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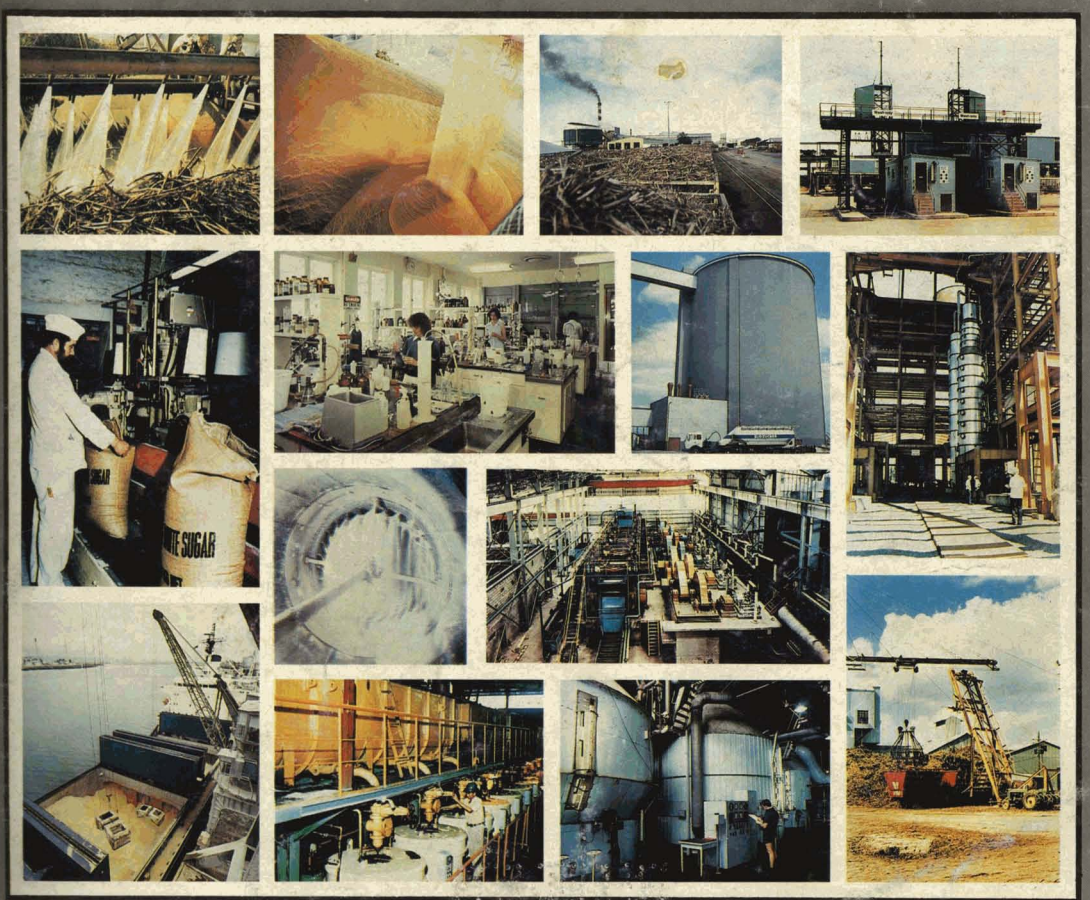

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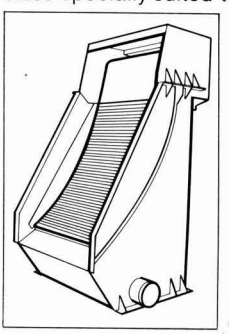

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NOTES AND COMMENTS

International Sugar Agreement

Hopes for a breakthrough at informal meetings in November of the Consultative Committee, a group of 12 exporting and 6 importing nations, were raised when, after an unpromising start, the chairman of the UN sugar conference, Sr. Jorge Zorreguita, put forward a compromise package which received a cautious welcome from major exporters and also seemed in line with EEC demands. The proposals stipulated that the first action to cushion a falling market should be to withhold surplus stocks in excess of the reference export availability (REA) and then, if the market continued to fall, security stocks would be held at the next action point. The total of REA's, which would be based on export performance during 1980-82, would be some 20-21 million tonnes after allowing for exports by medium and small exporters and some 800,000 tonnes by non-members. The EEC representatives seemed more sympathetic to the proposals but had to consult with member governments; the Community later informed the chairman that it thought there is a basis for further progress. A further meeting of the Consultative Committee was arranged to take place in January to work out the size of the REA's and stocks. Since this will take some time and a draft document has to be prepared to put before a resumed sugar conference, the proposed date of February was postponed for a month.

The ISO Council decided in November against a proposal by Australia to postpone from the end of 1983 until March 31, 1984 the date for accumulating ISO special stocks totalling 2.5 million tonnes. Australia had proposed the deferral in case the EEC, a non-ISO member, embarked on substantial de-stocking in order to maximize its export potential in 1983. Other members of the Council felt that any such moves by the EEC would signal a lack of progress in negotiations for a new International Sugar Agreement, and the Council decided to wait and see whether negotiations resume in Geneva in the coming spring before deciding whether to suspend the stocking obligation altogether. At the same time, the council approved requests by Fiji and El Salvador for temporary relief from their individual stocking obligations.

World sugar prices

Reflecting the availability of sugar the London Daily Price of raw sugar steadily declined through the month and from £139 per tonne on December 1 fell to £122.50 on December 28. The period was marked by an absence of final buying interest, while exporters such as Brazil and India were seeking year-end sales to strengthen their positions in respect of a possible new ISA. Raw sugar interest from the Soviet Union was unusually low for the time of year but rumours of possible buying from the EEC lifted the LDP very slightly to £124 per tonne where it closed on December 30.

White sugar supplies were freely available during the month and the EEC continued to export under restitution at around 55-60,000 tonnes per week. There was more activity than in the raw sugar market, with a number of countries covering prompt requirements before the year end. The LDP(W) consequently fluctuated more and the premium over raws tended to increase. A complicating factor was the fluctuation in currencies; for instance, during the second week of the month the LDP(W) in terms of sterling rose by £2.00 but fell by $5.00. From the end of December, however, the LDP(W) is only being quoted in US dollars while the LDP is to be quoted in both currencies.

South African sugar production fall[1]

With three of the Tongaat-Hulett sugar factories already closed down because of lack of sugar cane, the South African sugar industry had produced only 764,331 tonnes of sugar in the present season up to the end of August. The drought had taken a severe toll of the crop because at the same time in 1982 1,029,809 tonnes of sugar had been produced. In 1983, 6,881,892 tonnes of cane had been crushed up to the end of August, against 9,269,237 tonnes up to August 1982.

Meanwhile, David Hardy, Export Manager of the South African Sugar Association, explained how the industry has bought sugar from overseas to provide for South Africa's domestic needs and through substitution has managed to meet the country's export commitments. Mr. Hardy said it is estimated that production for the season will be 1,485,000 tonnes compared with an outturn of slightly more than 2.1 million tonnes for the 1982/83 season. So severe has been the effect of the drought on the supply of cane from certain North Coast areas that the three mills were closed after only 4-6 weeks of production, with a fourth mill due to close. It was planned that the mills would re-open towards the end of the year, but this depended on the adequate availability of cane. It is the first time in the history of the South African sugar industry that the continuous operation of factories has been interrupted in this way.

The first call on sugar produced is to cover the requirements of the domestic market which are estimated at 1,265,000 tonnes for the season, leaving a balance of 219,000 tonnes for the export market. This compares with an availability of 950,000 tonnes from the previous season. Consequently the main burden of the catastrophe has fallen on the export operations of the industry. To avoid the potential shortage of refined sugar for domestic consumption, 100,000 tonnes of bagged refined sugar was bought on the world market for delivery to Durban, plus 32,500 tonnes of raw sugar from Swaziland for delivery to the sugar factory at Malelane in the Eastern Transvaal for refining and packaging. Delivery in both cases was to be completed before the end of the year. It is believed that no further purchases will be necessary.

The imports have increased export availability of South African raw sugar to 340,000 tonnes. The extent of the problem which faced the Association in respect of its export market can be measured by the quantity of sugar which has been acquired to meet the substitution arrangements. The total tonnage involved is 467,000 tonnes of raw sugar for shipment between July and December 1983 and possibly in the early months of 1984. The supplying countries are Malawi, Mauritius, the Philippines, Swaziland and Thailand. Thus the total quantity of sugar purchased on the world market to resolve the domestic and export market problems arising from the drought was 600,000 tonnes. South Africa's customers, the import houses and refiners, have

[1] F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 523.

readily recognised the extent of the problems arising from the drought and have agreed to amend their raw sugar arrangements to enable South Africa to deliver alternative origin sugars in fulfilment of its contractual obligations.

World sugar consumption estimates

C. Czarnikow Ltd. recently published their forecast of sugar consumption for 1984[1]; they used the calendar year because information is most readily available on this basis, particularly for ISO members, and there are no special merits about a crop year basis. They have applied statistical methods to examine changes from year to year and have found that a least squares method provides a reasonably accurate means of forecasting, based on previous history. The results of their researches appear in a table elsewhere in this issue, but a number of interesting aspects arise in respect of the 1984 forecast compared with 1983. The first is that, in spite of low prices on the world market, consumption on a world basis is only shown to increase by some 2 million tonnes or just over 2%. In former times, consumption rises would be small in periods of high prices but would be greater when the price fell, so providing an average of 2½-3% as a trend. The smaller increase now seems to be the norm. Second, since HFCS usage is not included, sugar consumption in the USA is shown as falling by 175,000 tonnes, while Canada is also expected to consume 15,000 tonnes less and Japan only 37,000 tonnes more.

A third striking thing about the figures is that consumption in the Western Hemisphere is almost static in spite of increasing populations, while 1984 consumption is also forecast as little different from 1983 in Europe and Oceania. In Asia, however, an increase of 1.2 million tonnes represents a rise of 4.8% while in Africa, an increase of 220,000 is almost 3% higher, an indication of the importance of these two continents in the development of sugar markets and expansion of sugar industries.

FAO views on sugar up to 1990

According to a report prepared by FAO for its Commodity Problems Committee, consumption is likely to rise substantially on a global basis during the rest of this decade but still not as fast as production. By 1985, sugar usage should reach 98.2 million tonnes, raw value, rising to 110.4 million tonnes by 1990; these figures compare with a consumption of 91 million tonnes in 1982. In the developed countries, higher usage in the USSR and Eastern Europe would be offset by marked declines in North America and Japan and a smaller fall in Western Europe, so that consumption is likely to remain steady at about 47 million tonnes. Growth in developing countries is estimated to rise by about 24% between 1980 and 1985, to reach 51.3 million tonnes, and then by a further 24% up to 1990, to reach more than 63 million tonnes. The main growth areas are identified as Asia and Southern Africa.

However, the report considers it unlikely that current national policies in developed countries will reduce production; if past cycles are repeated, a substantial recovery in 1985/86 will be followed by rapid growth to the end of the decade. Major expansion plans in some producing countries such as China and Indonesia will only prolong the imbalance between supply and demand. Brazil and India are known to be considering expanding their industries but many projects are unlikely to materialize and production will have to adjust to consumption, according to the report. Sluggish economic growth and the rapid expansion in demand for HFCS and other artificial sweeteners are blamed for the stagnation in sugar consumption expected in the industrialized world. If future sugar prices are to be stabilized, efforts must be made to ensure that other sweeteners are not given preferential treatment, and a new sugar agreement that is both straight-forward and more flexible to allow quick corrective action in unstable markets needs to be introduced.

World sugar balance, 1983/84

F. O. Licht GmbH recently published their first estimate of the world sugar balance for the crop year September 1983/August 1984 and the figures are reproduced below[2]. Relating the figures to current price levels, Licht notes that "it is hardly astonishing that the optimism which was prevalent only a short while has evaporated. It is now recognized that there is still a substantial surplus of sugar, both raw and white, which is available for sale but for which outlets may not be found, and that a substantial price recovery will likely take two or more seasons, barring major crop disasters in key growing areas."

Sugar production is now put at 95.7 million tonnes, raw value, some 4.2% below the 1982/83 revised figure of 99.9 million tonnes. This is not the same as their recent estimate of world production but the present figure is on a strict calendar basis while the other was on an actual crop basis, which accounts for the difference. Nevertheless, it came as a shock to the market for Licht to put production and consumption at almost exactly the same, whereas a deficit of around 2 million tonnes had been widely expected, so that final stocks are hardly changed.

	1983/84	1982/83	1981/82
	tonnes, raw value		
Initial stocks	37,796,000	32,632,000	24,288,000
Production	95,675,000	99,956,000	100,575,000
Imports	27,895,000	29,104,000	31,890,000
	161,366,000	161,692,000	156,753,000
Exports	28,444,000	29,634,000	32,045,000
Consumption	95,634,000	94,262,000	92,076,000
Final stocks	37,288,000	37,796,000	32,632,000

US imports of blended sugar

Blends of sucrose and high fructose syrup fell outside the customs definition governing the import of sugar by the US and Canadian refiners supplied this blended sugar until stopped by a proclamation which applied a zero quota to the product. The matter was referred to the International Trade Commission[3] which has now issued its report[4]; the Commission concludes that it is practically certain that such imports do interfere with US support arrangements and it suggests the introduction of a quota system covering the blends. The President is not legally bound to accept the ITC proposals, however, and there are those who would like to see a larger duty differential than the present 1.00 cent/lb on refined sugar imports so that this might be considered before possible new measures are announced.

Pakistan sugar for export[5]. – The Minister for Food and Agriculture announced in November that Pakistan was to sell 147,000 tonnes of sugar to Iran, the first time that Pakistan sugar has been exported.

[1] *Sugar Review*, 1983, (1674), 209-210, 212.
[2] *International Sugar Rpt.*, 1983, **115**, 579.
[3] *I.S.J.*, 1983, **85**, 223.
[4] C. Czarnikow Ltd., *Sugar Review*, 1983, (1678), 232.
[5] *Westway Newsletter*, November 1983, 3.

Performance of the continuous low-grade pan at Tully mill

By R. BROADFOOT*, K. F. MILLER*, R. J. McLEAN† and R. D. ROOKWOOD‡

Introduction

Subsequent to advances made in the technology of continuous vacuum pans over the last decade, Tully mill decided to install a continuous pan for boiling *C*-massecuite. The unit was installed for the 1982 season. The continuous low-grade pan at Tully mill is based on a conceptual design submitted by Sugar Research Institute to Tully mill. The design for the pan evolved from experimental trials conducted at Rocky Point factory[1] and from the valuable operating experience obtained since the Mossman mill continuous pan was commissioned in the 1976 season[2]. Subsequently, the concept was developed jointly by Tully mill, the manufacturers, N.Q.E.A. of Cairns and the Sugar Research Institute to arrive at the final installation.

The Sugar Research Institute developed the "multiple mixed-cell" design for continuous pan installations because this approach allows flexibility in operation and is simple to control. Differences between this and the "long flow path" concept have been previously described by Broadfoot & Wright[3] who also listed a number of recommendations for the design of continuous low-grade pans. The design of the Tully continuous pan incorporates these recommendations and is similar to the layout suggested.

Some of the design considerations which have been incorporated into the unit include such items as ease of maintenance (e.g. replacement of the tubes in a "floating" type calandria), possible extension of path length should an increase in production rate be required in future years, and a high heating surface to volume ratio with an aim to achieve as much as possible of the total exhaustion in the pan in preference to providing a long residence time in the crystallizers.

This paper describes briefly the pan specification, the control operations and the results of performance trials.

Pan specification

The unit is a seven-compartment horizontal pan with a massecuite volume of 120 m^3 at a nominal boiling height of 0.5 m above the top of the tube plate. Its designed production rate is 34 tonnes/hr of *C*-massecuite from a *C*-seed addition rate of 8 to 10 tonnes/hr.

The cross-sectional layout of the pan is shown in Figure 1. The unit contains three separate calandrias which are arranged in-line. The top tube plates slope downwards towards the downtakes which are located

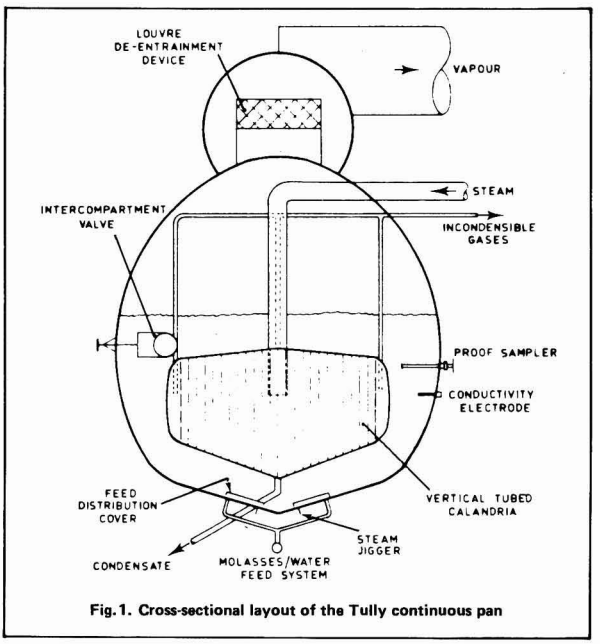

Fig. 1. Cross-sectional layout of the Tully continuous pan

Paper presented to the Australian Soc. Sugar Cane Tech., 1983.

* Sugar Research Institute, Mackay.
† Tully Cooperative Sugar Milling Association Ltd.
‡ North Queensland Engineering and Agents, Cairns.

1 Broadfoot *et al.*: *Proc. 43rd Conf. Queensland Soc. Sugar Cane Tech.*, 1976, 171-177.
2 Broadfoot & Wright: *Proc. 45th Conf. Queensland Soc. Sugar Cane Tech.*, 1978, 171-177.
3 *Proc. Australian Soc. Sugar Cane Tech.*, 1981, 23-29.


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R. J. McLean


R. D. Rookwood

along each side. The total installed heating surface area is approximately 1200 m^2 giving an average heating surface/volume ratio of 10 m^{-1}. The pan contains a very generous vapour space (approximately 90% of the massecuite volume) available for vapour disengagement.

Massecuite passes between compartments through openings beneath the calandria except at full division plates where massecuite flows through isolation valves near the top of the downtake. These valves allow sections to be isolated for pan boil-out operations.

The pan contains some internal partitions set across the longitudinal flow path to retard the movement of material along the boiling surface. All interior wall surfaces in the upper section of the pan were sprayed with an epoxy coating in order to limit crystal build-up on these.

The molasses/water flow to each cell is fed into the bottom of the pan through branched pipework arranged symmetrically about the longitudinal axis in order to provide even distribution of the feed. Jigger steam may be injected into the bottom of the pan beneath the calandria at points adjacent to each molasses/water feed entry.

The low-grade massecuite station

The arrangement of the process equipment in the low-grade station at Tully mill for the 1982 season is shown schematically in Figure 2. Seed material is prepared in a 27 m^3 Webre pan and transferred to a pair of horizontal stirred receivers. Variable-speed rotary lobe pumps meter the seed massecuite from the receivers to the first cell of the continuous pan. *B*-molasses is supplied from a constant-level overflow tank of 35 m^3 capacity while the main *B*-molasses storage tank is of 235 m^3 capacity.

Product massecuite from the pan flows over an adjustable weir and passes to a vessel from which it is pumped (fixed speed drive) a distance of 83 metres to a splitting box above the crystallizer station. This box divides the flow between two sets of crystallizers. Each set consists of three horizontal crystallizers of the Blanchard type arranged in series flow. The crystallizers are each of 73 m^3 capacity and are stepped downward by approximately 0.3 m between adjacent crystallizers to assist massecuite flow. The total crystallizer residence time was typically about 29 hours with cooling to about 40°C usually being achieved.

The massecuite from the final pair of crystallizers flows through a finned tube heater to a distribution pipe located above the low-grade centrifugal station. The centrifugal station comprises four BMA K1000 centre-feed centrifugals and three Bosco machines.

Pan control

The main control functions employed on the pan are:

(a) Vacuum is automatically controlled by regulating injection water flow to the condenser.

(b) Molasses/water feed to each of cells 1-6 is controlled by on-off action conductivity transducers on each cell, with pneumatically-operated ball control valves. A proportional-plus-reset action controller is used for water feed control to the final cell.

(c) Steam flows to each of the calandrias are automatically controlled to the selected set point flow rate.

(d) Seed addition rate to the first cell of the pan is set from the control panel by selecting the speed of the rotary lobe pump. The ratio of *C*-seed to the *B*-molasses inflow rate is maintained at a set figure.

(e) Massecuite operating level is fixed by the position of the product overflow weir.

(f) Production rate of the pan is controlled either by regulating the movement water flow to the *B*-molasses header to adjust the net "boil-on" of the *B*-molasses, or by altering the steam flow to the three calandrias.

Commissioning of the pan

The pan was first brought on line on 16th June, 1982, the commencement of crushing for the 1982 season. Cells 1-3 were filled to minimum footing level with batch-produced seed material and subsequently fed with *B*-molasses. Seed material was metered to the first cell at a controlled rate. When the massecuite level had risen sufficiently the inter-compartment valve between cells 3 and 4 was opened, allowing massecuite to flow through to the next pan section. Once the tube plate of calandria 2 (cells 4, 5) was covered, steam was admitted and, after an initial period on water, *B*-molasses feed to cells 4 and 5 commenced. In a similar manner the procedure was continued till sufficient massecuite was available to fill cells 6 and 7. This method of commissioning the pan proved to be very convenient as the only batch pan required for the operation was the graining pan to supply the seed material. Overall the commissioning went very smoothly despite initial problems with much of the instrumentation.

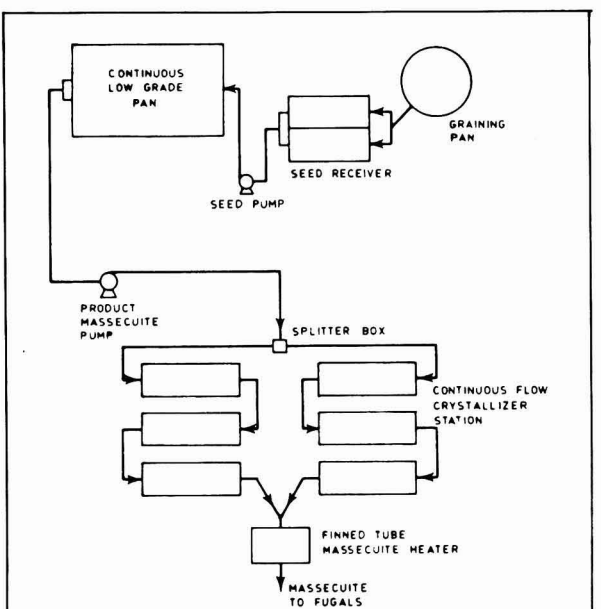


Fig. 2. Layout of the low-grade massecuite station at Tully mill

Pan operating procedures

Control functions

In general the control principles employed on the continuous pan have worked well although the on/off conductivity control of the *B*-molasses or water feed to cells 1-6 tends to be fairly coarse. However, while the resultant cyclic operation about the set point in each of these cells is not unduly affecting the pan operation at the current low throughput rate, it could cause a drop in performance when normal operation reaches the design throughput rate.

