcar*, 1988, **15**, (1), 79 - 86 *(Spanish)*.

The feasibility of producing crystal glucose and fructose syrup from invert syrup was determined in a laboratory system in which 0.5 g of glucose and varying quantities of ethanol were added to 200 ml of 90% inverted syrup after it had been concentrated by vacuum evaporation. Up to 42% glucose yield was obtained at an initial syrup Brix of 83 - 85°, addition at 50°C of 20 - 25% ethanol by weight and a retention time of 72 hours.

Monochloroacetic acid: the effect of its addition on the production of carboxymethyl cellulose

S. Askienasi, B. García, I. Menéndez C. and V. García. *ATAC*, 1988, **47**, (1), 2 - 6 *(Spanish)*.

Experiments are reported in which bagasse pulp was reacted with NaOH at 19% concentration to form cellulose alkali at 20 - 25°C, monochloroacetic acid then added with constant stirring at 40 - 50°C followed by drying and grinding of the carboxymethyl cellulose (CMC) obtained. Results showed that addition of a total of 62% of the acid in two equal doses 45 and 75 min after the start of the process gave the maximum degree of substitution (0.68) of the CMC. This compared with a degree of substitution of only 0.20 when 13% acid was added at the start.

Evaluation of some biotechnological alternatives for diversification of the sugar industry

E. L. Olguín, P. Téllez and J. González. *Rev. Asoc. Técn. Azuc. México*, 1988, **2**, (1), 18, 20 - 22; (2), 11 - 12 *(Spanish)*.

A survey is presented of fermentation processes employing *Saccharomyces cerevisiae* and *Zymomonas* spp. for production of fuel ethanol from sugar factory waste and by-products and for treatment of vinasse to provide fertilizer and single-cell protein. The applicability of the processes to Mexican conditions is assessed.

Biomass and the sugar economy

E. Orozco C. *Rev. Asoc. Técn. Azuc. México*, 1988, **2**, (2), 29 - 32 *(Spanish)*.

Biochemical and thermochemical utilization of cane by-products is briefly discussed, particularly concerning filter cake, bagasse and vinasse.

Effects of two methods of filter cake application on some soil properties

E. Pineda R. and N. Arzola P. *Ból. Inst. Nac. Invest. Caña Azúc.*, 1986, (3), 38 - 49 *(Spanish)*.

Application of filter cake at 65 tonnes/ha to canefields raised the T value and appreciably increased the exchangeable Ca content but had no effect on pH, hydrolytic and exchangeable acid, K or P.

Optimization of the process of alcoholic fermentation by means of fed-batch operation

J. N. de Vasconcelos and B. Valdman. *Brasil Açuc.*, 1988, **106**, (2), 38 - 48 *(Portuguese)*.

The study described was aimed at optimizing alcohol fermentation by fed-batch operation and variable withdrawal of the must. Progress of the fermentation was monitored by hourly sampling and analysis of reducing sugars, cells, ethanol, cell volume and Brix. The results are considered to show that the technique is more efficient than the conventional batch process for most indices of productivity.

Methodology for techno-economic modelling of the Jatibonico pulp plant

E. González S., I. Rodríguez R. and D. Rodríguez G. *Centro Azúcar*, 1988, **15**, (2), 43 - 53 *(Spanish)*.

A mathematical model of the technical and economic aspects of the process for bleached pulp manufacture from bagasse at the Jatibonico paper mill in Cuba is described.

Determination of statistical relations in the treatment of paper shavings at Jatibonico

E. González S., M. Morales P., M. López C. and B. Arregoitia O. *Centro Azúcar*, 1988, **15**, (2), 54 - 57 *(Spanish)*.

A study was conducted on the physical properties of paper shavings recycled from the paper machine to the mixer where wood pulp is combined with bagasse pulp, and a mathematical model was developed to describe the treatment of the shavings.

Determination of the heat cycle efficiency in a paper machine

G. Rumbaut S., E. González S. and B. Guirado G. *Centro Azúcar*, 1988, **15**, (2), 58 - 62 *(Spanish)*.

The utilization of heat for drying in a paper machine at a mill using bagasse semi-chemical pulp as raw material and the resultant weight of the paper are discussed.

Optimization of a stage with recycle in the paper industry

I. Rodríguez R., M. Estrada G., A. Valdivieso, E. González S. and D. Rodríguez G. *Centro Azúcar*, 1988, **15**, (2), 63 - 68 *(Spanish)*.

A preliminary study of unbleached bagasse pulp manufacture at a paper mill was carried out and mathematical models developed to describe the digestion, washing and classification processes with the aim of establishing optimum conditions.

Effects of hydrolyses on alcoholic fermentation. 2. Enzymic hydrolyses

M. O. Marques, J. Horii, J. P. Stupiello and E. B. Malheiros. *STAB*, 1988, **6**, (4/5), 49 - 52 *(Portuguese)*.

In order to make available for fermentation the constituents of polysaccharides in juice and molasses, they were subjected to the action of hydrolytic enzymes including alpha-amylase produced by *Bacillus subtilis* and amyloglycosidase produced by *Aspergillus niger*. The effects of the treatments were assessed by measuring the residual reducing substances, fermentation efficiency and conversion efficiency. The second enzyme proved superior to the first. A detailed study is necessary under controlled conditions of temperature and pH to examine the economics of its use.

Organic residues of the cane agroindustry. 2. Biological decomposition under controlled conditions

A. Polo, F. Andreux, C. C. Cerri and M. C. Lobo. *STAB*, 1988, **6**, (4/5), 53 - 56 *(Portuguese)*.

Bagasse (B), vinasse (V) and filter-cake (T) were used to prepare mixtures – 1:2 B:V and 1:1:1 B:V:T – for use as compost substrates. The mixtures were allowed to incubate for three months at 28°C under controlled soil moisture of 60% with and without correction of the C/N proportion and pH by addition of ammonium sulphate and gypsum, respectively. Only in the BT mixture did these corrections bring about a stimulation of the decomposition rate, but final changes in the weight and chemical properties of the materials were similar in all cases. Weight losses which attained 35% at the end of incubation occurred mainly during the first month in both mixtures. The C/N ratios decreased owing to carbon loss and the total exchange capacity tripled owing to oxidation of the materials. Water retention also increased independently of weight loss.

Pumping of vinasse: a study on loss of head

J. G. Peres and S. Suzaki. *Brasil Açuc.*, 1988, **106**, (3), 2 - 8 *(Portuguese)*.

A study of vinasse pumping was carried out to test the applicability of a number of formulae for the dimensioning of hydraulically smooth pipes. In addition, the specific mass, dynamic and kinematic viscosities of the vinasse were determined. The results obtained were similar to those for clean water.

Influence of the quality of final molasses on the efficiency of plants producing dry torula fodder yeast

A. López A., G. M. Kagana, R. Santos G. and H. Díaz P. *ATAC*, 1988, **47**, (3), 14 - 16 *(Spanish)*.

Results from a fodder yeast plant in Cuba are used to demonstrate the savings in final molasses that are made possible by enzymatic hydrolysis of the molasses. The hydrolysis is recommended because of the high sucrose and low reducing sugars contents typical of the molasses supplied.

Determination of the stages and basic variables in the paper manufacturing process using an experts' method

J. M. Delgado M., I. Gallardo A., E. Acevedo V. and H. Escandell F. *Centro Azúcar*, 1988, **15**, (3), 71 - 76 *(Spanish)*.

The requisite stages in the pulping, paper and power sections (the last section including water treatment and generation of steam and electricity) and important process variables in a bagasse paper plant are set out as selected by a group of experts.

Liquid sucrose. Profitable substitution of refined sugar in the pharmaceutical industry

I. Galbán, R. Consuegra, A. Rivero and M. López. *ATAC*, 1988, **47**, (4), 23 - 29 *(Spanish)*.

A system was developed for liquid sugar manufacture from refinery liquor which included active carbon treatment followed by filtration and further decolorization to 12 ICUMSA units using anion exchange resin, demineralization with cation and anion exchange resin and evaporation to 65°Bx and cooling to 30°C for storage; the final sucrose concentration was 63.3%, the invert sugar content 1.2% and ash content 0.04%. Counts of mesophiles, thermophiles, yeasts and moulds were below international limits. The quality of the product was greater than that of liquid sugar not subjected to resin demineralization and its storage properties were better. The economic benefits of replacing refined crystal sugar with the liquid product in the food and pharmaceutical industries are indicated.

Utilization of soil as purification medium for waste water from a torula yeast manufacturing plant

J. Z. Junco H., A. Márquez S., A. Dorta H. and E. Hernández L. *ATAC*. 1988, **47**,

(4), 48 - 55 *(Spanish).*

Column experiments showed that waste water from a yeast plant could be treated by percolation through soil. Results indicated a reduction in COD, total solids, N, P, K, Ca and Mg. Best results were obtained when the waste water was first diluted to 25% of its normal concentration. Dilution also reduced the corrosive properties of the waste, which had an initial pH of 3.3 and a final pH of 0.2.

Economic assessment of cane waste drying and compaction for export

O. Santana P. and M. Cordovés H. *CubaAzúcar*, 1988 (July/Sept.), 3 - 8 *(Spanish).*

The economics of collecting, crushing, drying and compacting cane waste intended for export as animal fodder at an annual rate of 10,000 tonnes during a 150-day season at a cane reception centre are analysed and a suitable technology described.

From bagasse to newsprint

N. Pérez A. and J. Ramón G. *CubaAzúcar*, 1988 (July/Sept.), 20 - 23 *(Spanish).*

Details are given of a project, Cuba 9, approved by the UN for manufacture of newsprint from bagasse which is suitable for any cane-growing country. The properties of the newsprint and the advantages of the scheme are indicated.

Synthesis of technical-grade CMC on a pilot plant scale using bagasse paper pulp by the suspension process

R. Hernández, L. García, R. Guadarrama and G. Mieres. *CubaAzúcar*, 1988 (July/Sept.), 30 - 36 *(Spanish).*

A process is described for manufacture of carboxymethyl cellulose from bagasse paper pulp which involves suspension in aqueous alcohol. The properties of the product are compared with those of imported CMC and the process conditions are compared with those used in a pressing technique.

Manufacture of invert syrup in Mexico. A real alternative towards diversification of the sugar industry

M. Enriquez P. *Rev. Asoc. Técn. Azuc. Méx.*, 1989, **3**, (1), 19 - 20, 22 - 23, 25 - 26 *(Spanish).*

Laboratory and pilot plant studies on Melacon high-test molasses manufacture at a Mexican sugar factory are reported and scale-up to industrial production and marketing of the product for e.g. yeast, L-lysine and monosodium glutamate manufacture and as feed for honey bees are discussed.

Preliminary study on the use of zeolite as support for the enzymatic inversion of sucrose

G. Lago, E. Duarte and M. Hernández. *Centro Azúcar*, 1988, **15**, (4), 51 - 58 *(Spanish).*

Zeolite from a Cuban source proved excellent as a support for immobilized invertase from *Saccharomyces cerevisiae*. In column tests, 95% inversion of sucrose was obtained at a sucrose concentration of 1.8M, a zeolite particle size >30 μm, 3 ppm of yeast (on zeolite), a temperature of 50°C and a flow rate of 0.8 - 1.0 ml/min.

Critical examination of anhydrous ethanol as motor fuel

F. Caballero P. *Rev. Asoc. Técn. Azuc. Méx.*, 1989, **3**, (3), 11, 13, 15, 17 *(Spanish).*

The pros and cons of producing anhydrous alcohol for use as a 20:80 alcohol: gasoline mixture in Mexico are examined. Two possibilities considered are: production of alcohol from molasses that is normally exported, and erection of an autonomous distillery with a crushing capacity of 4500 tcd. In both cases, a 100,000 litres/day distillery would be required. A major benefit would be the reduction in atmospheric pollution.

Utilization of sugar industry by-products in calf feed at Córdoba, Ver.

R. R. García, A. A. Yépez and J. C. O. Torres. *Rev. Asoc. Técn. Azuc. Méx.*, 1989, **3**, (3), 17, 20, 22, 25, 28 *(Spanish).*

A trial is reported in which fattening calves were fed for 258 days on a ration containing 15% sorghum, 26% molasses, 10% vinasse and 18% bagasse pith; an average weight increase from 218 to 433 kg was recorded, and the feed conversion rate was 17.11:1. In a further experiment, the inclusion of 10% dehydrated vinasse in a ration containing 18% sorghum and 26% molasses increased the average daily weight gain by 7% by comparison with that when no vinasse was included.

Inoculation of highly pressed beet pulp with lactic acid-producing bacteria

K. Mossakowska, E. Laskowska and K. Gozdek. *Gaz. Cukr.*, 1990, **98**, 13 - 18 *(Polish).*

Tests are reported in which beet pulp, with or without addition of 2.5% molasses by weight, was inoculated with lactic acid bacteria at 5 - 6 dm^3/tonne with the aim of preventing dry solids loss and providing optimum fermentation conditions during its ensilage. Comparison of results obtained 3 days and 6 months after initial storage showed that treatment of non-molassed pulp failed to have the desired effect since levels of acetic acid followed by butyric acid exceeded those of lactic acid, with butyric acid developing at a rapid rate; on the other hand, no butyric acid formed in the molassed pulp at any stage and the lactic acid level far exceeded that of the acetic acid. However, optimum fermentation occurred in molassed pulp without any lactic acid bacteria inoculation. It is recommended to increase the sugar content of the pulp before addition of molasses and to ensure a dry solids content no lower than 20%.

Operation of the resin decolorization station at Thames Refinery

By Anthony B. M. Latham
(Tate & Lyle Sugars, London)

Introduction

Thames Refinery operates 24 hours per day, 7 days a week, shutting down for 3 to 5 days at Christmas, Easter and August holidays. Over one million tonnes of raw sugar are refined each year. In 1981, as part of the overall plan to reduce operating costs, it was decided to replace the hydraulic char decolorization plant with an automatic resin decolorization plant.

The resin plant was installed in 1984/85 and 12 of the 32 cisterns of char were replaced with CAL carbon for the production of liquid sugar and to maintain the integrity of the organoleptic qualities of the liquor. To meet the requirements of the United Kingdom market, the decolorization plant is required to produce fine liquor of 80 I.U. colour to ensure that the white crystalline products conform to the specification of 17 I.U. colour.

This paper gives the operating experience and performance data of the resin plant from the end of 1985, when it was commissioned, until the end of March 1989.

Processes before decolorization

The cane raw sugar, received from a number of countries, is variable in quality and each origin has its own characteristics. It is not possible to select the origin of raw sugar to melt. The colour of the raw sugar varies from 1500 to 10,000 I.U. with an average of 3500 I.U. Colour occluded in the crystal varies from 500 to 1500 I.U.

The affination process removes about 60% of the whole raw sugar colour taking into account the colour recycled from recovery (remelt) and sweet water. The raw liquor produced has colour in the range 800 to 1800 I.U., with an average of 1250 I.U.

The carbonatation/filtration process removes 50 - 60% of the raw liquor colour to give filtered liquor to the resin plant with colours in the range of 400 to 900 I.U. and an average of 550 I.U. Filtered liquor contains 62 - 65% solids and is at pH 8.2 - 8.6, while its temperature is 78 - 80°C.

Decolorization plant

Resin cells

There are 16 flat-bottomed decolorizing cells, originally designed to have 11 m^3 of resin in each cell, but now containing 13 m^3 of resin. The cells are arranged in parallel in 3 stages, with the output from each stage being the input to the next. The first two stages of five cells contain macroporous acrylic resin and the third stage of six cells contains macroporous styrene resin.

The flow diagram of the plant is illustrated in Figure 1, with diagrams of the resin cell and regenerator vessels in Figures 2 and 3, respectively.

CAL Carbon

10 - 15% of the liquor from the Acrylic 2 stage is further decolorized by CAL carbon in two cisterns to 60 I.U. colour for liquid sugar products. The liquor after the styrene stage passes over nine CAL cisterns in parallel to give a final polish decolorization and to ensure the integrity of the organoleptic qualities of the liquor prior to the evaporation stage.

The CAL cisterns each contain 12.5 tonnes of carbon which is regenerated off-site by the suppliers. One cistern is regenerated every 7 to 14 days

Paper presented to Sugar Industry Technologists, 1989.