Normal operating procedures

During the design of the unit close attention was paid to the layout of the pan and associated pipework in order to achieve a simple and uncluttered installation and, in general, these objectives have been met.

The functions for normal pan operation are conducted at either the control room panel or the working side of the continuous pan. At normal pan floor level the working side of the unit contains proof samplers for all cells and the boiling massecuite surface is visible in each cell. Figure 3 shows an exterior view of the working side of the pan.

A minimum of supervision by the pan boiler is necessary during normal operation. The pan has shown good flexibility in handling a range of throughput rates, including total idling of the pan on movement water for extended periods, with no problems being encountered.

Start-up and shutdown

The start-up and shutdown procedures are relatively short and simple and are carried out by the normal pan stage operators. No additional operators are required for these procedures. It is the usual procedure for the continuous pan to be shutdown for the weekend stop at up to four hours prior to the finish of crushing for the week. This is possible because of the large *B*-molasses storage capacity.

Boil-out operations

A routine has been established where one section of the pan is boiled with water at the start of each week. This procedure has been very convenient and has ensured a continued efficient operation of the pan.

Pan operations and boiling conditions

Performance trials were undertaken over a two-week period towards the end of July 1982. Operating conditions were typical of normal factory operations and are summarized in Table I together with data from the commissioning period. During the performance trials the *C*-massecuite production requirement averaged only about 17-18 tonnes/hr, which is well below the design rate of 34 tonnes/hr. The *C*-seed addition rate was regulated to achieve a ratio of *C*-massecuite production rate to *C*-seed rate of 3.0 to 3.5. At this production level, molasses was usually fed to cells 1-4 only and cells 5 to 7 were controlled on movement water addition. The vacuum was controlled at about 13 kPa abs.

The massecuite boiling level in the pan was maintained at about 0.2 to 0.4 metres above the top of the calandria in the final cell. The boiling height differential along the length of the vessel was approximately 0.15 m at the rate of production during the trials. For most of the tests jigger steam was used on cell 7 only.

Pan crystallization and exhaustion performance

The seed massecuite pumped to the continuous pan was typically of 86% dry solids and 67 true purity with a crystal content of about 27% on solids. The mean size of the crystals in the seed to the continuous pan was about 0.12-0.16 mm.

The exhaustion work in the continuous pan was very good as shown by the analyses in Table II. These include dry substance and true purity, (based on double pol determinations) of the product massecuites and the pressure-filtered molasses. Massecuites at the pan dis-

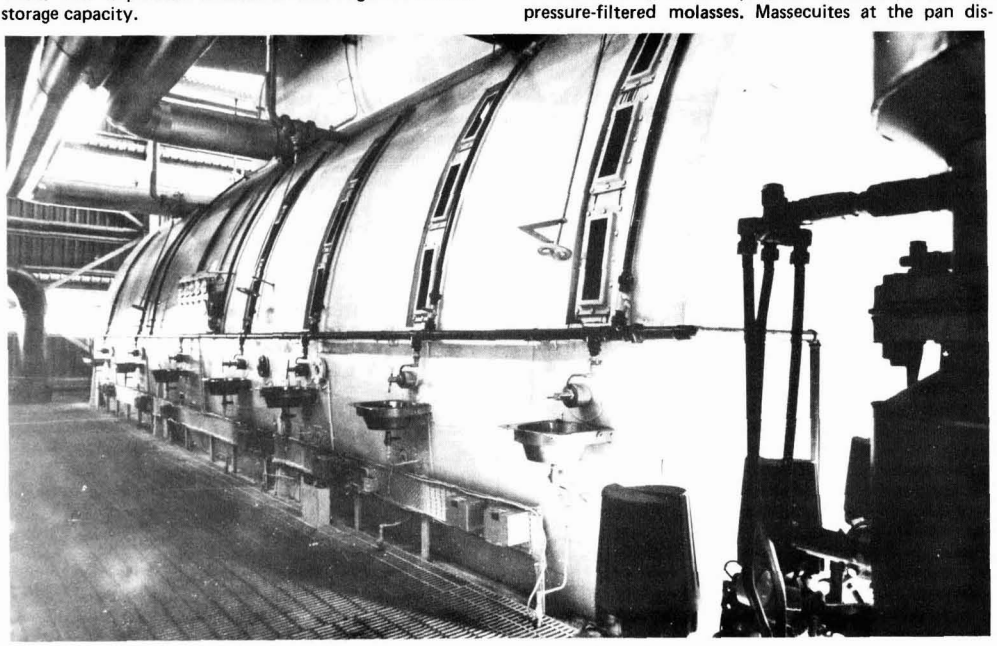


Fig. 3. View of the working side of the Tully continuous pan

charge were typically of 93% dry solids and had a crystal content of 35% on solids. The true purity of the product massecuite ranged from 63-65% with a true purity drop to the mother liquor purity of 18-20 units. This is a considerable improvement over the operation in the 1981 season when the purity drop normally achieved in the batch *C*-pan at Tully mill was 15.5 to 16 units.

their high dry solids and high crystal content. Brookfield viscosities were 400-800 Pa.s at a discharge temperature of 75°C. This value is approximately three times the usual "pan drop" massecuite viscosity from batch production.

The spread of crystal sizes in the product massecuite was acceptable, and was comparable to that from batch production. Size distributions of the crystal populations have not been determined but it is estimated.

Table I. Operating conditions in the Tully continuous pan

Date	Estimated *C*-massecuite production rate*, tonnes/hr	*C*-massecuite/ seed ratio	Calandria 1 (Cells 1-3)			Calandria 2 (Cells 4, 5)			Calandria 3 (Cells 6, 7)		
			Pressure, kPa abs	Steam† flow, tonnes/hr	Specific evaporation rate, kg/hr/m²	Pressure, kPa abs	Steam flow, tonnes/hr	Specific evaporation rate, kg/hr/m²	Pressure, kPa abs	Steam flow, tonnes/hr	Specific evaporation rate, kg/hr/m²
Commissioning period											
Week 1											
18 6.82			146	2.73	8.1	143	2.83	7.3	166	3.55	7.4
Week 2											
21.6.82			111	2.05	6.1	113	2.85	7.4	119	3.04	6.4
25.6.82			119	2.29	6.8	110	2.10	5.4	125	2.87	6.0
25.6.82‡			110	1.73	5.1	99	1.35	3.5	119	2.53	5.3
Performance trials											
Week 1											
28.7.82	17.3	3.3	133	2.33	6.9	121	2.43	6.3	160	3.48	7.3
30.7.82	11.9	3.4	147	2.70	8.0	125	2.36	6.1	160	3.31	6.9
Week 2											
2.8.82	–	–	138	1.99	5.9	120	2.14	5.5	162	3.88	8.1
3.8.82	22.9	3.0	151	2.55	7.6	135	2.42	6.3	173	3.77	7.9
4.8.82	17.7	3.5	149	2.33	6.9	136	2.19	5.7	144	2.35	4.9
5.8.82	18.8	3.1	149	2.34	7.0	129	2.22	5.7	139	2.17	4.5
6.8.82	–	–	174	2.88	8.6	153	2.82	7.3	161	2.54	5.3

* The *C*-massecuite production rate is estimated from the mass flow rates of seed and *B*-molasses. † Steam flow rates are measured condensate rates.
‡ Pan at idle on reduced steam flows.

Impurity:water ratios were very high in the product massecuite, being between 4.7 and 5.1. This compares with impurity:water ratios for good batch pan operation of 3.6. The quality of the massecuite produced from the continuous pan as measured in terms of the dry solids, crystal content, viscosity values etc. was very consistent as is evident from the data in Table II.

The viscosity of the product massecuites was measured using a Brookfield RVT viscometer and the Sugar Research pipeline viscometer, and these values are also given in Table II. Product massecuites discharged from the continuous pan were extremely viscous owing to

from photographic records, that the average size of the crystals in the product massecuite was about 0.30-0.32 mm. During the season the pan has produced massecuites free of fine grain and no fine grain has become evident during subsequent growth in the crystallizers.

Pan circulation and steam consumption

The pan circulates very strongly at economical steam consumption rates. Values of steam flow rates and calandria pressures are given in Table I for the three calandrias. Good circulation movement has been observed for a total steam usage of only 8 tonnes/hr of exhaust

Table II. Analyses of product massecuite from the Tully continuous pan

Date	Massecuite						Pressure-filtered molasses		Purity drop in product massecuite
	Dry substance	True purity	Crystal content on solids	Viscosity (temperature of measurement °C)		Impurity/ water ratio	Dry substance	True purity	
				Brookfield* Pa.s	Pipeline† Pa.s				
Commissioning period									
Week 2									
22.6.82	93.2	62.8	–	–	–	5.1	–	–	–
23.6.82	92.8	63.0	33.7	–	–	4.8	89.6	44.2	18.8
Performance trials									
Week 1									
27.7.82	93.1	65.4	35.8	548 (71.3)	289 (73.6)	4.7	90.1	46.1	19.3
28.7.82	93.1	64.7	33.4	480 (70.9)	265 (73.0)	4.8	89.5	47.0	17.7
30.7.82	93.0	65.0	35.9	404 (72.9)	233 (72.9)	4.7	89.5	45.4	19.6
Week 2									
3.8.82	93.3	65.9	35.8	444 (74.5)	252 (74.5)	4.7	89.8	46.9	19.0
4.8.82	93.5	64.7	34.6	780 (74.9)	284 (75.8)	5.1	90.2	46.0	18.7
5.8.82	93.3	64.7	36.0	604 (75.3)		4.9	90.0	44.8	19.9

* Brookfield viscosity values determined using spindle number 7 and speed 1 rev/min. † Pipeline viscosity values at a shear rate of 1 sec^{-1}.

steam at an average calandria pressure of 145 kPa abs. For a total installed heating surface area of 1200 m^2 this steam rate is equivalent to an average specific steam consumption rate of 6.7 kg/hr/m^2. This is considerably lower than the value of 12 kg/hr/m^2 which is the normal specific steam usage for the Mossman continuous pan[2] and 9-14 kg/hr/m^2 for the Racecourse continuous pan[4,5]. The low specific steam consumption may result, to some extent, from the excess capacity in the Tully pan at present throughput rates though it is obvious that the open internal design aids a strong circulation movement.

At current production levels the steam consumption rate in the pan is approximately 0.35-0.4 tonne steam per tonne of *C*-massecuite produced. This value is similar to consumption figures for other continuous pan installations in Australia and compares with a typical figure of about 0.4 tonne steam per tonne *C*-massecuite production for batch *C*-strike.

Values of heat transfer coefficient have been calculated and average about 110 W/m^2/°C for each of the three calandrias. Coefficients determined on the Mossman and Racecourse continuous pans[2,5] generally lie in the range 140-220 W/m^2/°C. The reason for the lower coefficient values on the Tully pan is not certain.

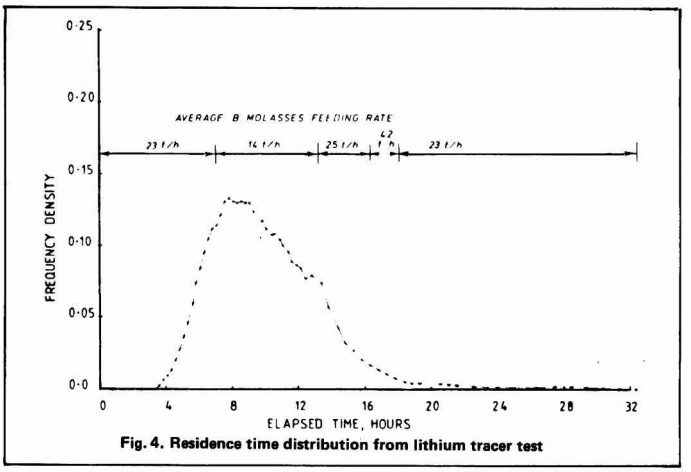


Fig. 4. Residence time distribution from lithium tracer test

Residence time distribution

A single lithium tracer test was undertaken producing the frequency distribution given in Figure 4. For the test the mean residence time was 9.6 hours and the coefficient of variation (CV) 0.33. This spread of residence times is considered reasonable, especially in view of the fact that some unavoidable variation in throughput rate occurred during the test (owing to wet weather interruptions). The shape of the curve is typical for a series of well-mixed compartments and indicates that no serious short-circuiting of material was occurring.

The spread of residence times in the pan is wider than measured in both the Mossman pan[2] (CV 0.25) and the Racecourse pan[4] (CV 0.12). This result was expected owing to the smaller number of compartments installed than in the Mossman unit and the much shorter path length than in the Racecourse pan. The approach adopted in the design of Tully pan was that the deficiencies introduced by an inherently wider residence time distribution are offset by the additional simplicity of operation and the improved circulation movement resulting from the reduced amount of internal steelwork.

Performance of the crystallizer-centrifugal station

Data on the exhaustion achieved through the crystallizers and the performance of the centrifugal station are shown in Table III. A purity drop of about five to six units was obtained in the crystallizers which is considered reasonable in view of the fact that the massecuite is very well exhausted at the discharge from the continuous pan. Overall, the pan-crystallizer station reduced the mother molasses to close to or below the target purity value. The result was achieved even though a large amount of final molasses (up to 15% on massecuite) was added to the intermediate crystallizers in each set in order to maintain massecuite flow. It should also be realized that for the period of the tests only four of the six crystallizers were being operated in continuous mode at full operational level; the remaining two units were kept with very low massecuite levels.

[4] McDougall & Wallace: *ibid.*, 1982, 383-388.
[5] Broadfoot *et al.*: *ibid*, 1983, 137-148.

Table III. Crystallizer-centrifugal performance for massecuites from the continuous pan

Date	True purity of massecuite ex pan	True purity of pressure-filtered molasses ex pan	True purity of pressure-filtered molasses at centrifugal entry	Expected true purity	True purity of final molasses
Performance trials					
Week 1					
27.7.82	65.4	46.1	–	–	45.2
28-29.7.82	64.7	47.0	41.4	40.2	46.0
29-30.7.82	–	–	42.1	40.6	44.3
Week 2					
02-03.8.82	–	–	40.4	40.9	45.0
03-04.8.82	65.9	46.9	41.3	41.2	44.0
04-05.8.82	64.7	46.0	40.1	41.1	44.3

Performance of the continuous low-grade pan at Tully mill

At the time of the performance trials a substantial loss of sucrose to the final molasses occurred during the centrifugalling step with the rise in true purity across the centrifugals ranging from 2.2 to 4.6 units. It was observed that some parent crystals were passing the screens and this would have contributed significantly to the purity rise.

Following the Sugar Research tests the final conversion of all BMA K1000 centrifugals to centre feed was completed and the screen type changed in the acceleration chambers of these units. Subsequent mill comparisons conducted between the apparent purity of the pressure-filtered mother molasses prior to spinning and the final molasses purity showed an average rise of approximately one unit of apparent purity for tests undertaken over a number of weeks.

Pan production capacity

During the trials the pan was operating well below the design capacity with average *C*-massecuite throughput rates in the range 18 to 23 tonnes/hr. Nevertheless, the observations were sufficient to indicate that good exhaustion work would be expected at the design throughput rate of 34 tonnes/hr.

At the design production level the average crystal residence time in the pan would be about 6.5 hours. It is expected that at this rate, cells 1-5 would operate on molasses feed and cells 6 and 7 on water addition. This would still provide in excess of two hours average exhaustion time on movement water prior to pan discharge.

As production rates are increased towards the design level no significant increase in total steam usage should be required as the main change will be to operate cell 5 on molasses feed rather than on balancing water as at present. This would then represent a saving in steam usage over the equivalent production in batch operation.

Conclusions

The continuous low grade pan at Tully mill has demonstrated the advantages of continuous boiling with the consistent production of well-exhausted massecuites of high dry solids content. The benefit of low steam usage (area basis) has been obtained while exhibiting good circulation movement.

The design of the Tully pan allows simple operating procedures to be employed with particular benefits being gained for the boiling-out procedures. The design is well suited to further expansion if required and lends itself readily to units of larger or smaller capacity.

During the 1983 season it is hoped to investigate slightly different modes of operation including a lowering of the *C*-massecuite purity below that processed in the 1982 season.

Acknowledgements

The authors acknowledge the assistance and cooperation of the management and staff of Tully mill during these investigations.

Summary

The continuous low-grade pan at Tully mill has operated very satisfactorily since it was commissioned at the start of the 1982 season. Performance trials have been undertaken and the results are presented. Particular attention is paid to the crystallization-exhaustion performance, the steam consumption rate and the control operations.

Performance de l'appareil à cuire continu AP dans l'usine de Tully

La cuite AP continue de l'usine de Tully a opéré de manière trés satisfaisante depuis son démarrage à la saison 1982. On a effectué des essais de performance et on présente les résultats. Une attention particulière fut portée à la performance d'épuisement en cristallisation, à la consommation de vapeur et aux opérations de contrôle.

Leistung des kontinuierlichen Nachproduktkochapparates in der Zuckerfabrik Tully

Der kontinuierliche Nachproduktkochapparat in der Zuckerfabrik Tully arbeitet seit seiner Indienststellung zu Beginn der Kampagne 1982 sehr befriedigend. Die unternommenen Leistungsversuche werden dargestellt. Besondere Aufmerksamkeit wird der Erschöpfung durch Kristallisation, dem Dampfverbrauch und der Regelung geschenkt.

Operación del tacho contínuo de bajo-grado en la azucarera de Tully

La operación del tacho contínuo de bajo-grado en la azucarera de Tully ha sido muy satisfactoria desde su comisión al comienzo de la zafra de 1982. Se han emprendado ensayos de cumplimiento y se presentan los resultados. Los autores prestan atención al operación cristalización-agotamiento, el consumo de vapor y las operaciones de los controles.

South African drought broken[1]. — The worst drought in the history of the South African sugar industry has finally been broken, with reports of good rains falling in all parts of the industry. The rains have fallen too late, however, to save the present season's crop which will be the lowest on record since 1970/71. Latest estimate of the crop is 1,410,000 tonnes, tel quel, of which 1,150,000 tonnes is earmarked for the domestic market. Last season, the crop was a record 2,125,993 tonnes. All the factories except Empangeni (which has closed down for good) and Darnall were still in operation at the end of November but the season was drawing to a close mainly because of irregular supplies of cane.

Boiling control by television[2]. — Closed-circuit television has been installed at Newark sugar factory to monitor the formation of crystals in the vacuum pans. DDS pan microscopes, attached to television cameras, have been fitted on each pan and send signals back to monitor screens in the central control room. Use of television is considered a logical step from the use of microscopes as a pan boiling aid in the development of the centralized control system at Newark.

Trinidad sugar imports[3]. — Trinidad is to buy up to 63,000 tonnes of raw sugar on the world market to replace supplies earmarked for shipment to the US. Trinidad's 1984 US supply quota is 20,650 short tons and, under US law, suppliers must ship domestically produced sugar, so that Trinidad will export locally produced sugar to the US and import world market sugar for domestic consumption. Trinidad also has an EEC supply quota of 69,000 tonnes, white value, equivalent to 75,000 tonnes, raw value.

Chile beet sugar expansion prospects[4]. — The contracted beet area for 1984 is 48,000 hectares which compares with 35,000 ha in 1983 when output amounted to 212,000 tonnes of white sugar. The planting was late that year and a better yield is expected in 1984 with production amounting to some 305,000 tonnes. Domestic consumption has been projected at 350,000 tonnes.

1 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 614.
2 *British Sugar News*, 1983, (57), 5.
3 F. O. Licht, *International Sugar Rpt.*, 1983, **115**, 594.
4 C. Czarnikow Ltd., *Sugar Review*, 1983, (1675), 216.

Processes for deliming sugar juices

By X. LANCRENON* and P. PRINTEMPS†

For the deliming of purified juices, i.e. after carbonatation, the most common technique used in the beet sugar industry is ion exchange. Most French sugar factories are equipped with a deliming plant to avoid the scaling of evaporators by calcium salts.

In French sugar factories, the thin juices contain between 40 and 200 mg CaO per litre of juice under normal conditions but, when the beets deteriorate during long storage or as a result of frost damage, the CaO content may increase to 500-600 mg per litre of juice. In certain countries these values occur even during normal periods.

Reference to the annual report of the Syndicat National des Fabricants de Sucre de France shows that, in 1950, when factories did not have deliming plants, 90% of them were obliged to shut-down for 10-18 hours, two or three times per campaign, for chemical cleaning of the evaporators. In factories where such cleaning was not done the steam consumption often increased by 20% above that at the beginning of the campaign. Moreover, when the evaporation surfaces were scaled, the Brix of the thick juice leaving the evaporator decreased from 65-66° to 50°, giving much longer pan boiling cycles and consequently poorer green syrup quality through increased formation of colour and invert sugars, caramelization, etc.

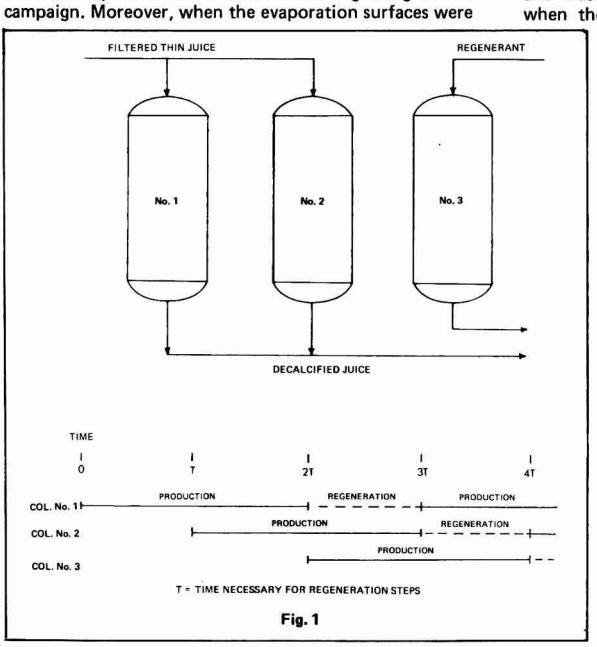


Fig. 1

X. Lancrenon

P. Printemps

Principle of deliming

Three different deliming processes are used in France at the present time. The main differences between them lie in the resin regeneration methods. For the deliming itself, the principle is always the same; the ion exchange resins are strongly acid cationic resins in alkali metal (K^+, Na^+) form. When juice containing calcium passes through the resin the following ion exchange takes place:

$$2\ R\text{-}Na + Ca^{++} \rightarrow R_2\text{-}Ca + 2\ Na^+$$

When the resin is entirely in calcium form it is exhausted and must be regenerated with sodium or potassium ions, when the reaction above takes the opposite direction.

Industrially, deliming plants include three identical ion exchange columns; two are in operation whilst the third is being regenerated or is waiting. The design of plants with three columns allows greater flexibility in use and more regular quality of the treated product.

The three different processes for regeneration of exhausted ion exchange resins are as follows: the conventional process, the Gryllus process, and the N.R.S. or Akzo process.