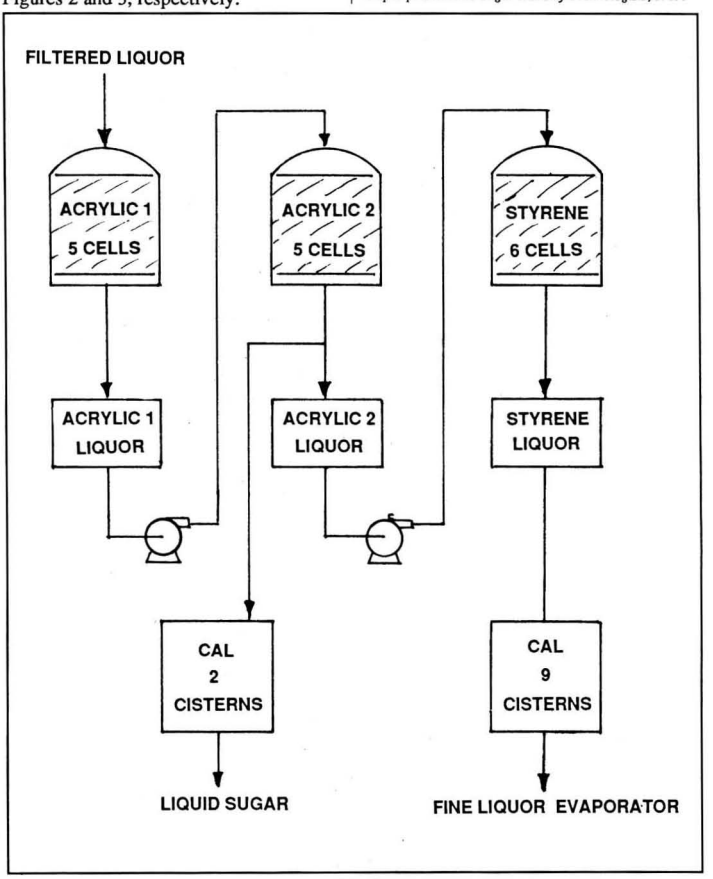


Fig. 1

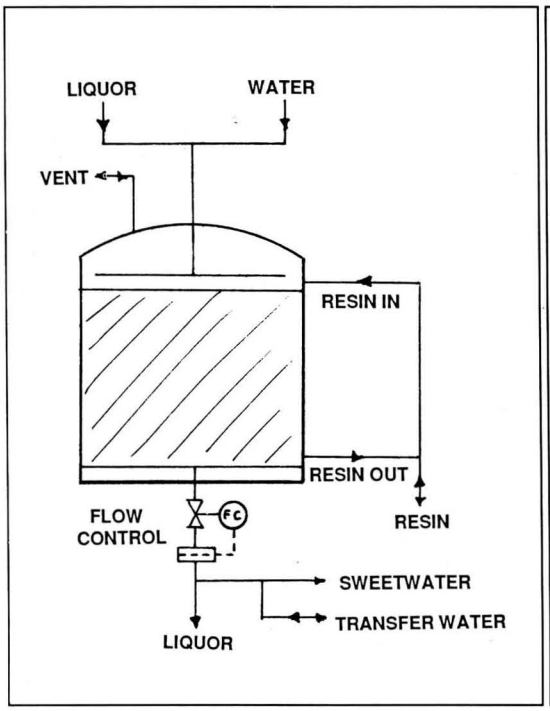


Fig. 2. Resin cell

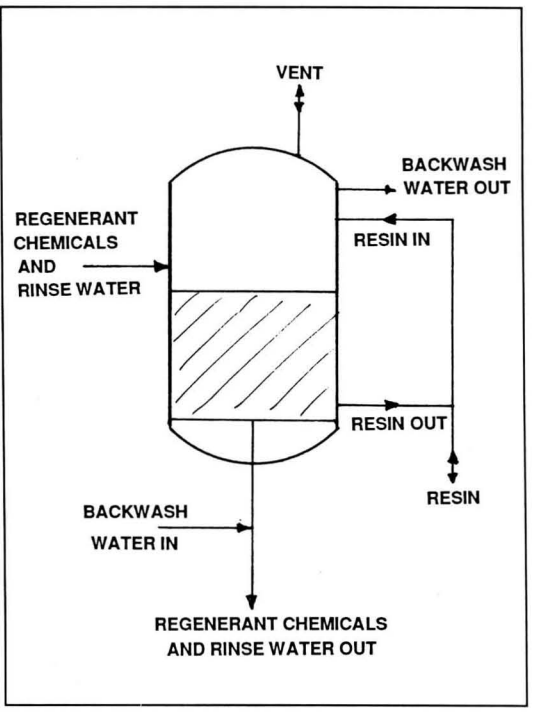


Fig. 3. Regenerator vessel

with an average regeneration tonnage of 0.05% on melt.

Resin regeneration

The resin is regenerated externally, with alkaline brine, in a separate building. Dedicated to each stage there is a regenerator and a holding vessel, to store regenerated resin. A fourth regenerator acts as a spare for the other three and for pretreating new resin.

The regenerant used is alkaline brine which is reclaimed from the styrene resin regeneration and re-used for the acrylic 2 and acrylic 1 resins in series. The concept of external regeneration was first seen in power station condensate polishing systems. It minimizes downtime on the cells, enables the preferred height to diameter ratios for cells and regenerators to be used and keeps regeneration chemicals out of the process buildings.

Transfer of resin

Resin is transferred hydraulically around the system. Resin damage is minimal at less than 0.4% per year, requiring no top-up. To keep the charges of resin discrete, and to prevent mixing, 99.9% complete transfers are required.

The installed system works very well and the only difficulties have been with resin clumping (aggregating) in the cells after a cycle in excess of 80 hours and in the regenerators after an acid treatment. In these cases the resin is air sparged prior to transfer. Why the resin aggregates after an acid treatment remains a mystery yet to be solved.

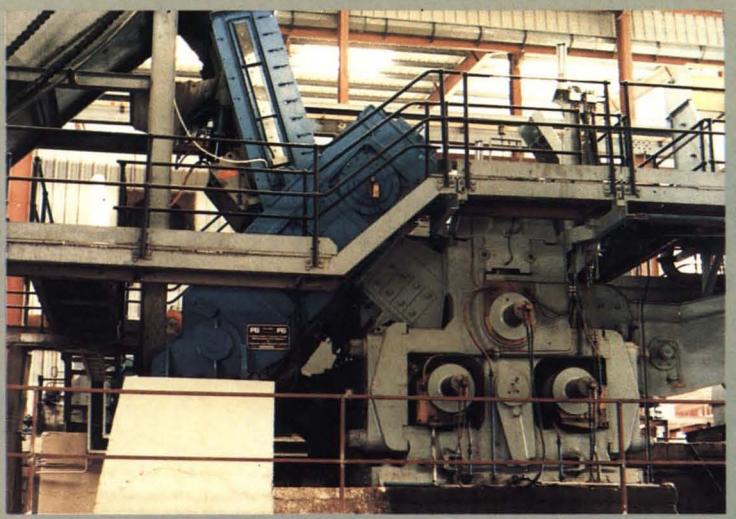
Associated plant

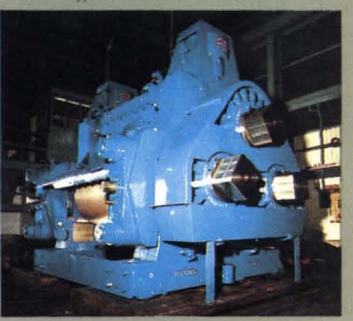
Associated with the plant are the liquor buffer tanks, a sweetwater tank, water tanks for backwash, transfer, and rinse waters, and chemical storage tanks for sodium chloride, sodium hydroxide and hydrochloric acid.

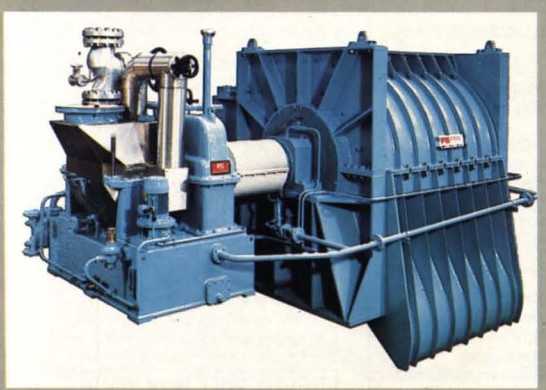
The water storage tanks enable

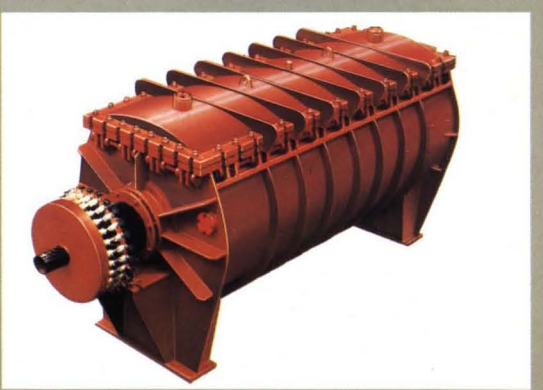
Table I. Plant data

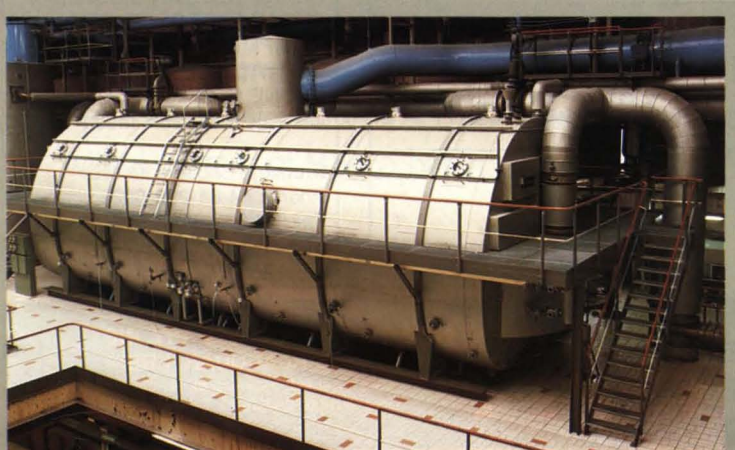
	Cell	Regenerator
Diameter, m	3.0	2.5
Height (shell length), m	1.85	4.65
Height (overall), m	2.65	6.05
Working volume, m^3	16	22
Material of construction	Stainless steel	Mild steel, rubber lined
Nozzles	120 on	88 on
(Wedgewire stainless)	250 mm matrix	240 mm matrix
Slot size, mm	0.2	0.2