The conventional process

Regeneration of the ion exchange resin (Fig. 1) is carried out with a 10% sodium chloride solution. The consumption of salt is 200 grams per litre of resin (or 170 g when brine recovery is practised). For an average lime salts concentration of 150 mg CaO per litre of juice, the capacity of the resin is 21 g CaO per litre of resin. Therefore, salt consumption is 200/21 or 9.5 g NaCl per g of eliminated CaO (or 8.1 g when brine is recovered).

Because of the introduction of sodium chloride for the regeneration, it is essential to sweeten-off the resin with hot water and, after regeneration, to sweeten-on the resin with thin juice; both of these operations involve marked dilution of the thin juice.

Disadvantages of this process are as follows: (1) dilution of thin juice, (2) consumption of hot water, (3) consumption of salt, (4) production of saline waste water, and (5) increased sugar loss in molasses, the melassigenic effect of sodium being greater than that of calcium.

* Assistant Manager, Applexion.
† Project Engineer, Applexion.

[1] Gryllus & Delavier: *Zuckerind.*, 1975, **100**, 493-501, 554-561.
[2] Le Henaff & Hervé: *Ind. Alim. Agric.*, 1977, **94**, 725-729.
[3] *Sucr. Franç.*, 1979, **120**, 263-267; *Sucr. Belge*, 1982, **101**, 369-380.

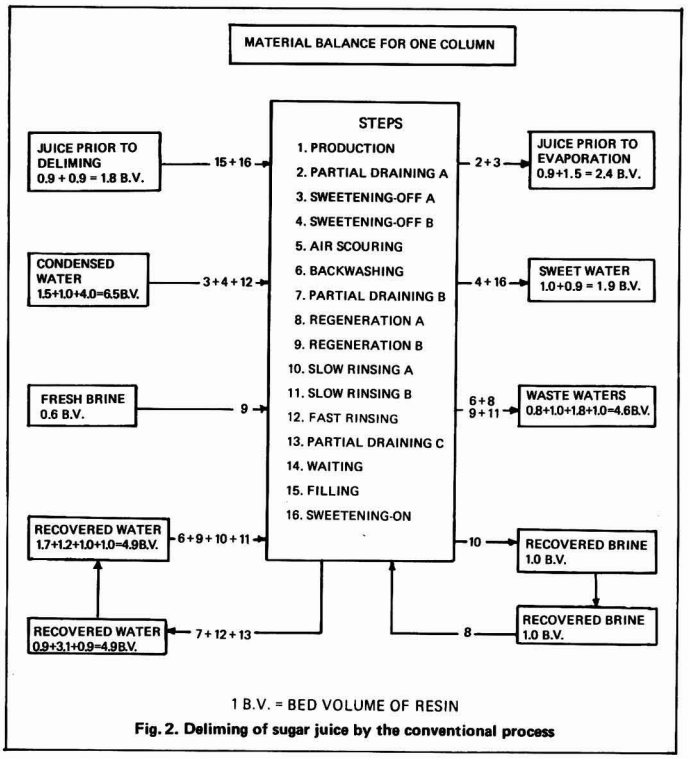


Fig. 2. Deliming of sugar juice by the conventional process

The Gryllus process

This process[1,2] was devised to eliminate the disadvantages of the conventional process. Regeneration of the resins is carried out with low green syrup (LGS), making use of the K^+ and Na^+ ions in this syrup to regenerate the resin.

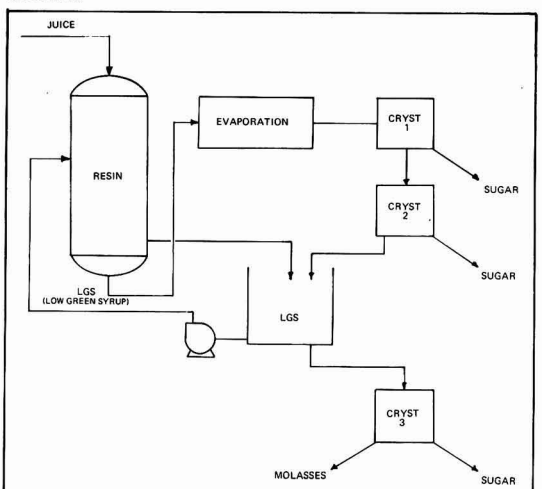


Fig. 3. Gryllus process flow diagram

The LGS is diluted to 76-78° Bx with sweet water from the last sweetening-off step (see Fig. 4). The temperature of the LGS, taking into account its viscosity at this concentration, must be 85°C.

The main advantages of the Gryllus process are as follows: (1) no water consumption, (2) no salt consumption, (3) no thin juice dilution, (4) no waste water, and (5) no increase of sugar loss in molasses.

It may be interesting to comment on the "Gryllus effect", i.e. the decrease in molasses sugar using the process. This occurs as the sum of two important effects of the Na^+ ion emanating from the regeneration of the resin and present in the molasses, namely its influence on the saturation coefficient of the molasses and its reduction of the molasses viscosity. Ponant[3] has reported on the influence of Na^+ ions on sugar losses in molasses, as follows:

Conventional molasses (resin regenerated with brine)	
Purity	59.1
Brix	88.57
Non-sugar:water	3.17
Temperature, °C	52
Viscosity, cp	8800

Gryllus molasses (resin regenerated with LGS)	
Purity	57.5
Brix	88.57
Non-sugar:water	3.30
Temperature, °C	49
Viscosity, cp	8800

The Gryllus effect is well illustrated in the following table showing the estimated sugar gain in relation to factory capacity by comparison with the conventional process of regeneration with salt, for a campaign lasting 85 days.

Daily slicing capacity, tonnes	Increased sugar recovery, tonnes
2000	220
5000	550
8000	880
11,000	1210

Experience with the Gryllus process

The first French factory to use this process was Artenay, which produces one of the best-known sugars in France for purity. It was found that there were: no appreciable change in colour formation in juice in spite of the presence of LGS, no increase of turbidity in the sugar (even without filtration of remelts), and no scaling of third-crop vacuum pans.

Dilution of low green syrup

It is to be noted that, for a typical French sugar factory, without storage of syrup, the Gryllus process causes a fall in Brix of the total quantity of LGS of about 5°. From this it might be inferred that (a) the duration of the third-crop boiling is relatively increased, and (b) the Gryllus process gives extra water to be evaporated. In fact, (a) the viscosity of the Gryllus LGS containing calcium is lower than that of the conventional LGS, thus giving the same third-crop boiling time in spite of the decrease in concentration, while (b) the increase in energy consumption for the third-crop boiling is balanced by the decrease in energy consumption for concentration of the juice. Moreover, it is to be noted that the total quantity of water to be evaporated in a factory using the Gryllus process is lower than that in a factory using the conventional process.

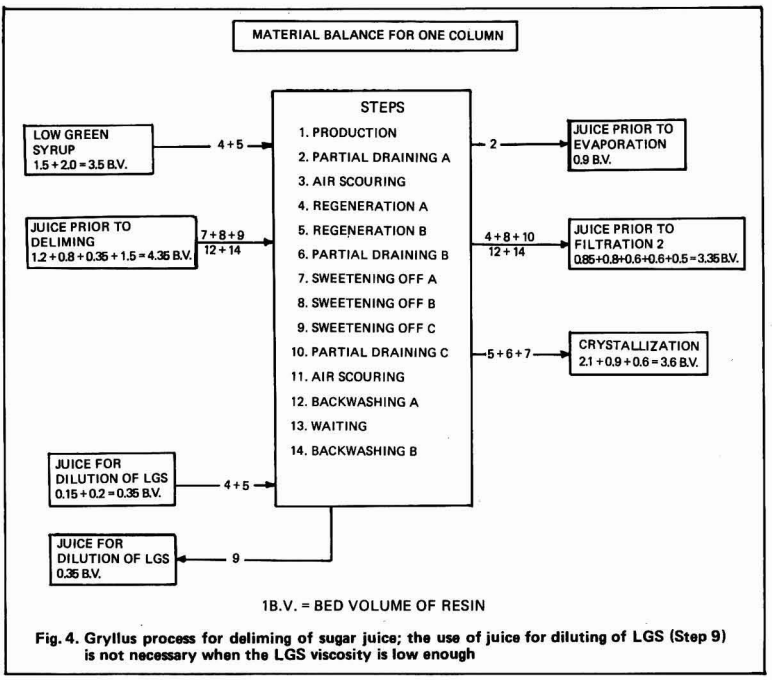


Fig. 4. Gryllus process for deliming of sugar juice; the use of juice for diluting of LGS (Step 9) is not necessary when the LGS viscosity is low enough

Limits of the Gryllus process

The limits of the process are fixed by the ratio of alkali metal ions to calcium in the juice to be treated. When the CaO level is very high, e.g. more than 500-600 mg.litre^{-1}, the alkali metal ions content is sometimes insufficient for good regeneration of the resins. This may be the case in Morocco or Spain but rarely occurs in France. In the same way, if the available quantity of alkali metal ions is artificially decreased, which happen in certain factories, the same effect can occur.

In France the admissible limit for storing thick juice, taking into account the average CaO content, is about 40% if the resins have to be regenerated with LGS. This problem can be overcome, as recommended by Gryllus, by regenerating with thick juice.

The N.R.S. (Akzo) process

This process was developed mainly to solve the problems encountered in the conventional process, mainly concerning waste waters[4]. The principle of the N.R.S. process is as follows: when the resin is exhausted, regeneration is carried out by means of delimed juice containing caustic soda, with 40 g NaOH per litre of resin. The calcium liberated combines with the sucrose present to give soluble calcium saccharate. To produce this soluble calcium saccharate the temperature of the regeneration juice must be lower than 50°C.

The juice after regeneration, containing caustic soda and calcium saccharate, is introduced into the carbonatation, where CO_2 decomposes the saccharate into sucrose and $CaCO_3$, the latter being removed by filtration.

Compared with the conventional process, the N.R.S. process uses more expensive caustic soda instead of salt; however, as the regeneration yield is better, the cost of regenerant is no higher for the N.R.S. process. Further-

[4] Pannekeet: *Ind. Alim. Agric.*, 1980, **97**, 757-760.

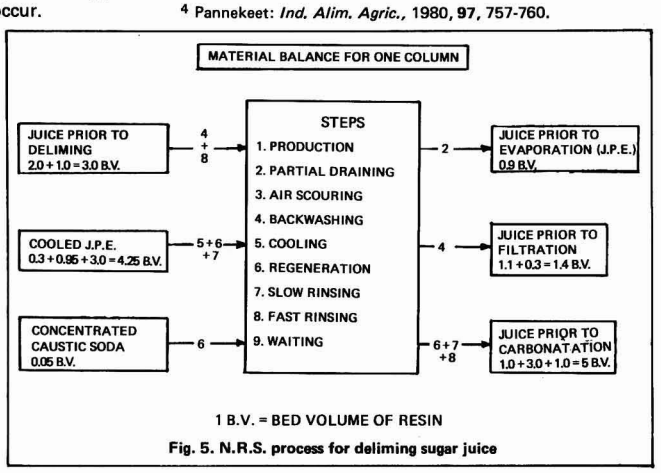


Fig. 5. N.R.S. process for deliming sugar juice

more, French sugar factories which add caustic soda to thin juices prior to concentration can obtain some advantage from the N.R.S. process as the caustic soda would be used for addition to the juice anyway.

The quantity of juice to be cooled to about 40°C is only a small part of the total quantity of juice passing through the plant so that the additional energy necessary for its reheating is insignificant.

Conclusion

We believe that sugar factories should have a deliming plant and use one of the two regeneration methods (Gryllus or N.R.S.) which have been in operation in several French sugar factories during recent years. The choice between the regeneration process to be employed will depend on each factory's own criteria: the crystallization capacity of the third-crop vacuum pans, consumption of caustic soda for addition to juice, use of final molasses, and sugar extraction.

Summary

Descriptions are given of ion exchange processes used in French sugar factories for beet juice deliming, viz. the conventional one involving resin regeneration with salt, the Gryllus process in which the resin is regenerated with low green syrup, and the NRS (Akzo) process in which delimed juice containing caustic soda is used for regeneration. Advantages and disadvantages of the processes are discussed.

Procédés pour décalcifier les jus sucrés

Des descriptions sont données de procédés d'échange d'ions utilisés dans des usines Françaises pour la décalcification des jus: la conventionnelle régénération des résines avec NaCl, le procédé Gryllus avec régénération à l'égout pauvre et le procédé NRS (Akzo) dans lequel du jus décalcifié contenant du NaOH est utilisé pour la régénération. Les avantages et désavantages des procédés sont discutés.

Verfahren zur Entkalkung von Zuckersäften

Beschrieben werden Ionenaustauschverfahren, die in französischen Zuckerfabriken für die Rübensaftentkalkung angewendet werden, das sind das konventionelle Verfahren mit Regeneration des Harzes mit NaCl, der Gryllus-Prozeß, bei dem das Harz mit unreinem Grünablauf regeneriert wird, und das NRS-(Akzo)-Verfahren, bei dem entkalkter Saft, der NaOH enthält, zur Regeneration verwendet wird. Die Vor-und Nachteile dieser Verfahren werden diskutiert.

Procesos para la descalcificación de jugos azucarados

Se presentan descripciones de procesos para cambio de iones que se emplean en azucareras francesas para la descalcificación de jugo de remolacha, es decir, el convencional en que la résina es regenerado con sal, el proceso Gryllus en que es regenerado con melaza intermedia, y el proceso NRS (Akzo) en que jugo descalcificado que contiene sosa caústica se usa para regenerar la résina. Ventajes y desventajes de los procesos se discuten.

The density of sugar crystals

By E. T. WHITE* and S. Y. GUO†

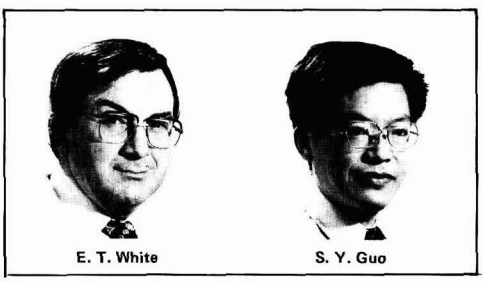
The density of sucrose crystals in $kg.m^{-3}$ at 25°C is commonly quoted as 1586.2[1,2], 1588.0[1] and 1577.2[3-6]. Where necessary, these values were converted to 25°C using the coefficient of cubic expansion of 1.1×10^{-4} per °C estimated by Honig[1].

In the course of studies on the amount of included liquor in sucrose crystals, we have had occasion to measure the density of pure non-included crystalline sucrose and find values substantially in excess of those quoted. We believe the difference is due to the presence of inclusions in the previous crystal samples.

Density values in excess of the commonly quoted values have been noted by Powers[7] and VanHook[8].

Presence of inclusions

The presence of inclusions in a sugar crystal can be observed by viewing the crystal immersed in a fluid of refractive index similar to that of sucrose. Following Mackintosh & White[9] we have used methyl salicyclate as the fluid. Many supposedly "pure" sugar crystals we considered showed significant internal inclusions or imperfections.



E. T. White S. Y. Guo

If the included liquor has a density of 1360 $kg.m^{-3}$ compared with about 1590 $kg.m^{-3}$ for sucrose at 25°C, an inclusion content of only about 0.4% by volume will reduce the crystal density by 1 $kg.m^{-3}$. Inclusion contents can be well above this value.

By using this visual inspection technique on a batch of crystals grown from pure sucrose solution, we were able to select a number of crystals that did not show inclusions.

Measurement of density

Three techniques were considered:

(1) Single crystal Archimedean weighing

The density of selected non-included crystals (∿ 5 mm) was determined by attaching each to a very fine

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1 "Principles of sugar technology". Vol. I. Ed. Honig. (Elsevier, Amsterdam), 1953.

2 "Chemical engineers handbook". Ed. Perry & Chilton. (McGraw-Hill, New York), 1973.

3 "CRC Handbook of chemistry and physics". Ed. Weast. 1980.

4 "Cane sugar handbook". Ed. Meade & Chem. (Wiley, New York), 1977.

5 Beilstein: "Handbuch der Organischen Chemie", 4th edn.

6 "Encylopedia of Chemical Technology". Vol. 19. (Wiley, New York), 1969, p. 152.

7 *Sugar Technol. Rev.*, 1970, **1**, 85-100.

8 *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1976, (26), 73-79.

9 *AIChE Sympos. Ser.*, 1974, (153), 11-20.

metal stirrup and weighing it in air and in carbon tetrachloride. After allowance for the buoyancy effects of the stirrup and air, the following density values were obtained for four such crystals at 25°C:

1592.9, 1592.7, 1590.8 and 1590.9 kg.m^{-3}.

Because of the relatively small mass of these crystals (0.2 – 0.3 g) the estimated error in the densities was relatively large at ± 2 kg.m^{-3}. While larger crystals would reduce the error, such crystals, with no visual imperfections, are hard to find.

(2) Multicrystal determination using an SG bottle

Here a group of smaller crystals (1 – 3 mm), all selected as appearing to be inclusion-free by the above immersion procedure, were used. Their density was determined by immersion in carbon tetrachloride using an SG bottle at 25.0°C. In the first test, 0.1 g of material was used to give a density of 1591.6 ± 6 kg.m^{-3}. To increase the accuracy, a larger 3 g sample was used and the density was evaluated at 1590.6 ± 0.8 kg.m^{-3}. The difficulty in obtaining large masses of non-included crystals detracts from the use of this method.

(3) Sink/float technique

This is the most accurate of the techniques considered and is attractive as it only requires a small amount of sample. Inclusion-free crystals were suspended in a beaker of carbon tetrachloride, to which either a denser liquid (tetrabromoethane in CCl_4) or a lighter one (heptane in CCl_4) could be added to make the liquid of the same density as the crystals.

From Stokes settling relation, the solution was estimated to have a density within ± 0.1 kg.m^{-3} of a crystal if, after agitation was halted, the crystal did not rise/settle by more than a few mm in a minute. The density of the liquid was then obtained using an SG bottle. Density values obtained by this technique were:

1591.2, 1591.8, 1592.1 and 1590.7 kg.m^{-3}.

These values are estimated accurate to within ± 0.6 kg.m^{-3}.

Density of sucrose

From these measurements we would estimate the density of pure non-included sucrose crystals to be 1591.5 ± 0.5 kg.m^{-3} at 25°C. This density is about 5 kg.m^{-3} above the previous values. The difference would correspond to a 2.3% inclusion content. It is also possible for sugar crystals to have even higher density values if they contain included scale, metal particles, etc.

The variation of density with temperature is given by Honig[1] as – 0.17 kg.m^{-3} per °C.

Inclusion content by density measurement

We have been measuring the amount of inclusions in sugar crystals by density measurements. A density gradient column (Fig. 1) allowing measurement over a very narrow range of densities is used. This is achieved by filling flasks A and B with carbon tetrachloride-bromoform mixtures very close to each other in density. The column is based on British Standard 3715:1964 and is described in further detail by Guo & White[10]. Close temperature control is essential. Precalibrated glass floats and large sugar crystals are inserted in the liquid as markers to indicate the densities at various levels. Densities are also checked by sampling the liquid at various levels. About 10 g of the washed and dried crystal sugar sample is added carefully to the top of the column. After an hour or so, the crystals will have settled to a position which indicates their density and thus their inclusion content. By removing the column layer by layer, crystal fractions with different inclusion contents may be recovered. Fig. 2 shows the distribution

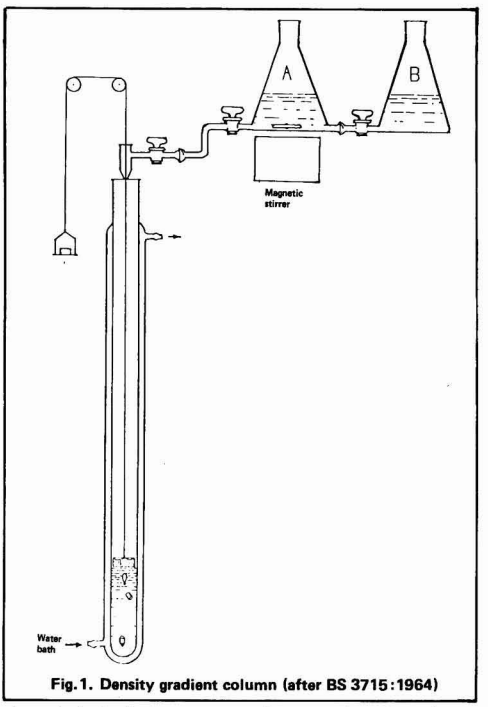


Fig. 1. Density gradient column (after BS 3715:1964)

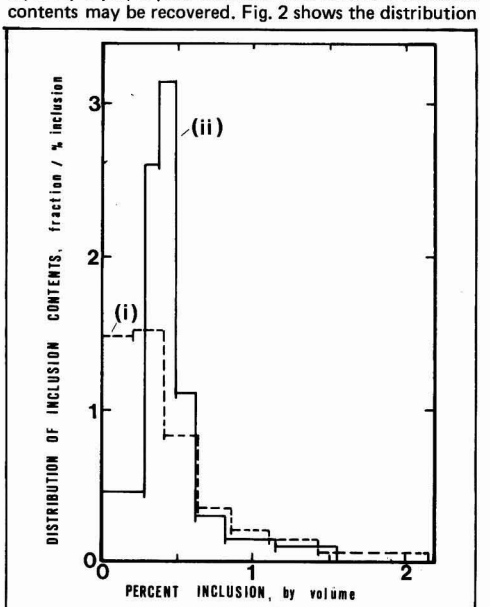


Fig. 2. Distribution of inclusion content. Batches of sugar crystals regrown after partial dissolution. (i) slow regrowth; (ii) faster regrowth (Both samples average about 0.45% inclusions)

[10] *Proc. Aust. Soc. Cane Tech.*, 1983, 219-224.

of inclusions measured in this way for two batches of sugar grown in the laboratory. The densities obtained using this column for non-included sugar crystals are consistent with the new density values determined above.

Conclusions

The density of non-included sucrose crystals is 1591.5 ± 0.5 $kg.m^{-3}$. This is in excess of commonly quoted values. The difference is probably due to the presence of inclusions. Using this value, differences in density may be exploited, using a density gradient column, to give inclusion contents in sugar samples.

Summary

The density of a number of inclusion-free sugar crystals was measured and found to be in excess of values quoted in the literature. The difference is attributed to the presence of inclusions, so that a density gradient column may be applied to determination of inclusion contents.

La densité des cristaux de sucre

On a mesuré les densités d'un nombre de cristaux de sucre, libre d'inclusions, et on a trouvé qu'elles dépassaient les valeurs renseignées dans la littérature. La différence est attribuée à la présence d'inclusions, ce qui fait qu'une colonne à gradient de densité peut être appliquée pour déterminer la teneur en inclusions.

Die Dichte von Zuckerkristallen

Die Dichten einer Reihe von Einschluss-frei Zuckerkristallen wurden gemessen. Die gefundenen Werten waren größer als die in der Literature angegebenen. Der Unterschied wird auf die Anwesenheit von Einschlüssen zurückgefuhrt, so daß die Methode zur Bestimmung des Gehalts an Einschlüssen mit Hilfe einer Dichte-Gradiente-Säule angewendet werden könnte.