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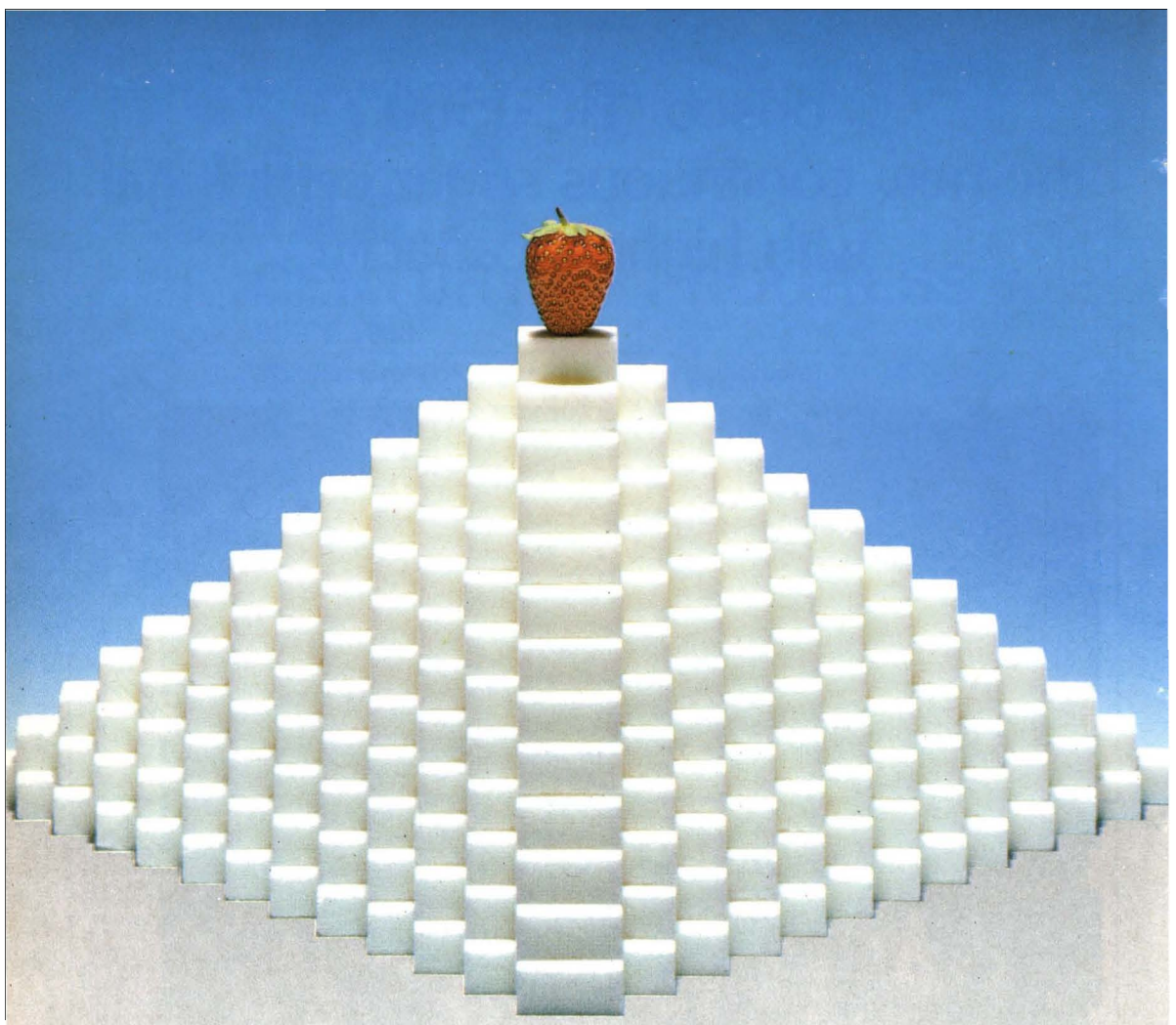

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La química de especialidades

water usage to be minimized by reclaiming part of the rinse water for backwashing and re-use of the transfer water.

Agreement was reached with the local authorities on the nature and volume of the effluent to be discharged from regeneration.

In general the effluent does not require treatment with chemicals but it can be treated with acid or alkali to meet the trade effluent requirements prior to being cooled and discharged to the sewer.

Manning and control

The decolorizing and regenerating plants are computer-controlled, as described elsewhere[1], as are some of the operations and controls. There is one process operator on each shift to monitor the plant and also to be responsible for the evaporator station.

Plant data

Some of the cell and regenerator plant details are given in Table I. The regenerator nozzles were originally P.V.D.F. rings with spacers to give 6 × 0.2 mm slots but these kept blocking with resin. They were replaced with Johnson stainless steel wedgewire nozzles which operate very well with no blockages.

Water passes through the nozzles in each direction and the internal side of the nozzles is protected by a separate in-line self-cleaning strainer having a 200 micron screen.

Operational and performance data

New resin pretreatment

All pretreatments are carried out at 15 - 20°C.

Acrylic resin: The resin is backwashed and then regenerated with 10% brine. After rinsing with cold water, the resin is heated slowly to 75°C by recirculating water, which is gradually increased in temperature, through the resin.

Styrene resin: To minimize the risk of trimethylamine being released into the liquor, the styrene resin is given a lengthy pretreatment which takes 3 days. The resin is backwashed and then treated with 4% NaOH followed by 0.5% NaCl. The caustic soda/salt treatment is carried out three times and then the resin is rinsed and heated slowly to 75°C.

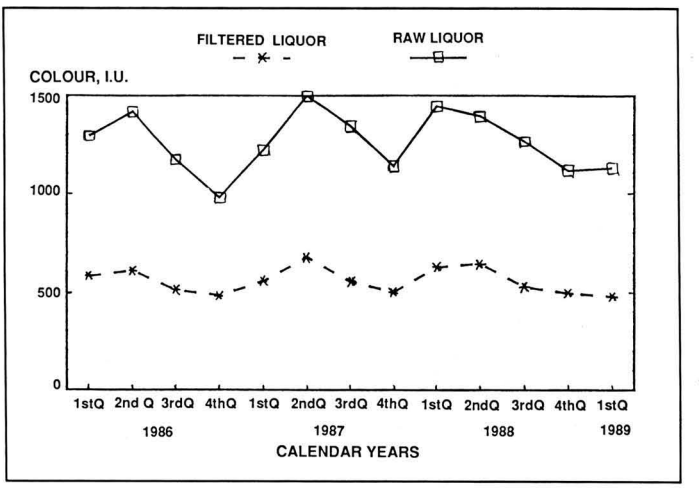

Fig. 4. Colours

Resins used in the plant

The following resins have been and are being used. All new resin is delivered in 1 m³ intermediate bulk containers (I.B.C.'s).

Acrylic

Rohm & Haas	IRA 958S
Bayer	AP 247A
Purolite	A 860

Styrene

Rohm & Haas	Duolite (Disa) A171S

1 Fitzpatrick: *Paper presented to Sugar Industry Technologists*, 1989; *I.S.J.*, 1989, **91**, 84.

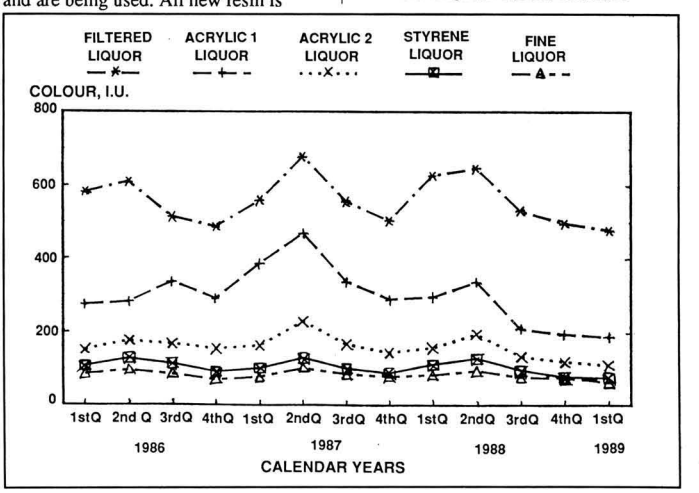

Fig. 5. Colours

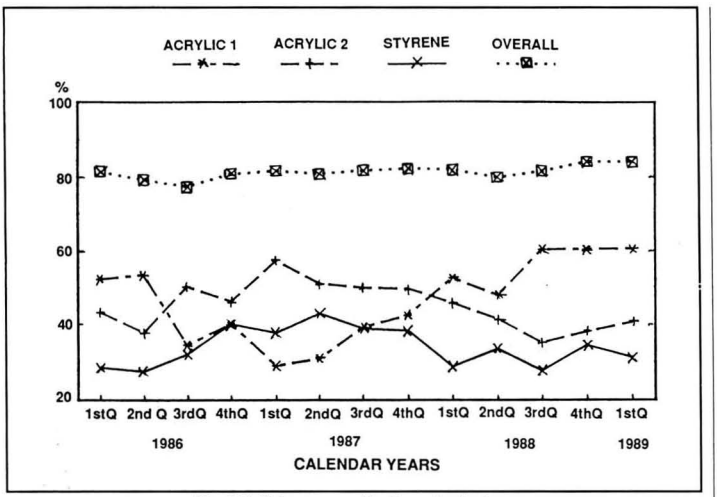

Fig. 6 % Colour removal in the resin plant

Rohm & Haas	IRA 900C
Dow	M.S.A. 1
Sybron	Relite D182
Bayer	MP 500 A

Operational data

Cells:	
Sweetening on	1.4 B.V.*/hr; 1.0 B.V. sweetwater
Sweetening off	2.5 - 3 B.V./hr; 2 B.V. sweetwater

Cycle length	
Acrylic 1 & 2	40 - 60 hr
Styrene	48 - 72 hr

*B.V. = Bed volume, currently 13 m^3

Transfer times:	
Cell to regenerator	25 - 40 min
Regenerator to holding vessel	25 - 40 min
Holding vessel to cell	25 - 40 min

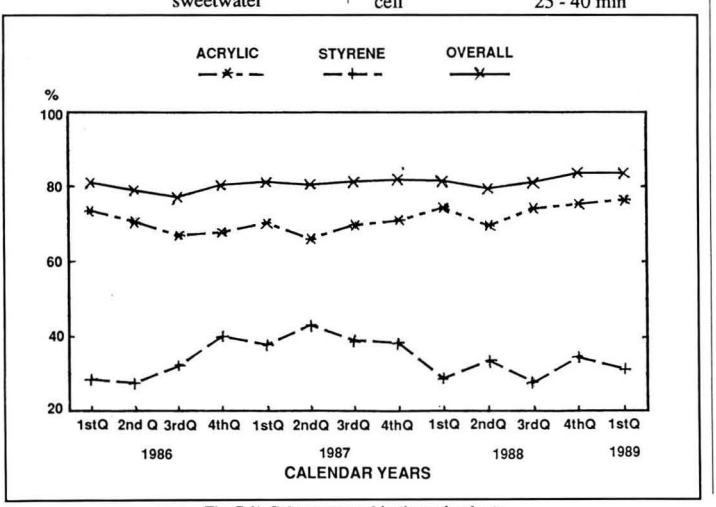

Fig. 7 % Colour removal in the resin plant

Regeneration:	
Backwash rate, B.V./hr	3.5
Alkaline brine:	
NaCl concentration,%	10
NaOH concentration,%	0.2
pH	12.0
temperature, °C	75
rate, B.V./hr	1.7
Quantity per regeneration, B.V.	3.4
Rinse rate, B.V./hr	2
Acid treatment frequency:	
Acrylic 1 cycles	5
Acrylic 2 cycles	17
Styrene cycles	23
HCl concentration, %	2.5

Decolorization performance

Data are given as graphs in Figures 4 to 9 of liquor colours, % colour removal, and colour loading and removal in I.U. B.V. per cycle. All liquor colours quoted are ICUMSA colours measured at 7.0 pH and at 420 nm. Colour loading is the quantity of colour in the feed liquor to a resin stage during the cycle. It is calculated by multiplying the feed liquor colour I.U. by the liquor volume in B.V. and is expressed as I.U. B.V. per cycle. It is not absolute as the liquor quantity is not the same as solids but it is useful for comparison purposes. Colour removal is the quantity of colour removed by a resin stage during one cycle, expressed as I.U. B.V. per cycle.

Liquor colours

Figure 4 particularly illustrates the variation in raw liquor colours. The period of higher colour raw sugars, usually of Caribbean origin, are the last month of the 1st quarter, the 2nd quarter and part of the 3rd quarter. These periods are also those of highest demand and throughput.

Figure 5 illustrates how the variability in the colour of filtered liquor, the feed liquor, is followed by the colours through the plant. Plant restrictions and failures prevented the maximum regeneration rate being achieved during periods of high colour loading, particularly in 1986. Also refer to

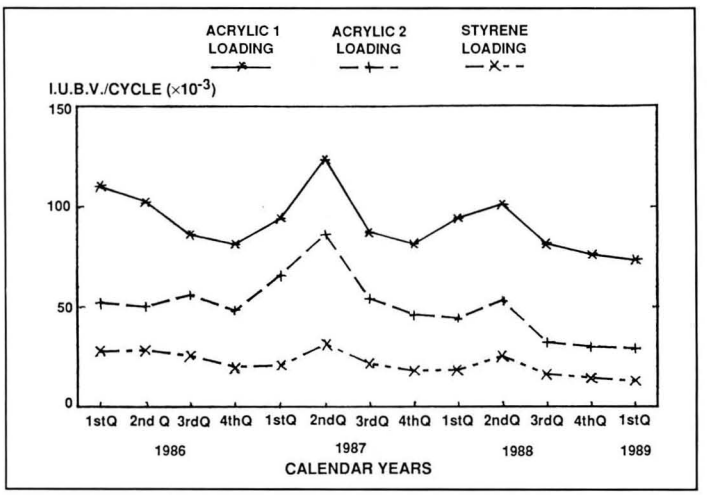

Fig. 8. Colour loading in the resin plant

Figure 10, resin regenerated. The graph also shows how the use of CAL kept the colour of fine liquor at 100 I.U. and below.

% Colour removal

As seen in Figure 6, Acrylic 1 performance rapidly fell off in the 3rd quarter of 1986, after a period of heavy colour loading due to several plant failures restricting regenerations and giving long cycles. These long cycles gave added complications on transfers. Chalk levels were high on the filtered liquor causing resin clumping and thus transfer problems. Failure of the acid treatment system further added to the problem as not all the chalk was removed in the regeneration backwashes. Fortunately the Acrylic 2 stage performed well.

During 1986/87, the inlet distributors were changed in all the cells and this successfully reduced bed turbulence. Also during 1987, all the acrylic charges were increased from 11 to 13 m³. During the 2nd half of 1988 and in 1989 to March, the required performance for Acrylic 1 stage was achieved.

Styrene resin colour removal was very disappointing at 30% in the first half of 1986, even though the resin was new. Improvements, giving up to 40% colour removal, were achieved by changing the inlet distributors and starting to regenerate with alkaline brine in May 1986. Because of apprehension about fishy odours from the trimethylamine, the styrene resin had been regenerated with brine only. There has not been evidence of odours since the change and, with CAL for protection, the use of alkaline brine has continued.

At the beginning of 1988, it was decided to reduce the acrylic resin life to 19 months and extend the styrene life to 21 months and, subsequently, to 25 months. Overall resin colour removal remained reasonably constant at 81% during 1987/88. 84% overall colour removal was achieved in the six months from October 1988 to March 1989 but colour loading was lower. Figure 7 illustrates the combined effect of Acrylic 1 and 2 resin colour removal.

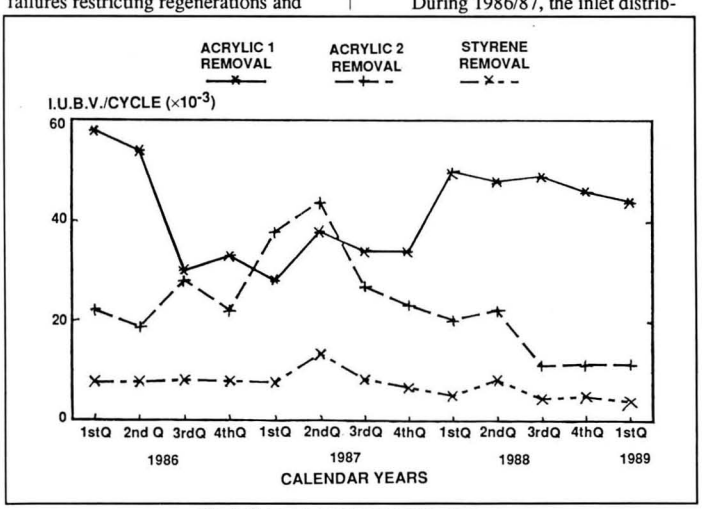

Fig. 9. Colour removal in the resin plant

Colour loading and removal per cycle

Figures 8 and 9 illustrate colour loading and removal in I.U. B.V. per cycle. Colour loadings of over 100,000 I.U. B.V. per cycle on Acrylic 1 are too high and the regeneration rate is adjusted to achieve less than 80,000 I.U. B.V. per cycle. The exceptional loading in the 2nd quarter of 1987 was due to a combination of high feed colours, from high colour raws, and inability to reduce the cycle below 55 hours. The Acrylic 1 resin charges at that time were 11 m³.

Styrene resin colour removal is low. The resin is not doing much work. This is an area which requires further investigation.

Resin regenerated and salt usage

Figure 10 shows the quantity of

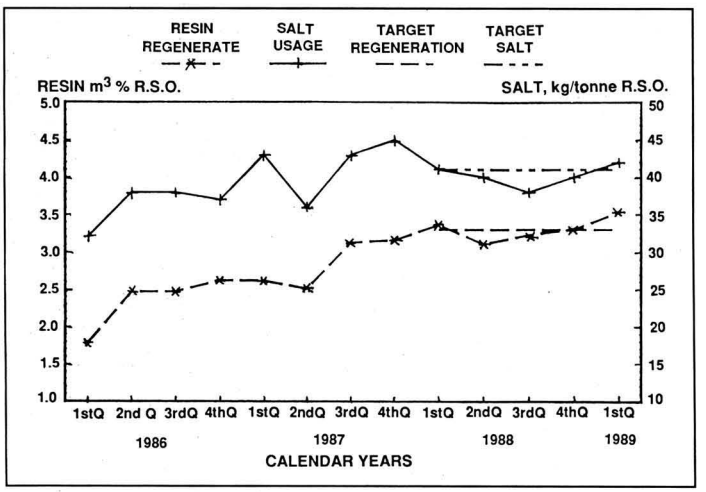

Fig. 10 Resin regenerated *vs.* salt usage

resin regenerated in m³, % refined sugar solids output (R.S.O.) and salt usage in kg per tonne R.S.O. From the beginning of 1988 the targets have been 3.3 m³ resin regenerating % R.S.O. and 41 kg salt/tonne R.S.O. One of the 44 m³ brine dilution tanks imploded in January 1986, restricting regeneration rates.