La densidad de cristales de azúcar

Las densidades de algunos cristales de azúcar libre de inclusiones se han medido y resultaban más alta que valores citados en la literatura. La diferencia se ascribe a la presencia de inclusiones y, por eso, una columna a declive de densidad puede aplicarse a la determinación de los contenidos de inclusiones.

Evaluation of the wetting capacity of sucrose solutions on copper surfaces

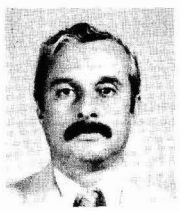
By ROBERTO GONZALEZ QUIÑONES and
JORGE LODOS FERNANDEZ
(ICINAZ, Cuba)

Introduction

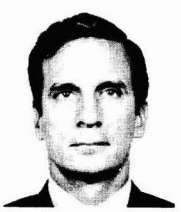
The chemophysical characterization of interface phenomena occurring during the contact of sucrose with heat transfer surfaces in sugar industry evaporation equipment is of extraordinary importance in order to provide a complete understanding of this complex process. It is evident that, among the many properties attached to it but less studied, are those connected with the surface moistening (contact angle ϕ), the surface tension (γ_{lv}), the adherence work (W_{ad}) of the solutions on metallic surfaces and their extension coefficient or capacity to spread spontaneously over them (S).

The available information regarding the two first properties is of some importance, but covers very superficially the system of interest to us: sucrose solutions and metallic surfaces.

In 1974, Ciz[1] studied the variation of ϕ in connexion with the Brix of the solution on a quartz surface at low temperatures. The values of ϕ reported are about 18° for solutions up to 30°Brix, thereafter increasing with the Brix in a linear manner up to values of 25°.



R. González Q.



J. Lodos F.

Surfactants applied reduce ϕ by 3°-4°; our previous studies[2,3] have described in a systematic form the behaviour of ϕ in sucrose solutions between 30 and 60°Brix at high temperatures on copper surfaces in the presence of surfactants, showing the linear dependence of ϕ with respect to the temperature, and non-linear dependence with respect to Brix.

The surface tension (γ_{lv}) of the sucrose solutions have been studied more extensively, but generally not in the usual range of temperatures occurring in the evaporating equipment. VanHook[4] studied the dependence of γ_{lv} on the Brix of solutions between 0-80°Brix at 27°C, showing its linear variation and the time dependence of values obtained with the ring method. Moreover, they showed the depressve action of surfactants.

Feldkamp[5] studied the effect of sucrose and salts upon γ_{lv} at low temperatures. Heitz[6] sums up the theoretical relations connecting γ_{lv} with the solution Brix, but does not faithfully describe the reality at high Brix. Our recent studies[3,7] report the behaviour of γ_{lv} in sucrose solutions with respect to Brix, temperature and the presence of surfactants. The thermal gradients of γ_{lv} have been calculated and their independence of the surfactant dose verified.

The general kinetic laws regulating γ_{lv} behaviour in the presence of surfactants have been developed by Krotov & Rusanov[8] and can be applied to sucrose solutions.

1 *Listy Cukr.*, 1974, **90**, 273-274.
2 Lodos *et al.*: *Mem. 42 Conf. ATAC*, 1979.
3 González & Lodos: *Mem. 43 Conf. ATAC*, 1981.
4 *I.S.J.*, 1952, **54**, 7-10.
5 *Chem. Eng. Tech.*, 1968, **40**, 548-549.
6 *Sucr. Belge*, 1971, **90**, 441-451.
7 González & Delgado: 1982, in press.
8 *Kolloid. Zhurnal*, 1977, **39**, (1), 48-56.

The adherence work (W_{ad}) and the extension coefficient (S) had not been previously studied in the systems under our attention, until a very recent study[9] carried out by us, in spite of being important indexes of a liquid's capacity to establish an effective and preferencial contact with the heat transfer surfaces, which should play a decisive role in the increase of heat transfer and in the prevention of deposition of other materials present or produced during the evaporation of industrial juices.

The present work sums up the wetting through the contact angle, surface tension, adherence work and the extension coefficient of 30 to 60°Brix sucrose solutions on copper surfaces at temperatures ranging from 60°C to 100°C in the presence of two surfactants.

Experimental procedure

The contact angle (ϕ) was obtained by the laying drop method described by Adamson[10], photographed against the light using a 35-mm camera and determining ϕ geometrically. For the temperature control a heating plate coupled to a contact thermometer and a suitable electrical control were used, which allowed us to work within a ± 1°C deviation. The exact temperature was determined using a Cu-Constantan thermocouple. The metallic sheets used were made of high purity metal (>99.8%) and mirror-polished to minimize deviations provoked by porosity as pointed out by Zisman[11].

The methodology used is described in our previous study[3], permitting a standard deviation, when reproducing the surface, of ±1° to be obtained. The reproducibility of the operator's reading was ±2°, and the ϕ variation due to gravitational effect within 2 min after deposition of the drop was less than 1°.

The surface tension (γ_o) was determined by the bubble maximum pressure method of Sugden[12] in a double-capillary system modified by us[7], working with submerged capillaries and a precise level control. This allows the measurement to be made in high temperature systems, or of very volatile liquids, without experiencing deviations described by Hommelen[13]. γ_{lv} is calculated using Kelvin's equation

$$\gamma_{lv} = K\Delta P$$

where K is obtained by calibration with twice-distilled water.

The temperature in the system was controlled within ± 0.1°C using a thermostat, and the standard deviation in the γ_{lv} determination was ± 0.2 mN/m. In every case the solutions used were prepared from refined sugar of a purity higher than 99.8%, and Brix controlled within ± 0.1°Bx. The surfactants used were Espumol H and Espumol K, commercial products common in the sugar industry, in proportions of 50, 100 and 150 ppm. The reversible adhesion work by unit surface of a liquid upon a solid was calculated using the Young-Dupré equation

$$W_{ad} = \gamma_{lv}(1 + \cos\phi) \qquad (1)$$

Boyd & Livingston[14] have shown that for surfaces of superficial high energy (γ_s) the adherence work is altered by the absorption of vapour films on them, and the diminution of the surface energy (γ_{sv}) of the newly formed system is given by $\pi = \gamma_s - \gamma_{sv}$, with the implication that the adherence work increases up to a value

$$W'_{ad} = \pi + \gamma_{lv}(1 + \cos\phi) \qquad (2)$$

or that, in general, $W'_{ad} - W_{ad} = \pi$ being greater as a function of the vapour absorption intensity.

The available literature does not report the evaluation in a specific form of this effect in the systems studied, although it is known that for surfaces subjected to a high temperature the vapour adsorption decreases noticeably. This criterion is used as a support for the analyses to be carried out.

The application of equation (1) to a liquid allows evaluation of the cohesion work (W_{co}) for a liquid.

$$W_{co} = 2\gamma_{lv} \qquad (3)$$

The extension coefficients of a liquid upon a solid was evaluated from the equation

$$S = W'_{ad} - W_{co} \qquad (4)$$

which can be converted to

$$S = \pi + \gamma_{lv}(\cos\phi - 1) \qquad (5)$$

which reminds us that this result is affected by the vapour adsorption in the same way as indicated for W'_{ad}.

Discussion of results

Figure 1 shows the behaviour of ϕ for sucrose solutions on copper at different temperatures. It may be noticed that at any temperature the increase in Brix produces an increase of ϕ. This increment is especially pronounced at low temperatures.

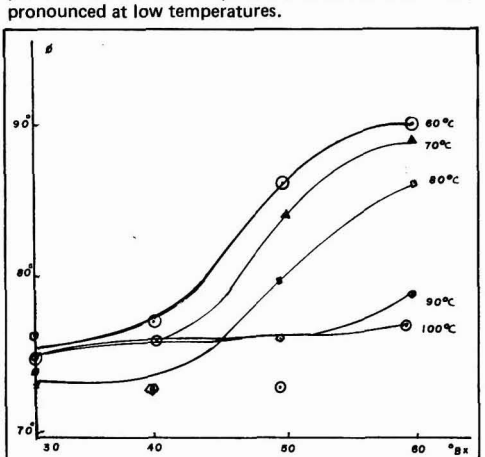


Fig. 1. Variation of contact angle in sucrose solutions on copper as a function of the Brix of the solution

Table I shows the variation of ϕ for 30 and 60°Brix solutions in the presence of surfactants. Diluted solutions (⩽ 30°Brix) are practically unaffected by the temperature increase; the wetting capacity of concentrated solutions is notably increased when temperature increases. In both cases the dependence $\phi = f(T)$ is linear, and its negative slope $d\phi/dT$ increases when the Brix is increased. The presence of surfactants does not affect $d\phi/dT$, and in every case it may be observed that the moistening is

9 González & Lodos: 1982, in press.
10 "Physical chemistry of surface". (Interscience, London.) 1967, p.477.
11 "Constitutional effects on adhesion and cohesion." Ed. Weiss, 1962.
12 *J. Chem. Soc.*, 1922, **121**, 858-866.
13 *J. Colloid Sci.*, 1959, **14**, 385-400.
14 *J. Amer. Chem. Soc.*, 1942, **64**, 2383.

improved substantially by the action of the surfactants. Espumol H is found to be more effective in dilute solutions, whilst Espumol K gives a better performance in concentrated ones.

Table I. Effect of surfactants Espumol H and Espumol K upon the contact angle ϕ in sucrose solutions

	30°Brix		60°Brix	
Temperature	60°C	100°C	60°C	100°C
Without surfactants	76°	75°	90°	78°
With 150 ppm Espumol H	45°	43°	81°	73°
With 150 ppm Espumol K	55°	52°	73°	58°

Figure 2 shows the variation of γ_{lv} with Brix at various temperatures. It may be observed that this linear, agreeing with VanHook[4], and, further, that the γ_{lv} increment provoked by the Brix increase diminishes as temperature rises.

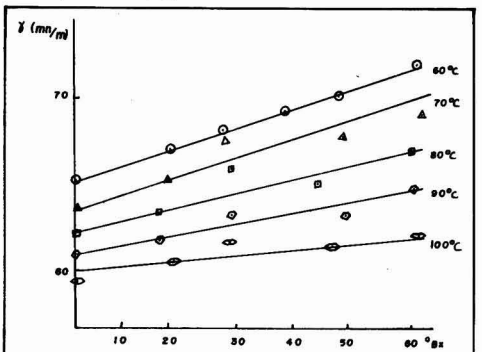


Fig. 2. Surface tension dependence on the sucrose solution Brix at different temperatures

Table II shows the γ_{lv} variation for 30 and 60°Brix solutions in the presence of surfactants. Both solutions are affected by the increase of temperature and the dependence $\gamma_{lv} = f(T)$ is linear with increasing negative values for the thermal gradient $d\gamma_{lv}/dT$ with Brix increase. Neither of these relations are affected by the presence of surfactants. In all cases γ_{lv} decreases noticeably in the presence of surfactants, but the effect of both surfactants is greater in diluted solutions.

Table III shows the adherence work of sucrose solutions, characterized by their relatively low values. It is clearly shown that, for concentrated solutions, when increasing the temperature, W_{ad} is not altered, owing to the compensation between the fall of γ_{lv} and the increase of cos ϕ, and that, for diluted solutions, W_{ad} decreases owing to the decrease of γ_{lv} values. For these weak solutions, the surfactants studied do not alter W_{ad} at high temperatures, and at low temperatures, the surfactants produce similar, rather poor effects.

Table II. Effect of surfactants Espumol H and Espumol K upon the surface tension (mN/m) of sucrose solutions

	30°Brix		60°Brix	
Temperature	60°C	100°C	60°C	100°C
Without surfactants	70.4	62.0	75.2	63.2
With 150 ppm Espumol H	51.2	41.4	62.3	53.3
With 150 ppm Espumol K	57.0	47.6	71.6	64.0

Table III. Effect of surfactants Espumol H and Espumol K upon the adherence work (mN/m) of sucrose solutions

	30°Brix		60°Brix	
Temperature	60°C	100°C	60°C	100°C
Without surfactants	85.7	76.8	75.2	76.2
With 150 ppm Espumol H	95.2	73.5	74.0	71.53
With 150 ppm Espumol K	94.0	72.2	92.5	102.4

It is very important to notice how Espumol H is not effective in concentrated solutions at low temperatures, and, at 100°C has a harmful effect. Espumol K, however, produces a very positive effect at both ranges of temperatures.

This W_{ad} response to the surfactant action may be only explained by their action upon ϕ, especially by Espumol K at 60°Brix. That this is a determinant phenomenon has been corroborated in one of our previous works[15], where it may be noticed that Espumol K is, basically, a wetting agent, preferentially acting at the solid-liquid interface, while Espumol H acts at the liquid-vapour interface. This aspect must be taken into consideration when determining the practical usefulness of a surface wetting agent, whereby, in the absence of a high concentration in both types of interfaces, an

[15] González & Lodos: 1982, in press.

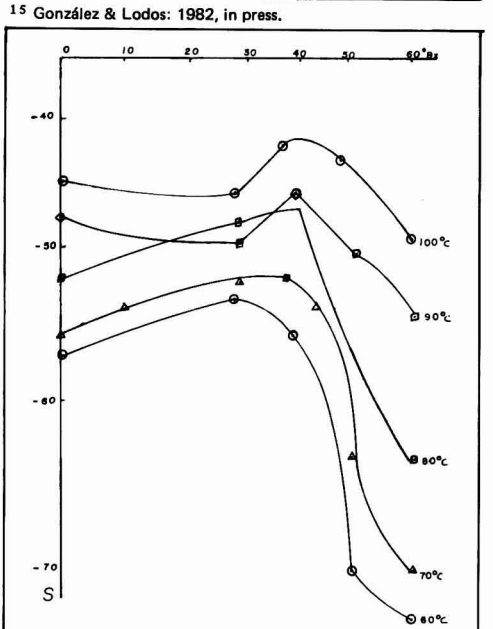


Fig. 3. Extension coefficient of sucrose solution on copper as a function of sucrose solution concentration at different temperatures

x

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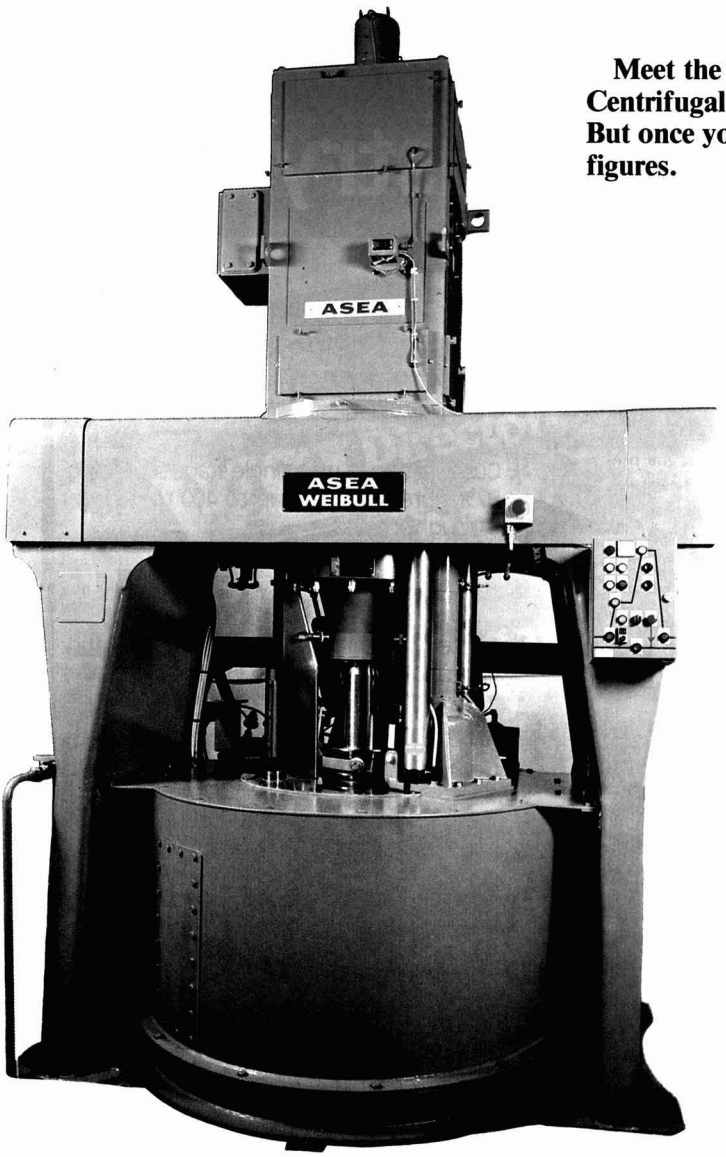

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equilibrium of their interfacial distribution may be obtained, such that the total actions measured by W_{ad} and S are high. A detailed knowledge of these factors and the laws determining their distributions are the means for making possible improved results in the heat transfer processes.

Figure 3 shows the variation of the extension coefficient S as a function of the Brix of the solution. With copper surfaces it is never possible to obtain a close and spontaneous contact ($S \geqslant O$) with the solution. This fully agrees with the practical observation given by values of $\phi \gg O$, which, moreover, is an indispensable condition for S to approach zero, according to equation (5), and also indicates that the value of π appearing in equations (2) and (5), in the range of temperatures studied is of little value. This validates the semiquantitative analysis of W_{ad} and S which is carried out.

The deterioration experienced by the extension of solutions when increasing the soluble solid contents above 30-40°Brix is determined by solute-solvent associations which, as might be expected, become weak with increase in temperature. Furthermore, the presence of a maximum around these values may be noticed; an index of the action of opposite factors of unknown origin.

Figure 4 shows the extension coefficient in the presence of surfactants. In every case, scatter is greater with diluted solutions than with concentrated ones, and we see that the presence of surfactants can make possible their total extension.

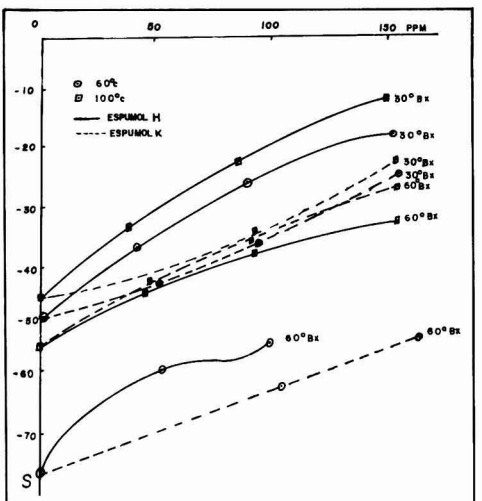


Fig. 4. Extension coefficient of sucrose solution of 30° and 60°Bx as a function of the Espumol H and K doses at different temperatures

For diluted solutions, Espumol H is more effective than Espumol K, which superiority is maintained by the effect produced upon γ_{lv} as shown by equations (3) and (4). Regarding the effect of both surfactants upon concentrated solutions at low temperature it is rather poor; at high temperatures their effect is improved, specially with Espumol K.

Now, with a solid base, it is possible for us to approach the behaviour of the studied properties of sucrose solutions in industrial evaporation. To carry this out, a quadruple-effect evaporator with 0.7 kg/cm^2 vapour pressure in the calandria and a triple-effect pressure evaporator with 2.2 kg/cm^2 calandria pressure were chosen.

Figure 5 shows that for both equipments the solution wetting is similar in the first two bodies, where the juice Brix is low, and the temperature value is such that it also improves the wetting action. All these advantages are made void in the 4th body owing to its relatively high Brix and low temperature. In the case of triple-effect equipment under pressure, operation in this zone of low wetting action is avoided.

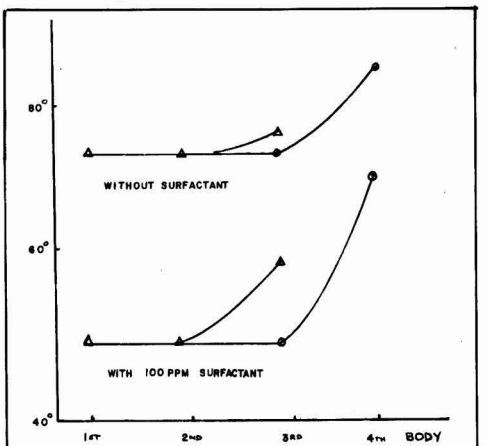


Fig. 5. Wetting of heat transfer surfaces in typical sugar industry evaporators

Figure 6 shows γ_{lv} values in the different evaporating bodies. In both equipments it may be noticed that γ_{lv} is high in the raw syrup bodies, especially in the concentrating body of the classical equipment, while in the triple effect under pressure operation in this zone of high γ_{lv} is partially avoided. The presence of the surfactant agent notably diminishes γ_{lv} in all bodies.

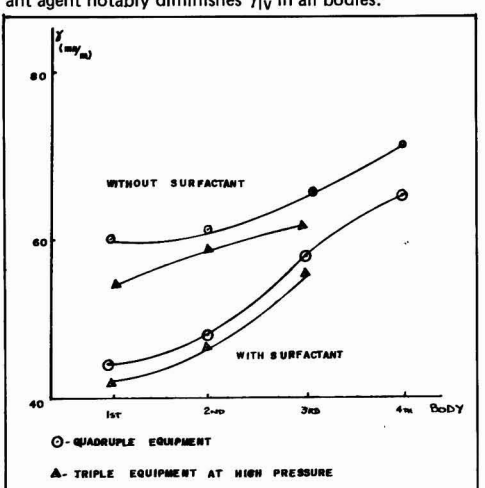


Fig. 6. Surface tension of sucrose solutions in process in typical multiple-effect sugar industry evaporators

Figure 7 shows that the extension coefficient in the different evaporator bodies. The extension is similar for

the first bodies, while in the concentrating bodies the extension is very poor, which explains the observed tendency for other materials present or formed in the juice to cover the heat transfer surfaces of these bodies. The surfactants studied ostensibly improve the extension action in all bodies, especially in the first ones.