The high usage of salt in the 1st quarter of 1987 was due to a trial period of regenerating with 12% brine when the resin charges were being increased from 11 to 13 m³. The objective was to maintain the quantity of salt to resin regenerated at approximately 150 kg salt per m³ resin.

The additional cost was high, so further trials with 10% brine for the 13 m³ resin charges were carried out. No deterioration in resin regeneration was perceived and it was decided to keep brine concentration at 10%.

Resin life

The resin is determined on time and number of cycles, backed up by a comparative decolorization test and resin capacity analysis in the laboratory. All new acrylic resin is put into stage 2 and exhausted resin is dumped from stage 1.

Acrylic resin life has been reduced from 24 months to 19 months and styrene life increased from 15 months to 25 months. This has not increased resin costs but, so far, has given an overall better performance. Gaining experience is slow, and it is too early to decide finally the optimum for Thames Refinery. The current status on life of resin when dumped is given in Table II.

Table II

	Acrylic	Styrene
Number of cycles	220	230
Age, months	19	25
B.V. liquor processed	30,000	28,500

Operating costs

The cost of operating the resin/CAL plant is significantly less than that for the char house. The actual material costs are given in Table III for financial years (October-September). The costs show a 32% reduction or approximately 50% when inflation is taken into account.

Process labour costs have also reduced by £250,000 per annum. The 28 personnel (7 per shift) required to operate the char house has been reduced to 4 personnel (1 per shift) to operate the resin plant. Water usage has reduced from 48% R.S.O. to 35% R.S.O. with a saving of £100,000 per annum.

Maintenance labour has been reduced by 6 personnel but maintenance materials costs are similar, owing to the higher value of the automated resin plant.

Decolorization of Jet 2

It was intended to decolorize Jet 2, from the second white sugar boiling, in two cells using polystyrene resin. Decolorization of up to 40% was achieved but considerable restriction to flow through the bed became apparent after 24 hours on some cycles. The cell bottom and distributors were damaged by implosion due to vacuum at the bottom of the cell. The restriction was found to be due to a precipitate of silica.

It was decided to abandon Jet 2 decolorization and the repaired cells will be moved and used on the acrylic stages.

Conclusions

Significant savings in operating costs have been made by the change from char to resin. The initial plant difficulties have been resolved and changes in operating procedures have been made to achieve a cost-effective decolorization operation.

The decision to have two acrylic stages has been vindicated for the Thames Refinery operation. The acrylic resin performance is now satisfactory

Table III. Decolorizing materials cost, £'000

	1983/84	1985/86	1986/87	1987/88	1988/89 6 months
Char	725	–	–	–	–
Resin	–	365	323	265	153
Fuel oil	439	28	–	–	–
Regenerant chemicals	–	212	237	265	124
CAL revivification	43	280	274	312	104
Total	1234	885	834	842	381
£/tonne R.S.O.	1.23	0.91	0.89	0.83	0.84

but styrene resin performance is still disappointing and it is necessary to improve this to achieve the 85 colour removal target at a reasonable cost. The investigation of Tate & Lyle Research and Technology into the mechanism of resin decolorization[2] will assist in this work.

Summary

A resin station to decolorize filtered, carbonatated liquor was installed in 1985 as part of a process renewal project. The station replaced the char house and has significantly reduced operating costs. The station has two stages of five cells containing acrylic resin and a third stage of six cells containing polystyrene resin. Each cell contains 13 m^3 of resin. The resin is regenerated externally in a separate plant with a regenerator and a holding vessel dedicated to each stage. A fourth regenerator is used for treating new resin prior to use. The resin is transferred around the station hydraulically. The regenerant used is alkaline brine which is reclaimed from the regenerating of styrene resin and used for the regeneration of the secondary and primary acrylic resins. The station is computer-controlled and manned by one operator who is also responsible for the evaporation station. This paper gives operational experience together with details of the performance data on decolorization, colour loading, cycle times, resin life and regenerant usage.

Operación de la estación de descoloración por resina en la Refinería Thames

En 1985 se instaló una estación de resina para descolorar licores filtrados y carbonatados, como parte de un proyecto de renovación de procesos. La estación reemplazó la casa de carbón animal y ha reducido en forma significativa los costos de operacón. La estación tiene dos etapas de cinco celdas que contienen resina acrílica y una tercera etapa de seis celdas que contienen resina de poliestireno. Cada celda contiene 13 metros cúbicos de resina. La resina es regenerada externamente en una planta aparte con un regenerador y un depósito de conservación disponible en cada etapa. Un cuarto regenerador es usado para tratar la nueva resina antes de ser usada. La resina es transferida alrededor de la estación en forma hidráulica. El regenerante usado es una salmuera alcalina que es recuperada desde la regeneracíon de la resina de estireno y usada para la regeneracion de las resinas acrílicas secundarias y primarias. La estación es computerizada y manejada por un operador quien es también responsable de la estación de evaporación. Este trabajo proporciona experiencia operacional como también detalla datos de funcionamiento en cuanto a descoloración, sobrecarga de color, tiempo de los ciclos, vida de la resina y cantidad del regenerante usado.

La station de décoloration sur résines à la Raffinerie de Thames

En 1985 on a installé une station de résines pour y décolorer de la clairce carbonatée et filtrée. Cette installation fit partie du projet de rénovation. Elle remplaçait la station de noir et elle a permis de réduire considérablement le coût d'opération. La station comporte deux effets de chacune cinq cellules remplies de résines acryliques, ainsi qu'un troisième effet de six cellules contenant de la résine au polystyrène. Chaque cellule contient 13 m^3 de résines. La résine est régénérée dans une installation séparée comprenant un régénérateur et un bac réservé à chaque effet. Un quatrième régénérateur sert au traitement de la nouvelle résine avant sa mise en service. La résine est transportée hydrauliquement à travers la station. On utilise de la saumure alcaline comme régénérant. Après la régénération de la résine au styrène la saumure est récupérée et utilisée pour la régénération des résines acryliques secondaires et tertiaires. La règulation de la station se fait à l'aide d'un ordinateur. Un seul homme y travaille et il est en même temps responsable pour la station d'évaporation. L'article relate l'expérience opérationnelle et donne des détails quant aux résultats obtenus pour la décoloration, la charge en couleur, les durées des cycles, la durée de vie des résines et l'utilisation des régénerants.

Betrieb der Station zur Entfärbung mit Harzen in der Raffinerie Thames

Eine Harzstation zur Entfärbung von filtrierten, carbonatatierten Zuckerlösungen wurde 1985 als Stufe eines Projekts zu Verfahrenserneuerung eingerichtet. Die Station ersetzte das Knochenkohlehaus und hat die Betriebskosten beträchtlich vermindert. Sie besteht aus zwei Stufen von je fünf Zellen mit Akrylharz und einer dritten Stufe von sechs Zellen mit Polystyrolharz; jede Zelle enthält 13 m^3 Harz. Das Harz wird ausser Haus in einer gesonderten Anlage regeneriert, mit einem Regenerator und einem Behälter pro Stufe. Ein vierter Regenerator wird zur Vorbehandlung neues Harzes angewendet. Das Harz wird in der Station hydraulisch herumgeführt. Alkalinische Salzlösung dienst als Regeneriermittel; sie wird durch die Regeneration des Styrolharzes rückgewonnen und zur Regeneration der sekundären und primären Akrylharze angewendet. Die computergesteuerte Station wird von nur einem Techniker bemannt, der auch für die Verdampfstation verantwortlich ist. In diesem Aufsatz werden Betriebserfahrungen dargestellt zusammen mit detaillierten Leistungsdaten hinsichtlich Entfärbung, Farbebelastung, Zyklenzeiten, Harzleben und Verbrauch von Regeneriermittel.

Trinidad sugar production, 1990[12][3]

Sugar production in the 1990 season totalled 119,000 tonnes, raw value, against last year's output of 97,000 tonnes. The result was the highest in twelve years and is attributed mainly to favourable weather and a calm labour climate.

2 Williams & Bhardwaj: *Paper presented to Sugar Processing Research Inst. Conf.*, 1988.
3 F. O. Licht, Int. Sugar Rpt., 1990, 122, 334.

Facts and figures

CITS 19th General Assembly, 1991

As has been announced previously, the 19th General Assembly of the Commission Internationale Technique de Sucrerie will be held in Cambridge, England during June 24 - 28, 1991. The priority themes for the discussions have now been announced; they are: "Progress in the technology of sugar crystallization" and "Technical aspects of data acquisition and data processing for process control and decision making". Papers on other subjects related to the manufacture of sugar may also be presented, of course. All those wishing to present a paper are invited to inform the General Secretary *before October 1, 1990* at the following address: Dr. R. Pieck, Klein Spanuit 9, B-3300 Tienen, Belgium (Telefax: +32-16-820826). The approximate title of the paper should be given and a brief summary must be added. When the paper is accepted for presentation, the authors will receive instructions as to the format of the final text (which will have to be sent before April 1, 1991).

Agro-food industry quality colloquium

Under the title "Qualité et industries agro-alimentaires" a European colloquium is to be held in Paris during October 18-19, on the occasion of the 1990 SIAL (Food industry exhibition). The sections will be concerned with quality and sensorial analysis, nutritional value, food hygiene and the European perspective, respectively, and, while no paper is specifically concerned with sugar, the notion of quality is one which is increasingly affecting sugar and sugar factory operations. Details may be obtained from the organizers, CRITT-IAA, 7 Ave. du Gén. de Gaulle, 94704 Maisons-Alfort Cedex, France (Telephone +33-1-4396-2576; Telefax +33-1-4893-1920). The cost of participation is FF.2000.

French sugar machinery exhbibition

SITEPAL 91 is an exhibition of equipment for the animal feed, grains and sugar industries. It will be held at the Porte de Versailles Exhibition Centre during March 5 - 8, 1991 and will include equipment for packaging, storage and handling, quality control, general industrial equipment such as boilers, data processing and automatic control, additives, etc. The exhibition is being organized by SEPAIC, publishers of a number of specialized magazines including *Sucrerie Française*, and further information may be obtained from this company at its address: 42 rue du Louvre, B.P. 551, 75027 Paris Cedex 01, France.

Pakistan Society of Sugar Technologists

The 25th Annual Convention of the PSST was held during July 21 - 23, 1990 at the Pearl Continental Hotel in Rawalpindi in the presence of members and visiting technologists from other countries.

Beet pulp production and utilization in France, 1989/90

A survey was carried out the Union of Agricultural Collectives in France concerned with beet pulp utilization and the results are presented in the form of a brochure. This gives details of the sources of different kinds of beet pulp (pressed, ensilaged, dried, etc.), production by regions, utilization, local consumption and exports, and it is noted that, owing to drought in France, a greater proportion of pulp production was used domestically and exports fell to the lowest level since 1986/87. The brochure was produced by USICA, 43-45 rue de Naples, 75008 Paris, France.

Australia sugar factory closure

The Cattle Creek sugar factory belonging to the Mackay Sugar Cooperative Association Ltd. will close this year.

Co-generation in Brazil[1]

In cooperation with sugar factories in the state, the Alagoas Energy Company (CEAL) will launch this year a project for cogeneration of energy using bagasse as fuel. Alagoas produces of the order of 20 million tonnes of surplus bagasse which will generate some 2 million MWh, the equivalent of the entire energy consumption of the state. The present generating system which serves the state is operating at full capacity and it is necessary to ration power. If the

1 *Alcool e Açúcar*, 1990, (52); through *GEPLACEA Bull.*, 1990, **7**, (6), Sugar Inf. 1.

Brazil's alcohol program

continued from page 182

fall too far. In addition, Brazil had discovered oil on its own territory and was able to export some of it.

But that was before the Iraqi invasion of Kuwait. The embargo on purchases of Iraqi-controlled oil has removed a sufficiently high proportion of supplies from the market that the cost of oil has gone up from $18 to $25 a barrel and who knows what it will be next week or next month? Even if Kuwait regains its independence and the embargo is lifted, the sudden threat to the world's oil supplies has been once again been brought sharply to public attention.

It was just such a situation which stimulated the alcohol program in the first place. When the oil shocks of the 1970's made people aware of how vulnerable they were to the decisions of a few Middle East rulers, the Brazilian enterprise seemed to be a highly sensible response. Even though the cost of the fuel was higher than from oil, it was payable in Brazilian currency and could not be interfered with by other nations. The cost of alcohol fuel has come down and, even though it is still higher than petrol from $18/bbl oil, the gap between it and petrol from current price oil has closed. It is likely that Iraq has caused a number of sugar producing countries with alcohol potential to think again about whether the Brazilians have got it all wrong.

project is successful, energy supplies will be guaranteed and it will not be necessary to establish nuclear energy plants.

New Pakistan sugar factories

Two of the new sugar factories referred to earlier[2] are in trial operation in addition to the Brothers factory in Chunian. They are the Chishtia Sugar Mills at Sallanwali in the Punjab and the Sakrand Sugar Mills in Sind. Both are of 3000 t.c.d. capacity and make white sugar, and both were designed, supplied and erected by Heavy Mechanical Complex at Taxila.

GEPLACEA efforts to increase sugar sales[3]

GEPLACEA, the organization of Latin American and Caribbean sugar exporting countries, is to increase the professionalism and knowledge of its staff who are working on the international marketing of sugar, in order to increase sugar exports of its member countries. GEPLACEA is seeking a more efficient sales team, along with improved monitoring of the international sugar market, to facilitate better and more coherent production and export strategies. The organization is planning seminars in Mexico City, New York, Havana, London, Paris and other cities for training purposes

Canadian sugar refining company ownership[4]

BC Sugars of Vancouver has entered into an agreement with Jannock Ltd. of Toronto to buy 50% of Lantic Sugars Ltd. for $Can. 110 million. Jannock can require BC Sugar to buy the rest of the Lantic shares after December 1991 while BC Sugar has a right to acquire them after December 1993. BC Sugar owns the two Canadian beet sugar factories as well as its own refinery (and has also diversified into other non-sugar interests), while Lantic Sugars operates two refineries in Montreal and Saint John as well as the Yonkers refinery in New York. Closing of the transaction, which is subject to regulatory approval, is expected to take place in February 1991.

New Australian sugar refinery[5]

The Managing Director of CSR Limited has indicated that Townsville, in North Queensland, is the favoured location of a new Aus$ 200 million sugar refinery to be built by the company[6]. It will probably be built within the next five years and will replace the company's refinery in Brisbane. The project still needs the support of cane growers, millers and the Queensland government to proceed.

EEC capital grants to ACP suppliers[7]

The European Community has approved the granting of structural aid worth 30 million ECU to the ACP sugar producers as compensation for the cut in guaranteed sugar prices. The aid will be in the form of 10 million ECU grants for each of the next three years, to be paid to EEC refineries processing ACP imports, on the understanding that they will be passed on to the exporters. The intention is to provide funds for the improvement of production structures and infrastructure to enable the producers concerned to grow sugar more efficiently and profitably whereby they can adjust to the new situation on the EEC sugar market.

El Salvador sugar exports, 1989[8]

Exports of raw sugar from El Salvador last year totalled 30,429 tonnes, a considerable reduction from the 81,873 tonnes exported in 1988. All the 1989 sugar went to the USA whereas in 1988 26,869 tonnes went to that destination and 55,004 tonnes to the USSR.

Kenya sugar situation[9]

The Miwani and Ramisi sugar factories in Kenya closed in 1988 and, although efforts have been made to revive Miwani these have been unsuccessful and the government has recently taken over the management so that a modest rehabilitation should begin soon. However, another factory – Muhuroni – is said to have gone bankrupt. On the other hand, rehabilitation of the Nzoia factory is expected to evolve into an expansion program to bring capacity from 3000 to 7000 tcd, while Sony factory is also set to expand from about 1200 to 2000 tcd. Feasibility studies have also been completed for new sugar factories in Busia and Siaya.

USSR sugar imports, 1989[10]

	1989	1988
	tonnes, raw value	
Australia	275,707	0
Austria	0	10,870
Brazil	251,986	204,144
China	12,708	0
Colombia	0	12,391
Costa Rica	0	47,097
Cuba	3,592,084	3,081,153
Dominican Republic	0	209,795
EEC	197,667	107,019
Finland	1,512	0
Guatemala	0	173,061
Honduras	0	40,024
Hungary	29,298	34,787
Mexico	144,965	384,879
Nicaragua	48,479	16,505
Poland	1,667	2,207
Rumania	26,035	0
El Salvador	0	41,927
Singapore	6,436	0
Sweden	27,141	0
Thailand	693,268	0
Unknown	303,757	0
Total	5,612,710	4,365,859

Cuban irrigation program support by North Korean finance[11]

The North Korean government has approved a considerable loan to support the irrigation program of the Cuban Ministry of Sugar. It will include construction of a factory to make 2000 water pumps per year for deep wells which can irrigate a cane area of about 100,000 ha.

2 *I.S.J.*, 1990, **92**, 150.
3 *Prensa Latina news agency report*, June 12, 1990.
4 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 378.
5 *Australian Canegrower*, 1990, **12**, (10), 2.
6 *I.S.J.*, 1990, **92**, 82.
7 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 392.
8 *I.S.O. Stat. Bull.*, 1990, **49**, (6), 11.
9 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 398.
10 *I.S.O. Stat. Bull.*, 1990, **49**, (6), 36 - 37.
11 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 396.

South Africa sugar exports[12]

Exports of sugar from South Africa in 1989 rose to 924,032 tonnes, raw value, from 909,159 tonnes in 1988. They included 370,939 tonnes delivered to Japan (369,023 tonnes in 1988) and 187,363 tonnes to South Korea (303,677 tonnes in 1988). No destinations are reported for the balance of 365,730 tonnes (236,459 tonnes in 1988).

Tanzania sugar factory rehabilitation finance[13]

It is reported from Tanzania that the Commonwealth Development Corporation is to provide $55.7 million for the financing of rehabilitation of the Kagera sugar factory which was destroyed by Ugandan soldiers after the invasion in 1978. New agricultural machinery and irrigation equipment will be required as well as factory plant. Three other factories (Mtibwa, Kilombero and Moshi) in the north of the country are also to be rehabilitated. Tanzania could raise its output to 450,000 tonnes against the current 100,000 tonnes. Lack of foreign exchange prevents sugar imports and the shortage has resulted in high black market prices.