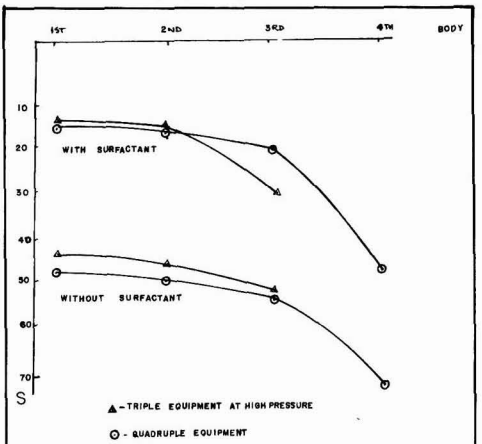


Fig. 7. Extension coefficient of sucrose solutions of heat transfer surfaces of typical sugar industry evaporators

Conclusions

1. Increase from 30 to 60°Bx of sucrose solutions provokes a rapid ascent of ϕ to higher values which then stabilize, while γ is a linear function of the Brix.
2. The temperature dependence of ϕ and γ_{lv} is linear and the thermal gradients in both cases become more negative with increase of the solution Brix.
3. Espumol H and K surfactants reduce ϕ and γ_{lv} by about 30-40% of the original value in diluted solutions, Espumol H being more effective. Concentrated solutions are notably less susceptible, with only 20-30% reduction due to the surfactant actions. In this case, Espumol H has more influence on γ_{lv}, and Espumol K more on ϕ.
4. The adherence work of sucrose solutions is generally low, with a relatively loose dependence upon the solution Brix. High temperatures favour concentrated solutions, but are adverse to diluted solutions.
5. Surfactants are only effective upon W_{ad} in diluted solutions when subjected to a low temperature, and to a very limited extent. For concentrated solutions an increase of up to about 33% is achieved by the action of Espumol K, while Espumol H does not show any influence.
6. Sucrose solutions do not spontaneously extend, in any case, on copper surfaces, especially in the case of concentrated solutions. High temperatures noticeably improve the extension action of solutions, to a very pronounced extent in the case of concentrated ones.
7. The presence of the surfactant is very effective with respect to S in dilute solutions, especially with Espumol H. Concentrated solutions are not so sensitive to surfactant action as are dilute ones. At low temperatures both materials produce a similar effect, while at high temperatures, Espumol K is significantly more effective.
8. The application of surfactants to products subjected to evaporation under different evaporating regimes is significantly effective for improving the wetting capacity of heat transfer surfaces by solutions, by comparison with untreated systems.

Summary

The wetting capacity of sucrose solutions between 30 and 60°Brix on copper heat transfer surfaces at temperatures ranging from 60°C to 100°C in the presence of two surfactants has been evaluated. Measurements of the angle of contact and the surface tension were effected, and the values obtained used in the calculation of the adherence work and the extension coefficient. Generally, copper surfaces are poorly moistened, especially by concentrated solutions. In all cases, high temperatures improve the wetting effect on surfaces. Also, in all cases, the adherence work is low and the extension coefficient is much less than zero. The presence of surfactants appears to improve the studied properties.

Evaluation du pouvoir mouillant de solutions de saccharose sur des surfaces de cuivre

Le pouvoir mouillant de solutions de saccharose entre 30 et 60° Brix sur des surfaces de transmission de chaleur en cuivre a des températures variant de 60°C à 100°C en présence de deux surfactants a été évalué. La mesure des angles de contact et de la tension superficielle était effectuée et les valeurs obtenues ont été utilisées dans les calculs des coefficients d'adhérence et d'extension. Généralement les surfaces en cuivre sont faiblement mouillées, spécialement par les solutions concentrées. Dans tous les cas, la haute température améliore l'effet mouillant sur les surfaces. Aussi dans tous les cas la force d'adhérence est faible et le coefficient d'extension est beaucoup moins que zéro. La présence de surfactants semble améliorer les propriétés étudiées.

Bewertung der Benetzungsfähigkeit von Saccharoselösungen auf Kupferoberflächen

Die Benetzungsfähigkeit von Saccharoselösungen zwischen 30 und 60 % TS auf kupferne Wärmübergangsoberflächen bei Temperaturen zwischen 60 und 100 °C in Anwesenheit von zwei oberflächenaktiven Substanzen wurde ermittelt. Messungen des Kontaktwinkels und der Oberflächenspannung wurden ausgewertet und die erhaltenen Werte für die Berechnung der Adhäsionsarbeit und des Ausdehnungskoeffizienten benutzt. Im allgemeinen sind Kupferoberflächen schlecht benetzbar, besonders von konzentrierten Lösungen. In sämtlichen Fällen verbessern hohe Temperaturen den Benetzungseffekt von Oberflächen. Weiterhin ist in sämtlichen Fällen die Adhäsionsarbeit gering und der Ausdehnungskoeffizient kleiner als null. Die Anwesenheit von oberflächenaktiven Substanzen scheint die untersuchten Eigenschaften zu verbessern.

Evaluación de la capacidad de mojado de soluciones de sacarosa sobre superficies de cobre

La capacidad de mojado de soluciones de sacarosa de Brix entre 30° y 60° sobre superficies para transferencia de calor de cobre, a temperaturas de 60°C a 100°C se ha valorado en la presencia de dos tensio-activos. Se han efectuado mediciones de ángulo de contacto y de la tensión superficial, y los valores obtenidos se han usado en el cálculo del trabajo de adhesión y del coeficiente de extensión. En general, las superficies de cobre no se mojan bien, especialmente por soluciones concentradas. También, en todos los casos, el trabajo de adhesión es bajo y el coeficiente de extensión es mucho menos de cero. La presencia de tensio-activos mejora las propiedades estudiadas.

World sugar consumption estimates, 1984[1]

	1984	1983
	tonnes, raw value	
Asia		
Afghanistan	107,000	100,000
Bangladesh	220,000	207,000
Burma	66,000	66,000
China	5,579,000	5,193,000
Hong Kong	103,000	101,000
India	7,153,000	6,788,000
Indonesia	2,041,000	1,950,000
Iran	1,045,000	1,051,000
Iraq	614,000	591,000
Israel	223,000	216,000
Japan	2,537,000	2,500,000
Jordan	131,000	124,000
Korea, North	101,000	104,000
Korea, South	447,000	443,000
Kuwait	80,000	75,000
Lebanon	93,000	92,000
Malaysia	512,000	496,000
Pakistan	1,041,000	991,000
Persian Gulf	110,000	104,000
Philippines	1,064,000	1,050,000
Saudi Arabia	520,000	474,000
Singapore	141,000	136,000
Sri Lanka	238,000	234,000
Syria	453,000	422,000
Taiwan	432,000	405,000
Thailand	676,000	662,000
Vietnam	207,000	205,000
Yemen, North	127,000	119,000
Other Asia	147,000	142,000
Total Asia	26,208,000	25,041,000
North and Central America		
Canada	947,000	962,000
Costa Rica	156,000	151,000
Cuba	702,000	660,000
Dominican Republic	225,000	218,000
Guatemala	289,000	278,000
Haiti	64,000	63,000
Honduras	136,000	129,000
Jamaica	105,000	105,000
Mexico	3,707,000	3,574,000
Nicaragua	143,000	140,000
Panama	84,000	81,000
El Salvador	156,000	153,000
USA	8,570,000	8,745,000
Other North and Central America	105,000	109,000
Total North and Central America	15,389,000	15,368,000
South America		
Argentina	996,000	999,000
Bolivia	205,000	198,000
Brazil	6,726,000	6,515,000
Chile	450,000	440,000
Colombia	1,072,000	1,000,000
Ecuador	353,000	341,000
Paraguay	80,000	77,000
Peru	599,000	591,000
Uruguay	92,000	94,000
Venezuela	749,000	728,000
Other South America	801,000	780,000
Total South America	11,374,000	11,035,000

	1984	1983
	tonnes, raw value	
Europe		
Albania	47,000	46,000
Austria	376,000	375,000
Bulgaria	442,000	436,000
Czechoslovakia	758,000	747,000
EEC	10,502,000	10,569
Finland	194,000	196,000
Germany, East	806,000	803,000
Hungary	564,000	558,000
Norway	182,000	179,000
Poland	1,572,000	1,573,000
Portugal	335,000	330,000
Rumania	712,000	701,000
Spain	1,172,000	1,165,000
Sweden	355,000	357,000
Switzerland	298,000	294,000
Turkey	1,355,000	1,314,000
USSR	13,040,000	12,865,000
Yugoslavia	895,000	876,000
Other Europe	48,000	49,000
Total Europe	33,653,000	33,433,000
Africa		
Algeria	678,000	644,000
Angola	122,000	117,000
Cameroon	73,000	68,000
Egypt	1,487,000	1,402,000
Ethiopia	169,000	163,000
Ghana	50,000	50,000
Ivory Coast	118,000	108,000
Kenya	394,000	374,000
Libya	133,000	129,000
Madagascar	101,000	99,000
Malawi	55,000	53,000
Mali	41,000	40,000
Mauritania	40,000	38,000
Mauritius	40,000	39,000
Morocco	733,000	712,000
Mozambique	109,000	112,000
Nigeria	750,000	800,000
Senegal	79,000	79,000
Somalia	73,000	71,000
South Africa	1,387,000	1,370,000
Sudan	430,000	415,000
Swaziland	20,000	20,000
Tanzania	118,000	118,000
Tunisia	181,000	175,000
Uganda	50,000	50,000
Zaire	82,000	78,000
Zambia	114,000	111,000
Zimbabwe	203,000	191,000
Other Africa	310,000	292,000
Total Africa	8,140,000	7,918,000
Oceania		
Australia	801,000	798,000
Fiji	40,000	39,000
New Zealand	156,000	158,000
Papua New Guinea	34,000	32,000
Other Oceania	14,000	14,000
Total Oceania	1,045,000	1,041,000
WORLD TOTAL	95,809,000	93,836,000

[1] C. Czarnikow Ltd., *Sugar Review*, 1983, (1674), 212.

CANE SUGAR MANUFACTURE

Dextranase — not a cure-all. J. A. Polack. *Sugar Bull.*, 1983, **61**, (15), 8. — Tests at Audubon Sugar Institute have confirmed the possibility of using dextranase to reduce the effects of dextran in boiling; good crystals have been formed as a result of the treatment, whereas boiling was impossible without treatment, any crystals that did form being elongated. However, even with treatment, boiling was slow; moreover, optimum conditions for dextranase effectiveness are: addition at 150°F to a syrup of about 30-35°Bx and a pH of 5.5 — conditions not easily obtained in a sugar factory without extra equipment. Under non-optimum conditions, more dextranase is required. For these reasons, there has been no work on the use of the enzyme in the USA for several years. However, recent problems involving dextran and penalties for it in raw sugar sales are expected to cause a renewal of interest in dextranase. On the other hand, its use will require approval of the Food & Drugs Administration, although the fact that dextranase has received official approval in Australia is expected to be a favourable factor.

Review of feeding devices in cane sugar mills. V. B. Pansare. *Maharashtra Sugar*, 1983, **8**, (6), 85, 87. — A brief review is presented of mill feeding devices, including the under feed roller, Donnelly chute and pressure feeders of the grooved and toothed type. Advice is offered on optimum feeding of cane.

Comparative study on various constituents of sugar cane juice affecting settling in the sulphitation and phosphatation processes. A. A. El-Kader. *Sugar J.*, 1983, **45**, (12), 5-8. — See *I.S.J.*, 1983, **85**, 308.

Direct white sugar. E. Duarte. *ATAC*, 1982, **41**, (5), 13-18 *(Spanish)*. — The main source of infection of white sugar produced direct from cane juice is in the centrifugal station where micro-organisms may occur in the wash water and in the generally non-aseptic environment. The moisture content of the sugar is a determining factor in the development of the contaminating micro-organisms and the deterioration of the sugar in store; under favourable R.H. conditions only yeasts and moulds present in the sugar can increase. When contamination has occurred, physico-chemical effects cannot be distinguished from microbiological ones. Direct consumption white sugar does not generally comply with the standards for refined sugar and thus is susceptible to deterioration in storage. It is recommended that the storage conditions be such as to minimize contamination and deterioration.

Some inorganic substances in colloidal state in the production of cane sugar. G. Fernández, M. Darias, M. Cardenas, C. Acosta and L. D. Bobrovnik. *ATAC*, 1982, **41**, (5), 60-65 *(Spanish)*. — Analyses were made of Ca and Mg compounds and phosphates in colloidal state in mixed and clear juices, syrup, sugars and molasses, and the results are tabulated and discussed. Colloidal phosphate and also Ca and Mg compounds tend to diminish from juice to syrup and molasses, owing to separation in clarification and by deposition as scale. The amounts in molasses are higher than in sugar, however, because of the general impurities concentration phenomenon, and increase from 1st to final molasses. Small amounts of colloidal silica were detected in the products analysed.

Waste treatment in the sugar industry. E. Valdés, M. C. Obaya and A. García. *Revista ICIDCA*, 1982, **16**, (1), 43-57 *(Spanish)*. — The nature of the problems of waterway pollution in Cuba by effluents from sugar factories, distilleries and yeast plants is described and recommendations made in order to reduce the contamination. The application of the methods is envisaged in a number of stages and the effects obtainable at different stages are tabulated and discussed.

More on recovery operations. R. S. Patterson. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.*, 1983, 22 pp. — Observations on practices in Louisiana sugar factories are discussed, with particular mention of molasses exhaustion. Advice is given on preparation of seed slurry, use of a Polaroid camera to photograph crystals in massecuite and to check for crystals in final molasses, use of a molasses extraction bomb (similar to a nutsch bomb) to establish the crystal content of low-grade massecuite and follow the progress of crystallization, and determining apparent density of massecuite as a guide to sugar degradation by the Maillard reaction. Other recommendations are also given whereby recovery operations can be improved.

Changes in milling practices. Anon. *Australian Sugar J.*, 1983, **75**, (1), 59-60. — Developments in cane milling equipment are discussed in a contribution from Walkers Ltd., the well-known cane mill manufacturers. The article covers shredders, the pressure feeder developed by CSR Ltd., and other mill feeders, including the continuous, heavy-duty gear-driven unit for bagasse feeding in a compressed form to a 3-roller mill, a continuous chain-driven medium-duty unit, and the toothed feeder also developed by CSR Ltd. Mill sizes have been increased, and spherical rollers introduced. In the 1980's, mills having rollers 2-2.75 metres long have been built, including the new Walkers 6-roller constant-ratio mill having rollers 1400 mm in diameter and weighing 44 tonnes; this mill is driven by a 2500 h.p. steam turbine through special reduction gearing. The mill overcomes many disadvantages of older mill designs and allows for a constant ratio between the feed and delivery roller work openings regardless of top roller lift. Other features are the roller pinions grouped in the main body of the gearbox with individual tailbars to each roller, and the special top roller hydraulics. Older cast iron toothed gears with bronze liner bearings have been replaced over the years with machine-cut steel gears.

Influence of some sugar cane juice components on the corrosion of CT-3 steel in the presence of oxygen. F. Corvo, A. Capero, R. Pascual and R. Hernández. *Rev. CENIC, Ciencias F]sicas*, 1980, **2**, (1/2), 181-194 *(Spanish)*; through *S.I.A.*, 1983, **45**, Abs. 83-587. Corrosion of CT-3 steel was studied electrochemically by constructing curves of current *vs.* potential and by weight loss measurements. Results showed that aconitic acid or SO_2 increased the corrosion rate, phosphate ions tended to decrease it, and calcium ions had no effect in neutral media. SO_2 acts by decreasing the pH and forming a surface layer containing sulphides.

BEET SUGAR MANUFACTURE

Utilization of turbine aerators for oxidation of waste water in sugar factory accumulation tanks. E. Glabski and B. Amerski. *Gaz. Cukr.*, 1983, **91**, 119 *(Polish).* Tests involving two AP 55-kW aerators having impellers of 2.2 m diameter, each installed on an accumulation tank at a sugar factory, showed that the free oxygen content in samples taken at varying distances from the impellers was inadequate in view of the high energy consumption and the considerable costs entailed. Only at 1 m from the impeller was the level reasonable, but in one case the BOD_5 at this point was greater than up to 25 m away.

Tests on auto-purification of sugar factory waste water involving new disinfectants. B. Zalicka. *Gaz. Cukr.*, 1983, **91**, 120 *(Polish).* — Tests were conducted in 35 dm^3 open tanks filled with sugar factory effluent to which each of four preparations was added at 5, 50 and 500 $g.m^{-3}$ doses. Generally, addition of the disinfectants had an adverse effect, ranging from slight to considerable, on the reduction of COD and BOD_5 achieved by auto-purification. Three of the preparations are toxic to fish at varying concentrations, while the fourth (Kamin RMO) is based on an ammonium salt and is widely used in the Polish sugar industry, although it too tends to inhibit purification, particularly at a dosage of 500 $g.m^{-3}$.

Juice purification in the new sugar factories of Voivodina region (Yugoslavia). K. Sörös. *Cukoripar*, 1983, **36**, 60-65 *(Hungarian).* — A description is given of the Novi Sad 76 juice purification scheme, and results obtained in the five new sugar factories constructed during the past six years in the Voivodina region (of which Novi Sad is the capital) are reported. Information is also given on the juice purification equipment installed in the factories, which are a result of cooperation between Abay S.A., Fives-Cail Babcock and the Yugoslavian organization MINEL.

A microprocessor generating system at Hajdusag sugar factory. L. Pocsi *Cukoripar*, 1983, **36**, 72-75 *(Hungarian).* A brief account is given of the development of the microprocessor from the first Intel unit produced in the USA in 1971. Details are given of the Intel 8085 microprocessor, with particular mention of its ALU (Arithmetic and Logic Unit) and of its function. A description is then given of a data generating system developed at Hajdusag sugar factory which embodies a portable microprocessor linked to a SZM-4 computer. The various types of program which it is planned to write, including those based on process monitoring by the system, are indicated.

Equipment requirements from the viewpoint of sugar industry technology. M. Macinski. *Gaz. Cukr.*, 1983, **91**, 121-124 *(Polish).* — The performance requirements of each individual process station and the type of equipment considered capable of meeting them are discussed. It is considered that, past a certain stage, it is preferable to develop new equipment specifically for a given task rather than try to do what is not possible with existing equpment.

Low-grade massecuite crystallization in the new sugar factories of the Voivodina region. S. Petrov. *Cukoripar*, 1983, **36**, 66-67 *(Hungarian).* — Brief reference is made to the introduction of vertical crystallizers for low-grade massecuite in four new Yugoslavian sugar factories, where the crystal content has been too low (typically 25.58% and 23.57%), so that molasses losses were too high. More attention to the supersaturation coefficient in boiling led to a marked rise in the crystal content at three factories (to 26.5%, 27.9% and 28.52%) which, coupled with the extended cooling period resulting from the expanded crystallizer station, would be expected to give the necessary reduction in molasses losses. It is pointed out that a 30% crystal content on dropping corresponds to a final level of 45% in the cooled massecuite, Some general advice is given on the basis of the experience already gained.

Can computer technology help the sugar industry? P. Slugocki. *Gaz. Cukr.*, 1983, **91**, 124-125 *(Polish).* While Poland has a few modern computerized plants, it is considered possible that in the near future the sugar industry will employ greater computer capacity, and the author discusses tasks for which it will be of greatest benefit, viz. coordination of mass flow with the aim of establishing central control of feed to individual stations, controlling the availability of transport for beet and waste material, scheduling of equipment maintenance, calculating the date for start of the campaign, assigning beet deliveries to individual factories, calculating factory profitability and making statistical and technological evaluations.

Monitoring the sugar manufacturing process for control purposes. T. Kalitynski and W. Wodowski. *Gaz. Cukr.*, 1983, **91**, 125-128 *(Polish).* — Collecting and processing of data obtained by monitoring the sugar manufacturing process is described in the case of Lublin factory to demonstrate the correct approach to programming with the aim of optimization and automatic control.

Spontaneous decomposition of molasses. J. Dobrzycki. *Gaz. Cukr.*, 1983, **91**, 129 *(Polish).* — The effects of molasses spontaneous decomposition, caused by an abnormal rise in temperature, are discussed. Where the dry solids content is also high (> 80%), the entire molasses will become a tarry mass; on the other hand, excessive dilution will lead to increased microbial action and indirectly contribute to spontaneous decomposition. The rise in temperature is a result of the Maillard reaction between invert sugar and amino-acids, and the heat generated will not be dissipated if the dry solids content is excessive. In most cases reported of beet molasses decomposition, the original beets have been stored for a prolonged period, frozen or grown under dry conditions, leading to excessive invert and amino-acid contents. A number of recommendations are made on means of preventing spontaneous decomposition, including regular emptying of molasses tanks, maintenance of alkaline conditions to prevent the Maillard reaction, automatic temperature control, monitoring of temperature, colour, invert, pH and purity, and use of hot water (not steam) to heat discharge pipes and entry points.

SUGAR REFINING

South Africa's new refinery at Noodsberg. R. Grafton. *Sugar y Azúcar,* 1983, **78,** (5), 38-39. — See *I.S.J.,* 1984, **86,** 21.

The refining qualities of raw sugar with special emphasis on ash, colour and dextran problems. J. C. P. Chen. *Zuckerind.,* 1983, **108,** 546-550. — The problems of ash, colour and dextran contents of Jamaican raw sugar intended for refining in the USA and subject to the criteria set out in No. 10 Contract are discussed, and suggested methods of improving sugar quality so as to avoid penalties for sub-standard sugar are indicated; these include the use of polymer flocculants in clarification to reduce the ash content and of massecuite surfactants to shorten low-grade boiling times, avoidance of overliming to decrease the colour of raw sugar after affination (the use of flocculants and surfactants will also help), and reduction in the delay between harvesting and processing as well as maintenance of a high degree of sanitation in milling in order to decrease the dextran content.

Possibilities for the use of a bacterial amylase in the cane sugar industry. N. Polanco D. *Paper presented to the 18th Congr. ISSCT,* 1983, 19 pp. — A bacterial amylase has been obtained which, on application at a rate of 0.5 g per tonne of cane, removed 65% of the starch present in cane juice. It was found during refining that, by application of 12 g of the enzyme per kg of starch present, an approximately 50% increase in the production rate of refined sugar was achieved, as well as substantial savings in filter aid. Additionally, fuel oil consumption was lower because liquor dilution was not as great as when the enzyme was not used. No ill-effects were observed on the final product quality.

Some ways to save energy at a sugar refinery. F. T. Desmond. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.,* 1983, 17 pp. — A detailed account is given of changes introduced in the boiler-house and in the refinery process which have reduced steam consumption from 200 lb to 175 lb per 100 lb of melt. Future steps are mentioned which are expected to reduce steam consumption further to 150 lb per 100 lb melt. Boiler efficiency has been raised from 78 to 82% by use of two large boilers and a small one, fitting of new burners and repairing baffles in a boiler, installing new combustion controls, adding gas firing to oil firing, applying combustion analysis and control, increasing boiler feed water temperature, coordinating start-ups, using diesel generators on shut-downs to reduce blow-off and non-production steam, use of a chelant program and steam line maintenance. In the refinery there has been a change from bone char to granular carbon, dissolved tailing and scalping sugars are melted and pumped to the carbon filter instead of earlier in the process. Sweetwater production has been reduced, with automation of the melter and monitoring of storage tanks for leaks and overflows.

The production of areado sugar at RAR refinery, Portugal. L. S. M. Bento. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.,* 1983, 22 pp. — Descriptions are given of the basic stages in the production of yellow areado sugar, typically of 96-97% total sugars, 2200-2500 ICUMSA colour units and 2.5-3.0% moisture content, from recovery syrup obtained from the white sugar section. The refinery, at Porto, handles cane raw sugar and produces 40-60 tonnes of yellow areado sugar per day (representing 10-15% of total sugar output). Advantages of areado sugar manufacture include a reduction in the amount of syrup treated in the recovery house and decrease in the quantity of molasses.