New Cuban cane derivative plants[14]

President Castro has told the Cuban parliament that new plants for the production of glucose, fructose and sorbitol, based on sugar cane as raw material, are under construction in the province of Camagüey, 480 km south-east of Havana.

Thailand sugar production, 1989/90[15]

Crushing of 33,560,000 tonnes of cane in the 1989/90 season in Thailand yielded 3,349,000 tonnes of sugar, tel quel, including 1,854,000 tonnes of raw sugar and 1,495,000 tonnes of whites. These combine to a raw value equivalent of 3,530,000 tonnes but may not be the final figures as raw sugar is still being remelted for purification to white sugar. With white sugar export commitments thought to exceed 600,000 tonnes and domestic requirements of more than 1.0 million tonnes, it would appear that the remelting of raws will have to continue. Some relocation of cane land and sugar factories is still taking place but is not expected to disrupt the 1990/91 season and there have been no reports of drought such as affected parts of the 1989/90 crop.

Pakistan cane sugar production

The total cane crop in Pakistan for the 1989/90 season was grown on 841,500 hectares, a reduction from the 876,900 ha of 1988/89, and amounted to 34,330,000 tonnes against 36,970,000 tonnes in 1988/89. The season started in the first week of September and ended on June 3, during which time 20.5 million tonnes of cane were crushed by the sugar factories, while some 8.5 million tonnes were used to make open-pan sugars such as gur, khandsari, etc. White sugar production reached a record 1,828,853 tonnes or 8.93% on cane, against the 1,817,936 tonnes of sugar from 21.7 million tonnes of cane in 1988/89, representing a recovery of 8.38%. In spite of the ever-increasing sugar production, Pakistan imports large quantities of white sugar to bridge the gap between domestic production and demand. It is believed that about 300,000 tonnes of white sugar will be imported this year.

New Indian sugar factories

Expansion of the sugar industry in Tamil Nadu state will raise total crushing capacity to 86,900 tcd from the 53,900 tcd level of 1988/89[16]. The program includes expansion of 14 factories and establishment of new ones; two, at Sakti and Dharani, commenced operations in March 1989 and two more, at Rajashree and Thiru Arooran, have taken initial steps to production. The Tamil Nadu Sugar Corporation will also be setting up two more factories this year. Sakthi Sugars Ltd. is putting up a sugar factory in the Dhenkanal district of Orissa state. The plant will have a crushing capacity of 2500 tcd and is intended to go into production in October 1990 at a cost of about 320 million rupees.

ADB grants for Asian sugar industries[17]

The Asian Development Bank (ADB) is to provide financial assistance to Indonesia, Papua New Guinea, the Philippines and Sri Lanka for the development of sugar cane production on existing plantations. The scale of the assistance has not been disclosed. The ADB sees the sugar sector as one that can absorb a large workforce and provide significant foreign exchange earnings for the countries concerned. The ADB has previously provided a separate grant for a comparative study of sugar production in the four countries.

Belgian sugar factories closure and replacement[18]

The two Belgian sugar factories at Brunehaut-Wez and Pecq-Warcoing, with the smallest slicing capacities in the country at 2800 and 3000 tonnes/day, respectively, are to be closed and replaced by a new sugar factory of 7500 tonnes/day capacity.

African sugar producers association possibility[19]

A meeting was held in Vienna during June 5 - 8, under the auspices of UNIDO, at which the founding of an association of African sugar-producing countries was discussed with the aid of officials of the corresponding organization in the Western Hemisphere, GEPLACEA. As a result of the meeting, representatives of the countries concerned decided to begin concrete endeavours toward prompt establishment of such a group.

12 *I.S.O. Stat. Bull.*, 1990, **49**, (6), 32.
13 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 398.
14 *Prensa Latina news agency report*, August 1, 1990.
15 *Czarnikow Sugar Review*, 1990, (1799), 106.
16 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 400 - 401.
17 *Qatar News Agency report*, July 13, 1990.
18 *Zuckerindustrie*, 1990, **115**, 601.
19 *GEPLACEA Bull.*, 1990, **7**, (7), Inst.Inf.-1.

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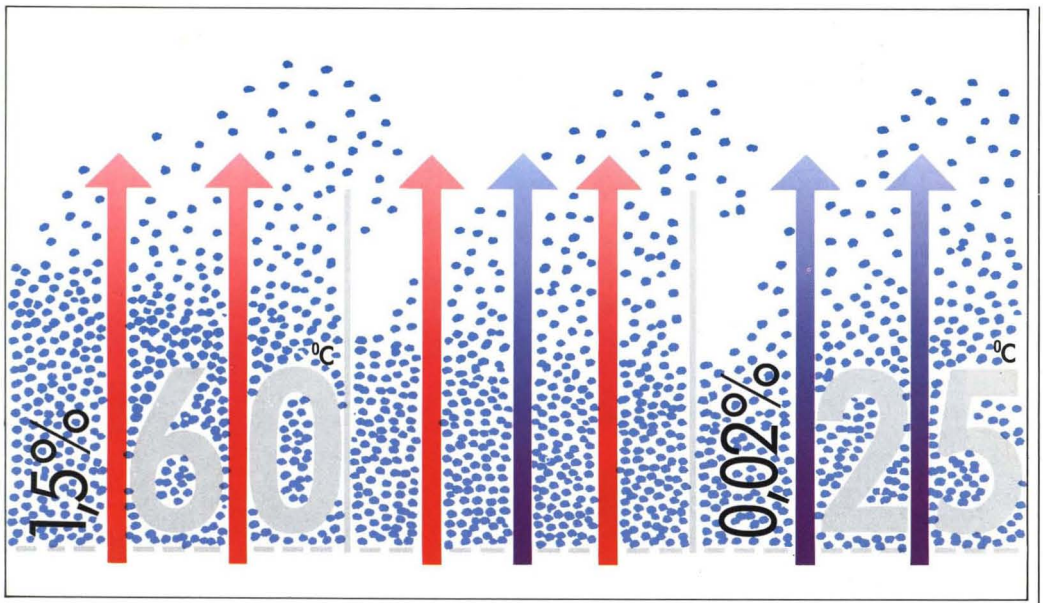
Drying and cooling by the fluidized bed principle



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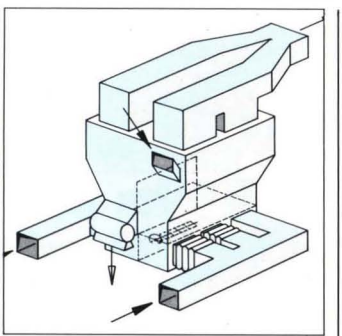

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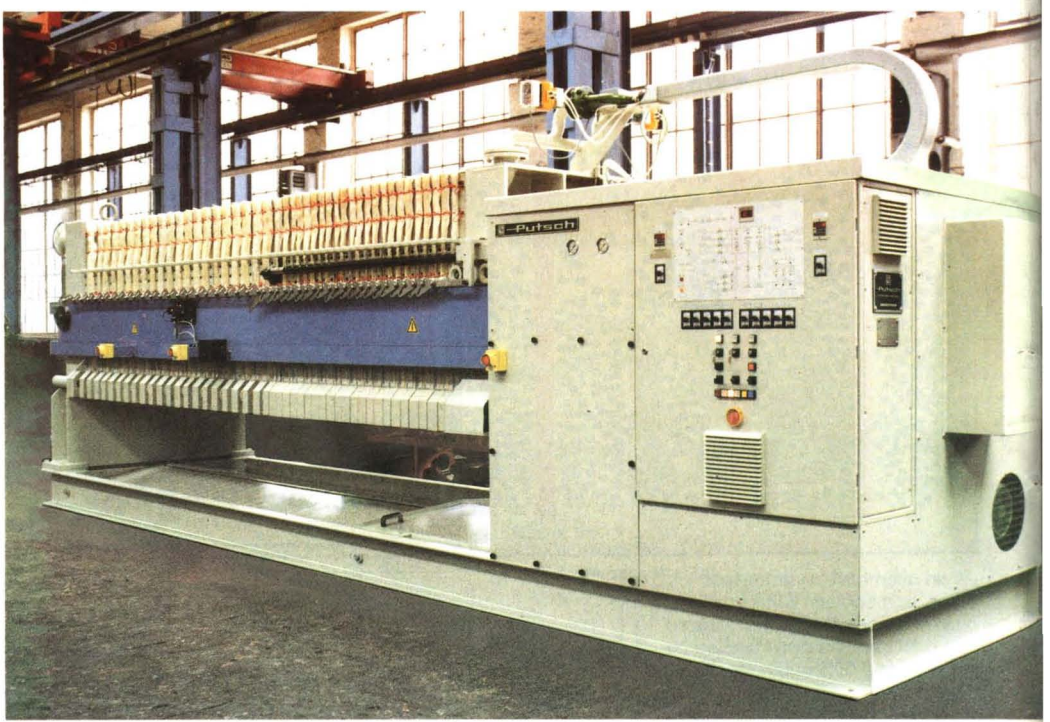

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