Refinery and laboratory studies on the use of Ecosorb precoat formulations for the clarification and decolorization of cane and beet sugar syrups. A. Tavares, R. Forman and R. Kunin. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.,* 1983, 19 pp. — Recent progress made in syrup clarification and decolorization using Ecosorb precoats on both laboratory scale and full plant scale at a number of cane and beet sugar refineries in North America is reviewed, and an economic assessment made of the process. The nature and properties of three new precoats are described. Ecosorb A S-451-A is a powdered cation exchange resin in Na^+ form intended for removal of calcium and for pH control; Ecosorb C GL-63 is a powdered activated carbon which has been developed primarily for simultaneous filtration and partial decolorization of dissolved washed raw sugars and clarified liquors, and Ecosorb R GL-65 is a powdered anion exchange resin in Cl^- form developed for decolorization. The performances of the three formulations are indicated, and advantages of precoat technology discussed. Existing filters can be used for the system, so that there is essentially no capital investment needed, and the process helps save energy while also minimizing the quantity of waste.

Raw sugar — VHP or VHQ. W. Simoneaux. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.,* 1983, 22 pp. — Tests on refining of Very High Pol cane raw sugar from Louisiana factories at the refinery of Supreme Sugar Co. Inc. are reported. All the sugar received was of at least 98.3 pol in 1981/82 and averaged 98.2 in 1982/83. Although it was superior to affined raw sugar in terms of colour and invert content in the first year, in 1982/83 problems were encountered in refining within three days of the start of the tests, with invert levels increasing considerably (approaching 1% in final liquor) and refined sugar boiling proving difficult. This was attributed to excessive invert and moisture in the stored VHP sugar; most of the sugar had a safety factor above the normal limit of 0.30. It is questioned whether VHP sugar should not be termed "Very High Quality", in view of the high safety factor, a maximum colour of 800 ICUMSA units and a minimum pol of 98.30. However, the advantages of processing VHP sugar are such that further work was to be carried out in 1983/84.

The new sugar house at Tirlemont. M. Braeckman. *Paper presented at 17th Gen. Assembly CITS,* 1983, 33 pp *(French).* — Details are given of the new fully automatic sugar house constructed at Tirlemont in Belgium. Previously, the refinery had used a 5-boiling scheme based on raw sugar and *B*-syrup with occasional use of thick juice over a short period; the system entailed large quantities of remelt and reboiling for production of white sugar and tablet sugar (for which a very high purity strike was necessary). The object of the new scheme was to eliminate the use of raw sugar and use

only thick juice and *B*-syrup as well as economize on energy consumption. Two sugars are produced, one for hard tablet and sachet sugar production, and the other for normal tablet sugar and other refinery products. The daily raw material consumption is 1000 tonnes each of thick juice and *B*-syrup, and 11 batch pans are used. Continuous centrifugals are used only for low-grade working. Full details are given of the sequence of operations of the station and particularly of the atomatic controls.

Packaging at Savannah sugar refinery. J. H. Dean. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.*, 1983, 14 pp. – Details are given of the packaging lines used at Savannah refinery in Georgia, USA, for 2-, 5- and 10-lb bags of granulated sugar, 1-lb cartons of icing and soft sugars, 1/8 oz envelopes of sugar and cartons of tablet sugar. The efficiencies of the different lines in 1982 are indicated.

A simplified scheme for raw sugar and remelt sugar processing. H. Kalka. *Gaz. Cukr.*, 1983, **91**, 83-85 *(Polish)*. – Problems encountered with conventional processing of cane raw sugar in Polish sugar factories are discussed, and details given of a modified scheme in which affination is omitted and the first stage is preparation of a 24-30°Bx melt from the raw sugar, which is limed with 8-10% CaO on sugar at 90°C for not less than 20 minutes and gassed with CO_2 before filtration and evaporation to 65°Bx. A 4-massecuite scheme for production of white sugars I and II (of 0.4-0.7°St and 0.7-0.9°St colour, respectively) is described.

Fine sediments originated from a pulse-bed system of granular carbons. Y. Kawai. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 12-17 *(Japanese)*. By fine sediment is meant fine carbon particles that pass through a 5 μm membrane filter but are caught on one of 0.45 μm. After adoption of a typical pulse-bed granular carbon system for liquor decolorization, fine sediment was found to be leaking into sugar products. In the pulse bed system the liquor flows upwards and spent carbon is withdrawn periodically from the bottom of the bed for regeneration; fresh carbon is fed to the top of the column. During processing carbon particles rub against one another and fine particles are formed by abrasion and are released into the coloured liquor being treated. A remedial measure adopted involves transference of a given volume of effluent to carbonatation after a decolorizing cycle, e.g. of 13-14 hours, while a ceramic filter has also been installed after the decolorizing column.

Studies on clarification of sugar liquor by magnesia. I. Fundamental tests in the laboratory. T. Kaga, K. Hamanaka, T. Hiramoto, Y. Ikari and S. Yokoyama. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 18-29. **II. Fundamental tests using a part of the factory line and recycle tests using a pilot plant.** T. Kaga, H. Inomata, K. Hamanaka, H. Suzuki, Y. Ikari and S. Yokoyama. *ibid.*, 30-41 *(Japanese)*.

I. Studies on refinery liquor clarification with MgO plus treatment with ion exchange resin were carried out. The process investigated consisted of treatment of 69-70°Bx remelt liquor with 0.4% MgO plus 1.2% perlite filter aid on Brix for ½-1 hour at 80°C. (MgO regenerated by calcining at 500°C for ½-1 hour was used plus any make-up MgO required.) The treated liquor was then filtered and demineralized with Amberlite IRC-50 resin followed by decolorization with Amberlite XT-5007 resin. Advantages of the process include its simplicity, energy savings (particularly because of the high Brix of the treated liquor), reduced pollution, fine liquor purity rise, lower costs, and savings in materials and resources (particularly of importance in view of a short supply of suitable active carbon in Japan). Disadvantages include increase in unknown sugar losses because of adsorption on the MgO cake, and dissolution of some MgO in the liquor (easily removed by resin, however).

II. Perlite was added to burnt $MgCO_3$ in a 3:1 weight ratio and the mixture had a decolorizing efficiency of 75-80%, a reducing sugar degradation efficiency of 20% and a lime removal efficiency of 30%. Filtrability was as good as with conventional carbon decolorization. After sweetening-off with hot water, 20% sucrose on MgO remained. Regeneration at 450-500°C for 30-45 min gave a suitable clarification aid. In recycle tests, the initial raw liquor charge was 1.3 tonnes per batch. During these tests, comprising 10 recycles, fresh MgO was used at the rate of 0.37% MgO on liquor Brix. In cycle No. 3 and subsequent cycles, a 10:1 mixture of recycled:fresh MgO was used and the total quantity increased by 0.02% on Brix per cycle; this was to allow for the amount of MgO soluble in the liquor and the fall in adsorption capacity. No perlite was used in the recycle tests. After completion of the 10th cycle, the quality of processed liquor and its filtrability were as after the initial cycle.

Improvements in a centrifugal for sugar. M. Kawase. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 42-48 *(Japanese)*. – Modifications to a centrifugal made by Hakko Engineering Co. Ltd. are described. They included replacement of a gate valve with a ball valve for massecuite charging, installation of three circular-sectioned arms in the bottom of the basket instead of four arms of rectangular section (resulting in a decrease in air flow and pressure, and hence prevention of scattering of sugar, so that sugar quality was improved and electricity saved) and coating of the inner wall of the sugar discharge chute and of the casing with polytetrafluoroethylene (Teflon) to prevent sugar adhesion.

Boiling operation for saving energy using a vacuum pan with stirrer. T. Tanaka, H. Nozaki and M. Akamatsu. *Proc. Research Soc. Japan Sugar Refineries Tech.*, 1983, (32), 49-59 *(Japanese)*. – The energy savings possible with a pan having a massecuite stirrer were determined in studies on brown soft sugar boiling. It was found that the supersaturation at the feeding point was too high, so it was set lower to avoid the need for a large quantity of balancing water to dilute the massecuite after seeding. While a refractometer was desirable for detection of the seeding point, a rheometer was adequate for its control. Use of forced circulation decreased steam flux from 6 to 1.5-3.0 tonnes.hr^{-1} in the first crystal growing stage, and from 6 to 4 tonnes.hr^{-1} in the second stage. Steam consumption was reduced from 4.58 to 0.41 m^3 (91%) when 40 tonnes of massecuite of 90 purity was boiled. Power consumption of the stirrer was 66.7 kWh per boiling, representing 0.1 tonnes of steam. Both evaporation and crystallization efficiencies were increased by forced circulation, the stirrer having the same effect as 2 tonnes of steam and 2 m^3 of water per strike and shortening the boiling time by about 25 minutes.

STARCH BASED SWEETENERS

Monosaccharides from sucrose. III. Modern D-glucose and D-fructose manufacture. M. Kulhanek and M. Tadra. *Listy Cukr.*, 1982, **98**, 281-284 *(Czech)*. — A survey is presented of the literature (52 references) on glucose and fructose manufacture and uses, with particular mention of starch-based glucose manufacture and its isomerization to fructose. The use of enzymatic processes and the major role played by ion exchange chromatography are discussed and particular reference made to the work done in Finland. Automatic control of the column process is described, and the article concludes with a brief mention of sucrose inversion and separation of the invert into glucose and fructose in a single stage[1].

Regeneration of a strong acid cation exchange resin for deionizing corn syrup solutions. C. A. Sauer and T. Brown. *Starch/Stärke*, 1983, **35**, 62-65. — The influence of regenerant flow rate and concentration on the regeneration capacity of cation exchange resin used to refine corn syrups was investigated. A strong acid exchange resin, Duolite C-26, was examined over a range of resin composition (expressed as the calcium fraction). Co-current regeneration was modelled using HCl at dosages ranging from 64 to 256 g.litre^{-1}. During regeneration, fractions of column effluent were collected and analysed for sodium, calcium and (when necessary) magnesium. Results showed that resin beds exhausted with large quantities of Ca^{++} (and other divalent ions) are best regenerated at high acid concentrations and low regenerant flow rates. Resin beds with large amounts of sodium and/or other monovalent ions are most efficiently regenerated at low acid concentrations. Flow rate had little effect on regeneration with large amounts of sodium. Syrup deionized before isomerization typically had a lower divalent ion content than syrup deionized after isomerization, suggesting that two separate procedures may be necessary in order for the most effective use to be made of the regenerant.

Exploring new sources of sugar — the rapid development of fructose production. L. T. Chang. *Food Sci. Technol.* (China), 1981, (7), 8; through *Food Sci. Tech. Abs.*, 1982, **14**, (5), 5L377. — Fructose is considered the best sweetener. By using enzymes, it is easy to transform glucose to fructose. Many starch-rich plants, e.g. corn, sorghum, sweet potato, potato, cassava, can be good raw materials for fructose-glucose syrup production. Because of the high content of starch, high price of co-products and ease of transport and storage, corn is the ideal raw material among them.

Energy conservation in the Szabadegyhaz isosugar factory. J. Rutkovszky. *Szeszipar*, 1981, **29**, (4), 161-162; through *Food Sci. Tech. Abs.*, 1982, **14**, (7), 7L525. — In the factory complex described, isoglucose syrup is produced enzymically from maize. The complexity of the heat-consuming equipment, e.g. large-capacity condensers, a large number of heat exchangers, rectifying and distilling columns, direct and indirect dryers, requires strict coordination of the available energy supply. The present consumption of energy, its production and the conversion system are described.

Fructose plant at Thomson. M. Kivimaki. *Kemia-Kemi*, 1982, **9**, (4), 282-284; through *Food Sci. Tech. Abs.*, 1982, **14**, (11), 11L787. — Production of food-grade fructose from glucose syrup at the new plant at Thomson, Illinois, USA, is described. The plant is operated by American Xyrofin Inc., a joint venture of Suomen Sokeri Oy. (Finnish Sugar Co. Ltd.) and Hoffman-La Roche. The plant has an annual production of 10,000 tonnes of crystalline fructose.

Adsorption characteristics of glucose and fructose in ion-exchange resin columns. Young Sung Ghim and Ho Nam Chang. *Ind. Eng. Chem. Fundamentals*, 1982, **21**, (4), 369-374; through *S.I.A.*, 1983, **45**, Abs. 83-359. The possible separation of glucose and fructose by adsorption chromatography was investigated. Tests were carried out using Dowex 1-X8 anion-exchange resin in the carbonate form, on which the distribution ratios were higher than for other forms of this resin. Water at 30°C was used as eluent. Rate and equilibrium constants were calculated by analysing the moments of elution curves. The effect of eluent flow rate (0.5-1.5 ml.min^{-1}) on rate constant was examined. By comparing the transport steps of two optical isomers, the contribution of intraparticle diffusion to axial dispersion was confirmed. For glucose, the more adsorbable component, surface diffusion was involved in the process of intraparticle diffusion. At most flow rates, adsorption was a major resistance, particularly for the smallest resin particle size (0.0465 mm). The elution curve predicted from the rate constants showed fairly good agreement with experimental data.

Special lining keeps products pure under rigorous conditions. Anon. *Food Eng.*, 1981, **53**, (8), 183; through *Food Sci. Tech. Abs.*, 1983, **15**, (1), 1L23. The liners used by A. E. Staley Manufacturing Co., USA, for their transport insulated tanks are reported. The company distributes more than 30 syrups (e.g. corn and high-fructose) for use in the manufacture of confectionary, beer, canned products, non-alcoholic beverages, etc. The epoxy linings comprise Plasite 7133; they withstand temperature fluctuations according to product type and processing techniques, and are expected to last 5-7 years.

Operational techniques for adsorption and ion exchange. P. C. Wankat. *Proc. Sci. Conf. Corn Refiners Assoc. Inc.*, 1982, 119-167; through *S.I.A.*, 1983, **45**, Abs. 83-657. The theory of various techniques is given and their applications to the separation of sugars, e.g. glucose and fructose, are outlined. First, a simple physical model is developed for solute movement in a packed bed; it is then used to explore briefly chromatographic separation and adsorption with countercurrent thermal regeneration. Continuous flow countercurrent, pulsed-flow countercurrent and simulated countercurrent systems are described. Less conventional techniques are moving-feed-point chromatography, two-dimensional chromatography, cyclic systems and parametric pumping.

Isosyrup, a new product on the sweetener market. M. Pohlova. *Prum. Potravin.*, 1981, **32**, (7), 416-418 *(Czech)*; through *S.I.A.*, 1983, **45**, Abs. 83-658. — Methods of producing high-fructose syrups are briefly reviewed. The reasons for their use and the main applications in Western countries are described.

[1] UK Patent 1,085,696; *I.S.J.*, 1968, **70**, 157.

NEW BOOKS

Hawaiian sugar manual, 1983. 16 pp; 15.2 x 23 cm. (Hawaiian Sugar Planters' Association, P.O. Box 1057, Aiea, HI 96701, USA). 1983.

This small booklet lists the officers and directors of HSPA and provides a directory of Hawaiian sugar companies, including those which are growers and processors, and those which are growers only, as well as Hilo Coast Processing Co., which grows no cane but processes that of two other companies. Details are given of cane areas, sugar production and calculated yield of sugar per acre for all the companies. A large table gives yield, area and sugar production figures for the industry from the 1908/09 season and it is noteworthy that, even though only 13 factories survived to the 1982 season, they produced 982,913 short tons of sugar, raw value, not so far short of the peak production of 1,234,121 tons in 1966. Articles describe the importance of sugar in Hawaii's economy and on the Hawaiian Sugar Planters' Association, which celebrated its century in 1982. A map shows the location of the factories and sugar terminals, while an article describes the C & H Sugar Co., which is owned by the Hawaiian sugar producers, and another provides details of wages, hours and working conditions for non-supervisory employees. Information is given on US sugar supply and use, imports and prices, while a glossary is provided of definitions of terms used in the industry.

Sugar Milling Research Institute annual report, 1982-1983. Ed. M. J. Kort. 23 pp; 20.7 x 29.7 cm. (Sugar Milling Research Institute, University of Natal, King George V Avenue, Durban, South Africa 4001). 1983.

At present the main thrust of research activities at S.M.R.I. is toward the reduction of losses during sugar manufacture; with milling and diffusion extraction above 97% there is little potential for reducing bagasse loss, but there is still incentive to reduce molasses and undetermined losses. Other categories of research into which projects are now classified include cost reduction, equipment evaluation, cane quality evaluation, sugar quality investigations and by-product developments. The projects briefly described in the report cover testing of wear-resistant materials for cane preparation equipment, checking the validity of using a composited sample of prepared cane over 8 hours instead of 4-hourly catch samples — the composite sample was found not to give a true value of Preparation Index, measurement of cane mud filtrability, investigation of the drop in purity between mud and filtrate, determining the effect of chemical cleaning methods on evaporator tube heat transfer coefficient, work on the development of a mathematical model of circulation in a vacuum pan, evaluation of a vertical tube calandria continuous vacuum pan at Maidstone and a Fives-Cail Babcock continuous pan at Illovo. Efforts are being made to measure kinetic rate constants for decomposition of sucrose in impure solutions as a function of temperature, pH and concentration in order to learn more precisely the degradation which can occur in evaporator vessels under pressure where juice may be at 115-120°C. Development is continuing of a microprocessor 8-loop controller, a prototype of which was tested at Amatikulu. Tests have been made on the performance of a mechanical vapour recompresser at Pongola, while flow characteristics of *C*-crystallizer stations at four factories have been examined in order to determine residence time distribution of massecuite and the heat transfer coefficients applying. Laboratory studies have been made of sugar crystal growth rate and changes in crystal shape, while a semi-automatic system has shown promise for determination of crystal size distribution in *C*-massecuite, The benefits of viscosity reduction by *B*-molasses treatment have been investigated as has the use of a gear pump for obtaining a representative sample of final molasses. New techniques for molasses composition investigations are a gel filtration method and more recently a gas chromatographic technique. Other projects include studies of *A*-centrifugals washing, performance of a continuous centrifugal in affination, investigation of undetermined losses at Pongola, rationalization of laboratory analyses in mill laboratories, assessment of a RFM 80 refractometer for Brix measurement, trials on a technique for analysis of low levels of monosaccharides and of lactic acid by gas chromatography, dextran determination, and bagasse moisture measurement, drying, storing and enzymic hydrolysis, as well as anaerobic digestion of factory effluent. Activities of the advisory and training divisions are reported as are publications by staff of the Institute, meetings attended, visitors, etc.

Analytische Betriebskontrolle der Zuckerindustrie. Teil C. Sondervorschriften. (Analytical factory control in the sugar industry. Part C. Special instructions). Eds. E. Reinefeld and F. Schneider. 199 pp; 15.6 x 21 cm. (Verlag Dr. Albert Bartens, Postfach 380 250, D-1000 Berlin 38, Germany). 1983. Price: DM 120.00.

Part C completes the book of analytical methods of the German Sugar Industry Association; Parts A and B first appeared in 1978 and covered routine methods to be used in the sugar factory laboratory, while Part C concerns analytical procedures of a more specific nature. Where possible and practical, ICUMSA official methods are specified. As with Parts A and B (for which a collection of sheets containing corrections and expansions is now available together with a subject index at a total cost of DM 14.40), Part C is in looseleaf form. It is divided into a number of sections: general instructions, primarily concerning photometry, enzymic methods, microbiological research and a collection of abbreviations and symbols for quantities and units; analytical procedures of a wider field of application arranged alphabetically in order of component (ranging from specific elements and compounds to general groups such as colloids and polysaccharides as well as water); factory products such as raw and white sugar; waste products, e.g. water and carbonatation mud; process media such as ion exchange resins, limestone, carbonatation gas, and fodder and methods used for their analysis; microbiological procedures; a glossary of terms used in the sugar industry; and a subject index.

The printing is very clear and the arrangement of the individual instructions very good. Use of the ring-binder permits easy reference, with the sheets falling and staying flat. For readers of German wishing to have a work of reference on chemical control this is an excellent publication.

LABORATORY STUDIES

Rheological behaviour of final molasses. E. R. Fleites, M. A. Moya and M. Darias. *ATAC,* 1982, **41,** (4), 38-46 *(Spanish).* — Final molasses samples from three Cuban sugar factories showed pseudo-plastic characteristics, but their viscosity values varied widely, as did their composition, although all showed a high linear correlation coefficient for the dependence of viscosity on temperature in accordance with Ostwald's law. It is considered that deeper knowledge of the effects of individual components is necessary before it can become possible to know the viscosity precisely.

The iso-electric point of colloidal substances in refinery liquors clarified by phosphatation. A. Fariñas and E. Alvarez. *ATAC,* 1982, **41,** (4), 55-60 *(Spanish).* Measurement of colloidal material in refinery liquors by gel filtration was found to be better than use of the Dumanskii-Kharin method which involves precipitation with alcohol. Variation of the pH by addition of phosphoric acid affected colloid removal, and this was maximum at pH 4.3, assumed to be the iso-electric point.

The surface tension of sucrose solutions. R. González Q. and J. Delgado C. *ATAC,* 1982, **41,** (5), 42-50 *(Spanish).* A bubble tube method was employed for measurement of surface tension of sucrose solutions of 20-60°Bx between 60° and 100°C in the absence and in the presence of 50, 100 and 150 ppm of two surfactants, Espumol H and Espumol K. The two surfactants reduced the surface tension of the sucrose solution in all cases. The surface entropy was calculated from the change of surface tension with temperature, and from this a corresponding value estimated for crystalline sucrose as well as its free surface energy.

X-ray studies of calcium sucro-carbonates. J. Grabka, J. Dobrzycki, Z. Galdecki and M. Glowka. *Ind. Sacc. Ital.,* 1983, **76,** 37-39 *(Italian).* — X-ray studies of calcium sucro-carbonates prepared in the laboratory have revealed the presence of calcium carbonate incorporated into the amorphous suspension and perhaps in greater amount than in the case of the crystalline compound. The suspension of calcium sucro-carbonate, used as a very efficient coagulating medium in purification, should be freshly prepared.

Studies on the browning of technical sugar juices with particular reference to phenolic components. E. Reinefeld, K. M. Bliesener, V. Borrass and U. Poltrock. *Paper presented at 17th Gen. Assembly CITS,* 1983, 29 pp *(German).* — The influence of phenolic components (catecholamines, phenol carboxylic acids and related compounds) on colour formation in beet juices was studied by HPLC. Results showed that dihydroxyphenylalanine (DOPA), formed immediately after slicing of the beets, is rapidly oxidized to melanines which are eliminated during juice purification; thus no DOPA was found in raw juice. On the other hand, phenol carboxylic acids and associated compounds were found for the first time in both beets and juices, and quantitatively determined. The alkaline conditions of juice purification led to an increase in the free (non-esterified) phenolic compounds such as monophenols. *o*-Diphenolic compounds had no significant effect on thick juice colour. Model tests with various additives, e.g. sodium sulphite, hydrogen peroxide, Fe^{+++} and air, showed that, because of their failure to react to any large extent with catecholamines, they did not significantly affect juice colour. Sulphite ions retarded DOPA formation from tyrosine, whereas the colour of thick juice was noticeably increased by reaction between Fe^{+++} and monophenols. Investigation of compounds formed by micro-organisms, particularly thermophiles and mesophiles, showed that the latter bacteria caused increase in thick juice colour, although mixed infections could cause the formation of completely different metabolic products.

A dust attrition test for granular carbon adsorbents. V. R. Deitz. *Paper presented to the 42nd Ann. Meeting Sugar Ind. Tech.,* 1983, 28 pp. — A description is given of the procedure and equipment used to determine the rate of dust formation when air is passed through a bed of granular carbon[1]. Results have shown that the test is successful in differentiating between carbons from various sources. There is no need for correlation with large-scale plant experience. However, while the dust attrition values are reproducible, the estimated initial dust content (mg per g) is governed by a number of uncontrollable factors. Larger carbon particles were found to suffer greater attrition than smaller particles. Other aspects discussed are carbon behaviour in a regeneration kiln (in which no change in dust attrition was observed within experimental uncertainty) and the use of mixtures of bone char and granular carbon for refinery liquor decolorization in which the true average dust attritions have deviated from the calculated arithmetic averages. It has been found that use of a pre-attrition process can considerably reduce dust attrition of a given carbon.

The influence of brightness and saturation on the whiteness evaluation of sugar. T. Ananta. *Maj. Perusahaan Gula,* 1979, **15,** (1/2), 1-10 *(Indonesian);* through *S.I.A.,* 1983, **45,** Abs. 83-683. — Four methods for the objective measurement of the whiteness of crystalline sugar are discussed and assessed. Graphs of relectance at 560 nm against that at 450 nm are straight lines; their slopes give a measure of the influence of brightness and saturation on the whiteness evaluation. Saturation values obtained from measurements by these two methods do not differ much. When the brightness is kept constant and the saturation is increased, it has practically the same effect on whiteness evaluation, whether the measure used is the remission value (which gives more weight to brightness) or the whiteness value (which gives more weight to saturation). When the saturation is kept constant and the brightness is increased, the effect on whiteness evaluation is 15 times as great when the remission value is used as when the whiteness value is used.

Direct determination of fibre in cane by the press method. S. G. Gandana. *Maj. Perusahaan Gula,* 1980, **16,** (1), 22-25 *(Indonesian);* through *S.I.A.,* 1983, **45,** Abs. 83-722. — A method used a Hafico hydraulic press was developed. Washing of the pressed residue is done directly in the container of the press. Fibre contents found showed a high correlation with values calculated according to the Hawaiian method. The method is simple, rapid and accurate. The Hafico press is cheaper than other presses employed for direct cane analysis.

[1] Deitz: *I.S.J.,* Supplement, 1978, 7.

BY-PRODUCTS

Use of residues from the cane harvest in the feeding of livestock. B. Mesa, J. Ruíz, A. Puíg, R. Frontela, G. Faez, J. Prado, E. Glez, N. Antropovsky and R. Ramos. *ATAC*, 1982, **41**, (4), 49-54 *(Spanish)*. – Mention is made of the pre-revolution incorporation of cane leaves in animal fodder and a survey presented on the emphasis given after the revolution to use of by-products from the sugar industry as a contribution to increasing self-sufficiency in animal husbandry. The residues are largely the material separated from millable stalks at the existing in-field cane cleaning stations, and this quantity – 10,000 tonnes/day in 1979/80 – is expected to rise to 15,400 tonnes/day in the 1985/86 season, while a further 3400 tonnes/day is expected from new cleaning centres to be built in the interim. A program is planned of constructing plants for the production of pre-digested feed comprising molasses, urea and bagacillo.

Physiological considerations on the yeast *Candida utilis*. M. A. Otero, M. Klibansky. A. García and R. Estévez. *Revista ICIDCA*, 1982, **16**, (1), 21-29 *(Spanish)*. – Fermentations of *C. utilis* NRRL Y-660 on cane molasses on a continuous basis were studied and measurements of biomass production, residual reducing sugars and yield factors at steady state were determined for each dilution rate. In addition, the contents of nucleic substances, i.e. RNA and DNA, were also measured and the logarithmic response of RNA to dilution rate was corroborated, although no similar behaviour was observed for DNA. The values obtained for yield factor and specific substrate consumption rate were in good agreement with previously reported values.

Utilization of bagasse boards. E. León, J. L. Valdés and R. Almagro. *Revista ICIDCA*, 1982, **16**, (1), 30-42 *(Spanish)*. – The increase in production of bagasse particle boards and in manufacturing plants between 1966 and the late 1970's is briefly summarized and an account given of the nature of the boards and their properties as well as suitability for manufacture of furniture in place of wood.

Alcohol fuels: the Brazilian experience and its implications for the United States. A. S. Nemir. *Sugar J.*, 1983, **45**, (12), 10-13. – Reference is made to the Brazilian program of alcohol manufacture from cane and its use as motor fuel, and comparison is made with the manufacture of alcohol from corn in the USA.

Raw materials for the production of ethyl alcohol and their comparative economics. P. J. M. Rao. *Indian Sugar*, 1983, **32**, 751-771. – See *I.S.J.*, 1983, **85**, 350.

Removal of silica from black and green liquor in the bagasse sulphate pulp factory. C. H. Wen, J. P. W. Yang and S. L. Sang. *Rpt. Taiwan Sugar Research-Inst.*, 1983, (9), 57-63. – Bagasse has a higher silica content than woody raw materials for pulp production, and the ash content rises when the cane carries mud or clay as a result of mechanical harvesting. During alkaline sulphate cooking, the silica dissolves in the black liquor as soluble alkali silicate and is transferred to the green liquor. Problems associated with a high silica content in black liquor are mentioned; the silica should be removed before or during evaporation. Studies are reported on samples taken from Pintung bagasse pulp factory. Results of these showed that treatment of the black liquor with lime under optimum conditions removed 80-90% of the silica; identical treatment of green liquor removed 40-50% of the silica, although aluminium sulphate was more effective than lime, removing 70-85% of the silica from green liquor, but some of the NaOH in this liquor was converted to sulphate.

Beet factory lime for wheat. I. Wallace. *British Sugar Beet Rev.*, 1983, **51**, (2), 40-41. – The value of filter cake from beet sugar factories as a nutrient and pH adjuster in wheat crops, particularly where the soil pH is below the optimum even though a preceding beet crop may not show symptoms of this, is briefly discussed.

Comparison of the effect of energy consumption between final molasses and cereal diets for growing and fattening pigs. P. Lezcano and M. Castro. *Cuban J. Agric. Sci.*, 1983, **17**, 57-66. – In feeding trials with diets based on maize or final molasses, the daily weight gains of growing and fattening pigs and feed conversion were greater with the cereal than with the molasses ration despite a higher digestible energy consumption in the case of the latter. Factors possibly affecting final molasses utilization are discussed.

Some physiological aspects affecting the diarrhoea of chickens fed molasses. L. Savón, R. J. Alvarez, S. Elizalde and G. Martínez. *Cuban J. Agric. Sci.*, 1983, **17**, 83-92. Rations containing 59.35% final molasses that had been specially treated with addition of 3% active zeolite were compared with rations containing the same amount of molasses, but untreated, and containing 65.75% maize, in regard to the composition of the ileum, caeca, faeces and serum. Results are tabulated, and showed that the zeolite treatment had no beneficial effect in reducing faecal moisture content or the laxative effects of a high molasses ration; one factor possibly affecting the consistency of the faeces was a level of sodium in the diets which was above the normal requirements of chickens.

There's more to cane than meets the eye. J. M. Paturau. *Fiji Sugar*, 1983, **8**, (2), 25-27. – Economic factors to be considered in the utilization of cane by-products are briefly discussed. It is stressed that the economic importance of bagasse and molasses as the two chief by-products from sugar manufacture has varied appreciably over the past 50 years; in the case of molasses, fermentation products were almost ousted by petroleum derivatives, while the utilization of bagasse as raw material for paper and particle board manufacture developed at a slow rate. However, in the recent past, the energy crisis has caused a major change, and there is every possibility that the fermentation industries will have a bright future, while bagasse paper and particle board industries are now well established. As regards sucrose derivatives, the author warns against being too optimistic in view of the difficulties (greater than expected) of producing and marketing the products, particularly in competition with petrochemicals; nonetheless, it is felt that non-food use of sugar will make progress, Diagrams

[1] *Rev. Cienc.*, 1972, **5**, (9).

are presented showing the by-products of the cane sugar industry and products from sucrose of actual or potential importance.

Pollution and energy management through the anaerobic approach. L. M. Szendrey, P. E. Schafer and G. H. Dorion. *Ind. Wastes,* 1982, **77,** (8), 31-34; through *S.I.A.,* 1983, **45,** Abs. 83-737. — Bacardi Corporation of Puerto Rico is using an anaerobic reactor of new design to treat distillery wastes from rum manufacture. The system is described in detail with diagrams of the reactor and the plant layout. The medium in the reactor consists of "Vinyl-Core" sheets on which the micro-organisms grow. The system came into operation in December 1981 and by May 1982 was generating enough methane gas to replace about 75 barrels of fuel oil per day. The distillery waste is fed to the reactor at 250,000-300,000 gal/day; decreases obtained in BOD and COD (in mg/litre) were from about 40,000 to 4000 and from about 90,000 to 25,000, respectively. The gas produced (0.9-1.2 million ft^3 per day) contains 52-66% methane and 38-46% CO_2.

Prevention of molasses spoilage during storage. A. I. Andrukh. *Fermentnaya i Spirtovaya Prom.,* 1982, (7), 15-17 *(Russian);* through *S.I.A.,* 1983, **45,** Abs. 83-744. Results (sucrose, reducing sugars, N, colour) of storing normal and defective (78° and 68-69°Bx, respectively) beet molasses for 60 or 150 days at 10° or 30°C indicate the great advantage of storing at 10°C or below. To remove it from storage, the molasses must be locally heated to 20°-25°C (according to viscosity and equipment capability); electrical heating is preferred to steam or hot water since it is simpler and does not necessitate frost protection.

Manufacture of alcohol in a (sugar) factory. P. M. A. A. Chenu. *Inazucar* (Dominica), 1979, **4,** (25), 42-47 *(Spanish);* through *S.I.A.,* 1983, **45,** Abs. 83-747. Many cane sugar factories in Brazil have distilleries attached in which molasses is fermented to alcohol. Depending on market conditions, it may be desirable to ferment some of the juice which contains crystallizable sugar. Withdrawal of this juice must take place at a point which does not adversely affect the heat balance of the factory. The possibilities of using mixed juice, last mill juice, clarified juice, filtered juice or sulphitated juice are considered; in general, it is best to use mixed juice but in certain cases last mill juice may be preferable.

Feasibility of converting a beet sugar plant to fuel ethanol production. G. S. Hammaker, H. B. Pfost, M. L. David and M. L. Marino. *Report prepared for The Scottsbluff-Gehring Payroll Development Foundation Inc. under US Dept. of Energy Contract No. DOE/CS/83010-TI,* 1981, 228 pp; through *S.I.A.,* 1983, **45,** Abs. 83-748. — A feasibility study carried out in conjunction with the Great Western Sugar Company is described. The main possibilities considered were: (1) conversion of an existing beet sugar factory to produce 15 million US gal of ethanol per year from 2000 short tons of beet per day during the campaign and from grain during the inter-campaign, (2) a new factory to use the same feedstocks and give the same output, (3a) conversion of an existing beet sugar factory and installation of extra equipment to process 4000 tons/day of beet during the campaign and grain in the intercampaign, and (3b) as (3a) but processing 2000 tons/day of beet together with grain during the campaign. Conventional processes would be used for juice extraction and fermentation. Carbon dioxide would be recovered and sold; vinasse would be concentrated and added to pulp for use as fodder. Detailed analyses show that all the alternatives would be technically and economically viable. Hybrid beet and corn would be more economical than sugar beets as feedstocks. Conversion of an existing factory would be preferable to building a new factory.

Comparative characteristics of alcoholic yeast strains during fermentation of molasses wort at high Brix. S. T. Oliinichuk, A. D. Kovalenko and A. F. Tkachenko. *Fermentnaya i Spirtovaya Prom.,* 1981, (2), 35-37 *(Russian);* through *S.I.A.,* 1983, **45,** Abs. 83-749. Tests are reported showing the superiority of osmophilic strains M-5 and Sh-1 over the often-used V-30 when used to ferment 26°Bx wort. Alcohol concentration reached 11.44 and 11.47% v/v, respectively, compared with 10.84%, with most impurity concentrations lower; biomass reached 20-22 $g.litre^{-1}$, almost double that for V-30; unfermented sugar concentration was around 5 $g.litre^{-1}$ (12.5 for V-30). At 30°Bx, strain M-5 performed best: 17 g biomass per litre; 12.97% ethanol; 0.93% unfermented sugar.

Bagasse CMP (chemimechanical pulp) for newsprint. J. V. A. Peltonen. *Proc. EUCEPA Int. Mech. Pulping Conf.,* 1981, 25 pp.; through *S.I.A.,* 1983, **45,** Abs. 83-783. — Laboratory and pilot-plant development work since 1978 with Egyptian and Indian bagasse to develop a simple and economical chemimechanical pulping process for bagasse is described. The yield of CMP bleached with peroxide or dithionite was above 80% on depithed bagasse. Chemical pretreatment can be very mild, requiring neither pressure vessels nor elevated temperatures. Typically, caustic consumption was 30 kg and refiner power input was 1.3 mWh per tonne of pulp. Strength properties of the pulp were comparable to those of softwood refiner mechanical pulp, and the light-scattering coefficient was 42 $m^2.kg^{-1}$, superior to that of any other type of bagasse pulp. The BOD of the effluent was about 130 kg/tonne of pulp. Various possible alternatives, including integration with a kraft process, are mentioned. Pilot-scale pulp production and papermaking trials with a fourdrinier and with a high-speed Valmet Symformer F machine demonstrated that up to 90% bagasse CMP can be used in newsprint furnish.

Conversion of cellulosic fibres to monosaccharides and lignin. F. le Grand. *Sugar y Azúcar,* 1983, **78,** (6), 57, 60, 64, 68. — Details are given of a process and pilot plant for treatment of bagasse in which SO_3 gas (diluted to low concentration with air) is led into a column carrying stationary particles of bagasse and is converted into sulphuric acid by reaction with the water in the bagasse. (It is very difficult to effect thorough mixing of small fibre particles of low moisture content with a liquid mineral acid.) The acid (of 70-85% concentration) converts alpha-cellulose from its crystalline form to an amorphous state. After comminution of the bagasse particles, the alpha-cellulose and hemicellulose are hydrolysed to give a product containing 20% glucose and 20% xylose. The pH is adjusted to about 4 with lime and the solution subjected to anaerobic fermentation, whereby the glucose is converted to ethanol while the xylose is unaffected and is converted to a syrup of value as an animal fodder. The lignin component, unaffected by the acid, and any residual fibre are used as fuel for the various process stages.

PATENTS

UNITED KINGDOM

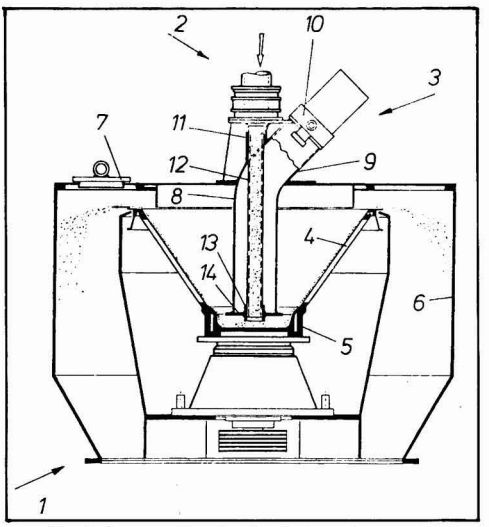
Purifying sugar fatty acid ester. Mitsui Toatsu Chemicals Inc., of Tokyo, Japan. **2,065,102.** April 3, 1980; June 24, 1981. — Crude sugar fatty acids containing fatty acid glycerides as impurities are treated with a lipid splitting enzyme (acylglycerol lipase), with or without a reducing agent (sodium dithionite, vitamin C, glutathione, 2-mercapto-ethanol), in the presence of water.

Ethanol production. Tate & Lyle Ltd., of London, England. **2,065,699.** November 17, 1980; July 1, 1981. An aqueous feedstock containing at least 140 g/litre (at least 180 g/litre) (200-250 g/litre) of one or more fermentable sugars (prepared from cane juice, molasses or a carbohydrate raw material including cassava, maize, potatoes, etc.) is fermented by a micro-organism (a flocculating yeast) at a concentration in the fermentation vessel of at least 30 g/litre [>35 g/litre (40-80 g/litre)] of cells of the micro-organism measured as dry weight, with (<0.5 vol/vol/min) oxygen passed through the vessel as required to maintain the process. The fermentation is operated at a dilution rate of $>0.7\ hr^{-1}$ to give a broth containing >70 g/litre (100 g/litre or more) of ethanol, some cells and 0.30 g/litre (0-15 g/litre) of residual fermentable sugar. The cell concentration is maintained by recycling at least 85% of the cells separated from the withdrawn fermented broth by centrifuging or sedimentation. The residual carbohydrate is fermented under anaerobic conditions.

Separating sugar crystals from massecuite. Z. P. Chen, of Kaohsiung, Taiwan. **2,067,592.** January 16, 1980; July 30, 1981. — See US Patent 4,247,341[1].

Continuous centrifugal. Hein Lehmann AG, of Düsseldorf, Germany. **2,068,763.** December 15, 1980; August 19, 1981.

The centrifugal 1 is provided with a massecuite metering device 2 and a microwave heater 3. The centrifugal is of the conventional type with a frustro-conical drum 5 and observation ports in the casing 6 are provided with covers 7 linked to the heater so that microwaves generation ceases when the cover is opened. The heater has a tubular member 8 which is inclined at an angle of about 45° at its upper end and serves as a guide and means of tuning to the microwave frequency. It is linked with the discharge 11 from the metering unit 2 so that the massecuite feed stream falls downwardly through a heat-resistant glass pipe 12 located centrally within the vertical section of tube 8. The tube 8, discharge 11 and guide bush 13 and ring plate 14, which locate the end of the pipe 12, are all made of steel or alloyed steel which reflect microwaves. The microwaves pass through the glass and are therefore absorbed by the molasses fraction of the massecuite, heating it rapidly as it passes down pipe 12 into the acceleration



pot 5 of the centrifugal, dissolution of crystals being minimal.

Production of alpha-galactosidase and hydrolysis of raffinose. ENI Ente Nazionali Idrocarburi, of Roma, Italy. **2,068,972.** January 27, 1981; August 19, 1981. The title enzyme is produced by culturing *Saccharomyces cerevisiae* (var *oleacus,* NRRL-Y12056 or var. *oleaginus,* NRRL-Y12057) yeasts at 20°-40°C and pH 4-7 in the presence of melibiose. Yeast cells or an extract of them containing the enzyme may be used to effect hydrolysis of raffinose (as a constituent of beet molasses).

Production of immobilized glucose isomerase. CPC International Inc., of Englewood Cliffs, NJ, USA. **2,068,974.** January 30, 1981; August 19, 1981. — A non-ionic surfactant (a polyethoxylated alcohol or polyethoxylated phenol) is added to a culture of a glucose isomerase-producing micro-organism, or moist cells from such a culture, or an aqueous suspension of such cells. The culture is autolysed to solubilize the enzyme without solubilizing the polysaccharides present and the polysaccharide-free enzyme solution brought into contact with a carrier which can adsorb it.

Production of alcohol from juice. Fletcher and Stewart Ltd., of Derby, England. **2,069,000.** January 22, 1981; August 19, 1981. — A charge of carbohydrate-containing material (sugar juice) is fermented to produce an aqueous solution of an organic product (alcohol) which is separated (by liquid-liquid extraction or by distillation) (after separation of yeast or other fermenting agent) into a product-rich stream and a product-lean stream (of 0.1-1.0% product concentration) which is partly [30-90% (65-75%)] recycled to the fermenter and the remainder treated (in a second distilling unit) to separate further product, leaving a residual waste stream.

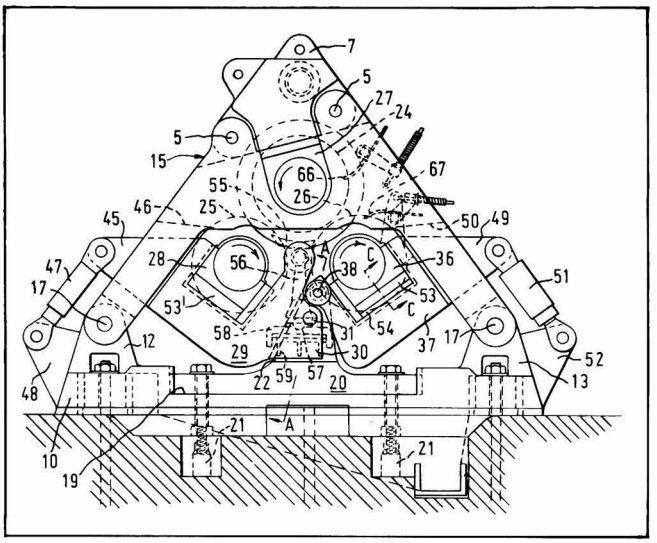
Cane mill. W. A. Nurse, of Bickley, Kent, England. **2,069,869.** December 22, 1980; September 3, 1981.

Mill beds 10, linked by cross beams, form a rigid

[1] *I.S.J.,* 1983, **85**, 124.

Copies of specifications of United Kingdom patents can be obtained on application to The Patent Office Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent, England (price £1.75 each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C., USA 20231 (price 50 cents each).

base to support two A-shaped frames, further rigidity being provided by another cross-beam linking the top caps 7. The caps are secured to the upper parts of frames 15 by pins 5 while the bottoms of the frames are connected to lugs 12 and 13 on the beds 10 by pins 17. Between the frames extend a top roller 24, a feed roller 25 and a discharge roller 26, the ends of which are provided with bearings 27, 28 and 36. Bearings 27 are held rigidly in frames 15 by the top caps 7 while the lower roll bearings 28 and 36 are carried by chairs 29, 37 and pivot about lugs 22. Lugs 45, 49 at the outer ends of the chairs are connected to hydraulic rams 47 and 51 which extend from lugs 48 and 52 which are integral with the beds 10 and supply the pressure which acts on cane passing through the mill.



Variation of the pressure in the rams allows maintenance of any desired ratio between the work openings between the feed and top roller and discharge and top roller, respectively. Suitable packing plates may be provided between the bearings and any of three sides of their housings in the chairs so as to vary the apex angle of the triangle formed by the roller axes, while a spherical bearing is provided for the chairs so as to accommodate uneven transverse movement of the feed and discharge rollers. A trash plate 55 between the lower rollers is rigidly secured to beam 56 which is linked via a plain spherical bearing to a trunnion 57 supported by a chair 58 and stool 59 secured to the chair 29 of the feed roller.

Preparation and use of immobilized enzymes. Tate & Lyle Ltd., of London, England. **2,070,022.** February 20, 1981; September 3, 1981. — The enzyme is immobilized as part of an external gel deposit on inert support material. The external deposit forms at least 3% (10-75%) of the product volume and may be a continuous matrix enclosing the support material or a discontinous and irregular coating on it. The gel deposit comprises 50-95% water and the support material is particulate bone char. The product is made by treating the inert support material with the enzyme (as a solution of at least 25% solids) and a water-miscible organic solvent (acetone) (in that or the reverse order) and then a cross-linking agent (glutaraldehyde) to gel the coating. Steps are taken to prevent agglomeration of the product while, if agglomeration takes place, it is broken down. For every 100 ml of support material an enzyme solution containing 4-20 g dry weight of enzyme solids is applied for support materials having up to 10% porosity, or 15-40 g enzyme dry solids for above 10% porosity. The product has a volume 5-30% greater than the bulk volume of the support.

Producing L-glutamic acid by fermentation. Ajinomoto Co. Inc., of Tokyo, Japan. **2,071,646.** December 14, 1979; September 23, 1981. — L-glutamic acid is produced by culturing aerobically on an aqueous medium (containing e.g. beet molasses, cane molasses, glucose or sucrose) a mutant derived from a L-glutamic acid-producing micro-organism of *Brevibacterium* or *Corynebacterium* genus resistant to glutamic acid or its analogues *(B. lactofermentum* AJ 11292 and AJ 11293, *B, flavum* AJ 11294 and AJ 11295, *C. acetoacidophilum* AJ 11296 and AJ 11297NS and *C. glutamicum* AJ 11298 and AJ 11299).

Animal fodder. S. A. Azucarera Argentine Comercial e Industrial, of Buenos Aires, Argentina. **2,073,244.** November 11, 1980; October 14, 1981. — *Torula* or *Candida utilis* is grown (continuously) in vinasse in the presence of ammonium and phosphate salts, one or more of the elements Mg, Mn, Zn, B, Cu, Co, Mo, I and Se (in solution) is added, and molasses, chloramphenicol and formaldehyde are also added to the medium, with H_2SO_4 to maintain the pH at 3 or below. The yeast suspension may be used as animal fodder.

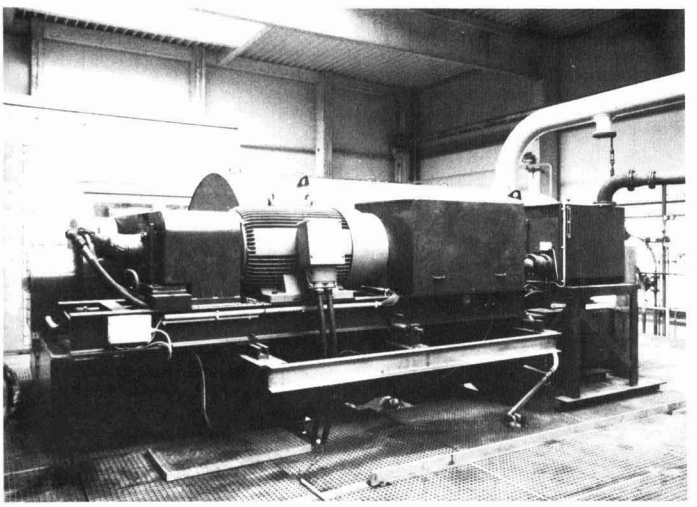
Alcohol production. Unisearch Ltd., of Kensington, NSW, Australia. **2,074,188.** March 3, 1981; October 28, 1981. — Alcohol is produced by culturing in a medium containing e.g. sucrose, glucose, starch or cellulose hydrolysates, a strain (CP4 or ZM 481) of *Zymomonas mobilis* which has a specific alcohol productivity, at 30°C and pH 5 and in a medium containing 200 g/litre of glucose, of at least 4.0 g/g/hr, a specific glucose uptake rate of at least 8.0 g/g/hr and an alcohol tolerance of at least 120 g/l in batch culture of a 300 g/litre glucose solution or 60 g/l in continuous culture of a 150 g/l glucose solution.

Preparation of fructose polymers, fructose and glucose. CPC International Inc., of Englewood Cliffs, NJ, USA. **2,077,269.** June 2, 1981; December 16, 1981. — A product containing >55% fructose is obtained by subjecting sucrose (in a solution of at least 20%) at 25°-65°C and pH 4.5-6.5 to the action of a cell-free fructosyl transferase enzyme derived from *Pullularia pullulans* (ATCC 9348) capable of converting the sucrose to a mixture of glucose, fructose and polysaccharides containing at least 66% of fructosyl moieties, linked by 2,1-beta linkages, subjecting the mixture to the action of (immobilized) glucose isomerase and hydrolysing the polysaccharides in the mixture in the absence of active isomerase enzyme.

TRADE NOTICES

Centrifuge for beet soil dewatering. KHD Humboldt Wedag AG, Postfach 91 04 57, D-5000 Köln, Germany.

Currently the world's largest centrifuge of its type, the S 7-1 solid-bowl unit with a screw conveyor has been successfully tested for dewatering the sludge from beet washers during two successive campaigns in a West German sugar factory. Three Humboldt Wedag S 6-1 centrifuges had previously been used for the task over two years. The S 7-1 centrifuge bowl has a diameter of 1.8 metres and is more than 4 m long, and is designed for hourly throughputs of about 200 m^3 of sludge. The sludge at the factory has a dry solids content varying from 10 to 20% and this is increased to at least 61% by the centrifuge.



The specially developed hydraulic drive ensures low energy consumption; an electric motor of only 250 kW with two starters drives the bowl and the screw via the hydraulic drive, whereby the bowl can be restarted, should clogging take place, without the need to take the machine to pieces.

Carbon steel sprocket wheels. Ewart Chainbelt Co. Ltd., Colombo Street, Derby DE3 8LX, England.

Ewart can now supply sprocket wheels made from medium carbon steel to meet virtually any conveying or transmission need; carbon steel offers better wear qualities than mild steel, equalling those associated with cast iron, but is able to withstand heavy shock loading. Sprockets made by Ewart have teeth that are accurately profiled to match a given chain pitch; the teeth can be flame-hardened to meet particularly demanding requirements such as where the smaller sprocket of a drive is subject to heavy wear or has to cope with abrasive conditions. Sprocket types produced include special double-plate designs and split wheels, the latter being easy to remove and replace. Bosses, central or offset, are bored to customer specifications; wheels running loose between locating collars, in applications involving double- or multi-strand chains, can be supplied with brass, gunmetal or phosphor bronze bushes in the bore.

Entrainment separators. Glitsch Inc., P.O. Box 226227, Dallas, TX 75266-6227, USA.

Glitsch Inc. has expanded its line of entrainment separators to include three distinct types covering the entire range of droplet sizes: chevron or baffle types for sprays and other large liquid particles $\geqslant 10$ μm in diameter, mesh types for mists and other intermediate size droplets $\geqslant 3$ μm, and fibre-bed types for fine mists and other very small liquid particles $\leqslant 3$ μm. A new brochure, Bulletin 332, gives engineering data on all three types.

Ash and bulk material conveying. Macawber Engineering Ltd., Shaw Lane Industrial Estate, Doncaster, South Yorkshire DN2 4SE, England.

A full-colour, 8-page brochure, issued by Macawber Engineering, describes the company's ash-handling system which is capable of removing ash from boilers and other plant in almost any industrial situation. The Denseveyor system designed by Macawber transfers the material in small batches at low velocity (<3.5 m/sec) in a fully-enclosed pipeline in a comparatively non-agitated condition. Fine ash and clinker pass via an ash breaker into a conveying chamber; when this is full an automatically controlled feed valve closes and the ash is transferred by high-pressure air in a solid "slug". The Macawber Controlveyor for transfer of bulk materials over distances up to 200 m is also a completely sealed system which operates on a high material: air ratio, with the material continuously pumped through small-bore piping. If required, a weighing system can be incorporated although material is dispensed to an accuracy of within ± 2%. The Controlveyor is sited directly beneath a main storage point and transfers the material at a fully controlled rate.

PUBLICATIONS RECEIVED

Microprocessor-based circular chart recorder. Kent Industrial Measurements Ltd., Eaton Socon, St. Neots, Huntingdon, Cambs. PE19 3EU, England.

The P105M is believed to be the world's first microprocessor-based circular chart recorder. Its chief advantages lie in the ability of users to specify a standard recorder and key in, via membrane switches, the appropriate input range, linearization, alarm format and set points for each input channel, plus chart speeds and other necessary parameters. The recorder will measure, display and record signals from a wide range of transducers. Full details are given in leaflet P105M 0983/1.

Dust filtration. Heinrich Lühr Staubtechnik, Postfach 360, D-3060 Stadthagen, Germany.

A leaflet available from the manufacturers describes Lühr flat bag dust filters and lists their advantages. The company also manufactures flat-tube heat exchangers designed to cool dust-laden air and gases, and these are featured in a separate leaflet.

Trade notices

Piston-membrane pumps. Abel Pumpen & Maschinenbau, Leimkugelstrasse 13, D-4300 Essen, Germany.

A 4-page leaflet outlines the materials of construction and advantages of Abel horizontal piston-membrane, double- and quadruple-acting pumps for feeding materials to filter-presses or for the transfer of sludges at capacities up to 90 $m^3.hr^{-1}$ and pressures up to 40 bar. The pumps are self-priming and have no glands in contact with process liquid.

Filter-presses for solid-liquid separation. Gebrüder Netzsch Maschinenfabrik GmbH & Co., Postfach 1460, D-8672 Selb/ Bayern, Germany.

A brochure (Technical Information FP 005) available from Gebrüder Netzsch gives details of their filter-presses available for use in various applications in a number of industries. Both chamber and frame-type presses are included.

Filter-press feed pumps. Thomas Willett & Co. Ltd., Whittle Road, Meir, Stoke-on-Trent, Staffs. ST3 7TP, England.

The Willett flow control pump is a single-acting, hydraulically-driven reciprocating piston or ram-type unit which is suitable for handling highly-abrasive materials as well as flocculated materials which must not be broken up during pumping. A brochure from the manufacturers describes the salient features of the pump, including the controls.

Sugar factory equipment. Tsukishima Kikai Co. Ltd., 17-15 Tsukuda 2-chome, Chuo-ku, Tokyo 104, Japan.

Literature available from Tsukishima Kikai describes, in English and Spanish, the wide range of equipment manufactured by the company for both the beet and cane sugar industries, as well as for starch-based sweetener production and cane by-products utilization. Individual leaflets, in English only, describe the S series cane shredder, the TSK low-head vacuum pan, STV short-tube vertical evaporator, LTV Kestner and semi-Kestner long-tube evaporators, juice heater, the TPF rotary pressure filter, Conix continuous centrifugals and a cane mud filter.

Water filtration. Carter Industrial Products Ltd., Bedford Road, Birmingham B11 1AY, England.

A leaflet describing the range of Carter Doucet automatic and continuously operating filters/strainers/hydrocyclones is available from the suppliers.

Type M full-bore valves. Saunders Valve Co. Ltd., Grange Road, Cwmbran, Gwent NP44 4XX, South Wales.

Details are given in a new brochure, of the body materials, end connexions, seats and seals for the type M valves which range from 15 to 100 mm which have nylon-coated or stainless steel balls, manual lever operation, and provide ease of maintenance.

Water treatment. Flowline Watercooling Ltd., Ashford Industrial Estate, Shield Road, Ashford, Middlesex TW15 1AU, England.

A series of brochures describe and illustrate the range of Flowline equipment, including air-blast and tower coolers, system controllers and pumps, design and installation.

Castrol products for the cane sugar industry. Burmah Castrol Co., Burmah House, Pipers Way, Swindon, Wilts. SN3 1RE, England.

A product data list gives details of Castrol industrial lubricants used for gears and transmissions, compressors, turbines, steam cylinders and corrosion prevention in cane sugar factories. It is emphasized that the list represents only a brief introduction to the extremely wide range of Castrol lubricants available.

Filter presses. Edwards & Jones Ltd., Whittle Road, Meir, Stoke-on-Trent, Staffs. ST3 7QD, England.

Literature from Edwards & Jones describes their filter presses, most of which are of the side-bar type with electrical closing gear and side-bar plate-moving gear; descriptions are given of opening and closing and of the plate-moving operations. Details are also given of plates, filter cloths and ancillary equipment, including pumps, while information is provided on specific applications of Edwards & Jones equipment.

Filter presses. Hans Kübler Maschinenbau, Dietlinger Strasse 93, D-7534 Birkenfeld, Germany.

Leaflets from Hans Kübler give details of Hakü chamber filter presses, including membrane presses (a development in which the filter-cake is additionally compressed by injection of air or water into the membrane plate, with consequent reduction of the internal volume of the chamber. There are five models and a total of 65 types of Hakü chamber presses available, for which technical data are given.

Loadcell weighing. Solidate Ltd., Sandy Lane, Moston Road, Sandbach, Cheshire CW11 9HT, England.

Descriptive literature is available from Solidate on loadcell weighing equipment, covering weighbridges, platform scales, pallet scales, shear beam loadcells, crane scale systems and a multi-purpose programmable weighing controller.

Self-setting cane mill. Fives-Cail Babcock, 7 rue Montalivet, 75383 Paris Cedex 08, France.

A new brochure from Fives-Cail Babcock gives details, in French, English and Spanish, of the FCB 4-roller self-setting cane mill, which is particularly advantageous in handling cane that is difficult to handle because of too fine preparation, a high imbition rate, imbition at a high temperature, or where the mill is preceded by a diffuser. FCB 3-roller self-setting mills have already gained wide acceptance, with 240 supplied to factories in 27 countries during the past 20 years.

Precision nozzles. Lechler GmbH & Co. KG, Postfach 1709, Höhenstrasse 24, D-7012 Fellbach, Germany.

A brochure from Lechler describes the company's precision nozzles, atomizing equipment and complete spray systems available for use in a number of industries, including sugar manufacture.

Filter presses. Eberhard Hoesch & Söhne GmbH & Co., Postfach 116, D-5160 Düren, Germany.

A brochure from Hoesch gives details of their filter presses for liquid/solids separation, as used for carbonatation mud treatment, including standard plate-and-frame, recessed plate and membrane types. They may be provided with suitably-controlled valves for completely automatic hydraulic operation. Also described are Hoesch filter plates. Operational data are given as well as performance data from test reports for specific applications. A separate brochure outlines the activities of the company in various fields of manufacture and customer service.

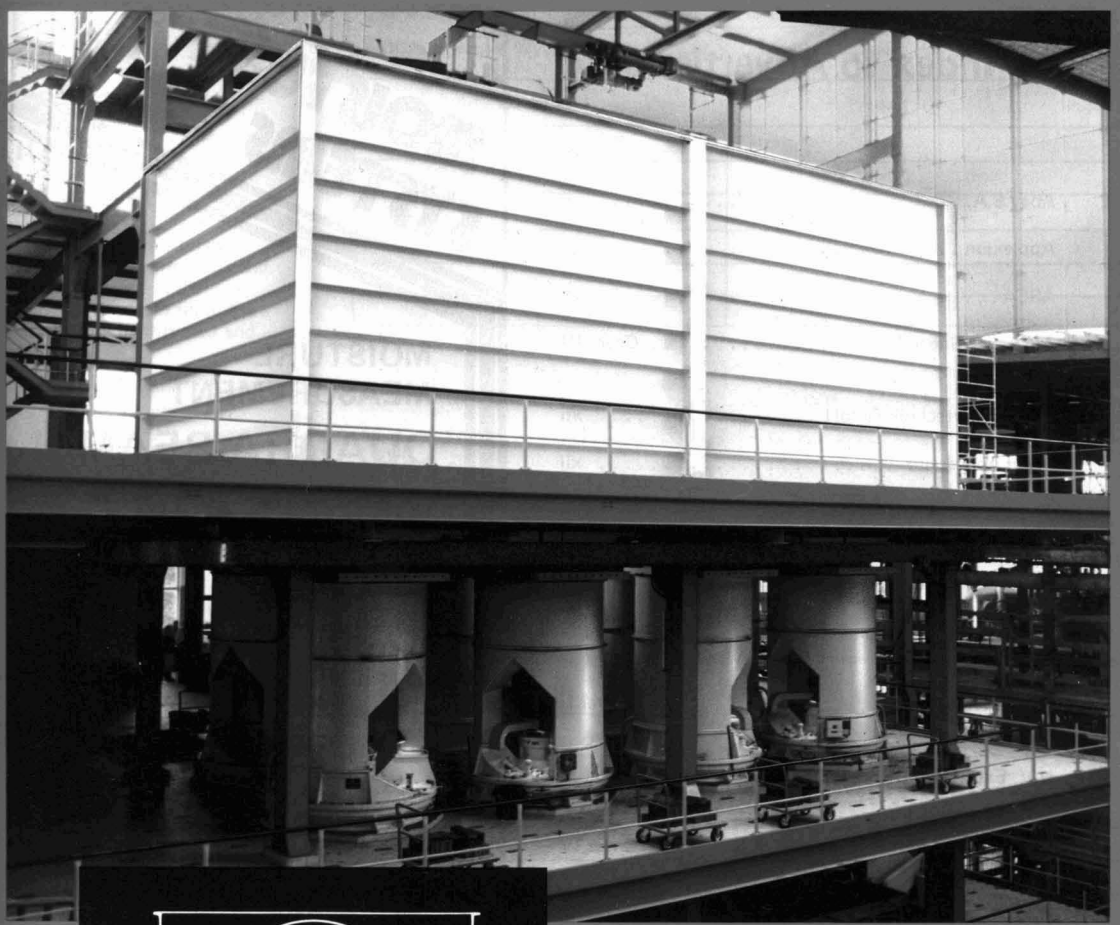
Check valves. Saunders Valve Co. Ltd., Grange Road, Cwmbran, Gwent NP44 3XX, South Wales.

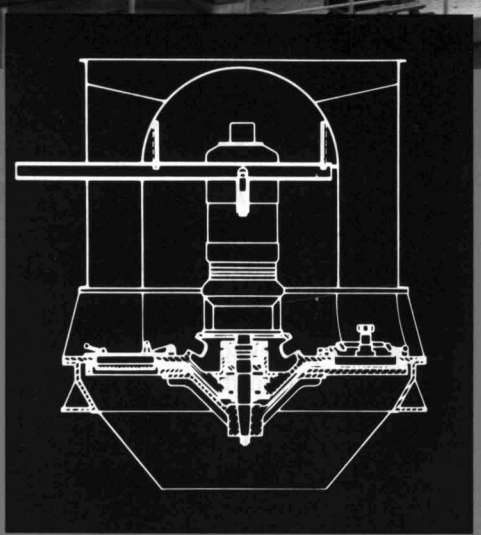
Saunders have introduced a non-return valve, the NX, which is designed to keep a check on pipeline flow and may be used vertically or horizontally. A leaflet describes the valve and the types of material available for the body linings.

Bagged sugar handling. — A £65,000 order has been won from British Sugar plc by Paterson Hughes, the unit handling division of British Ropeway Engineering Ltd., for the design, supply and installation of a pallet handling and storage system for bagged sugar at Kidderminster factory. It will provide a two-way system for the transfer of loaded and unloaded pallets between the warehouse and loading bay and will be in the form of a two-tier power roller conveyor system with a division by hand-operated roller shutter at the boundary between the warehouse and loading bay. An air curtain and overlapping plastic door flaps will prevent damp air drifting from the loading bay into the warehouse. Each system comprises single 2.3 m long and double 3.7 m long conveyors; the high-level section will contain one single and three double non-reversible units while the low-level section will have two single and five double reversible units. The overall length at floor level is 23.3 metres. Each powered conveyor consists of ball-bearing rollers, chain-driven one to the other; each drive will handle a 1.3-tonne loaded pallet at a speed of 40 ft/min (12.2 m/min). Pallets will be loaded from either side of each section at the warehouse end by two fork-lift trucks, then automatically conveyed to the far end of each section in the loading bay from which they will be taken by fork-lift truck to a waiting road truck. A system of photoelectric cells on each conveyor permits the pallets to accumulate. Once the system starts operation, all unoccupied conveyors run but stop locally as the fork lift truck approaches and deposits pallets; when the truck has reversed away from the conveyor, the latter resumes and transfers the pallets to their destination.

New autonomous distillery in Brazil. — Alcool Boa Esperança Ltda., a new autonomous distillery, is being established in Boa Esperança, Espiritu Santo. It is provided with a 22 in x 36 in mill, the first of such a reduced size to be built by Zanini, who are also supplying the rest of the equipment for a production capacity of 40,000 litres of alcohol per day.

Fire protection for sugar packaging complex. — Vermiculux, a fire-resistant casing for structural steel from Cape Boards and Panels Ltd., is used to protect main structural members as well as bracing in the sugar packaging building at Bury St. Edmunds factory of British Sugar plc. The five-storey builing is separated from a single-storey warehouse by only a 25-mm expansion space; the warehouse measures 100 x 75 metres and has a capacity of 20,000 tonnes of suga..





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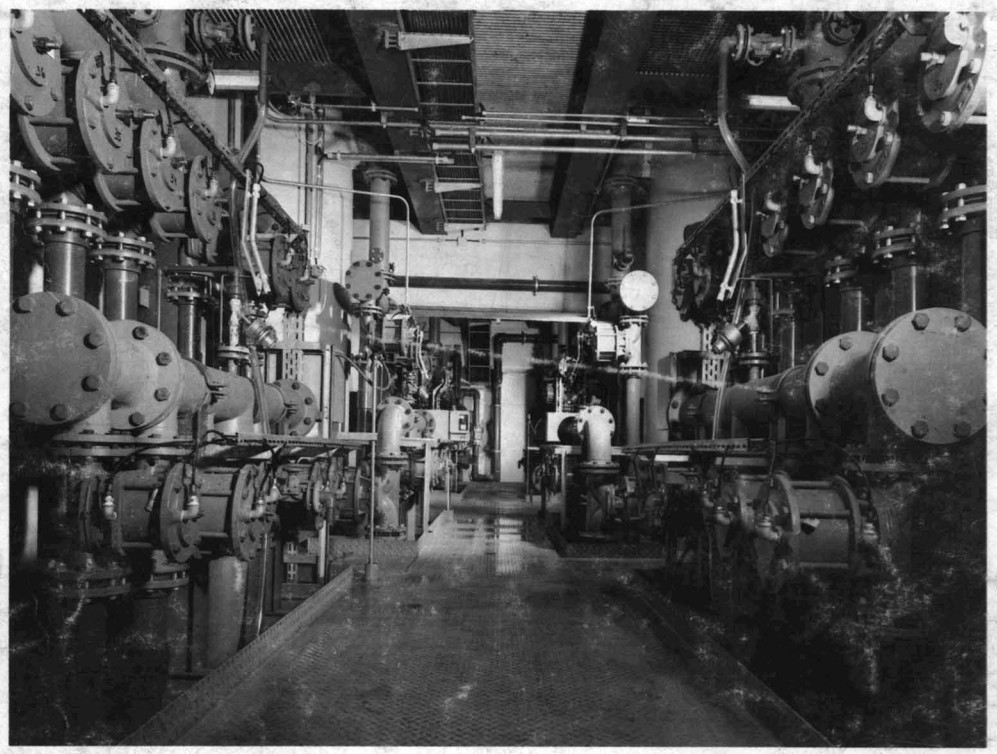

View of a double ion exchange line for the decolourization of liquid sugar in the Norddeutsche Zucker-raffinerie.
Overall design, supervision of construction and erection by IPRO.

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