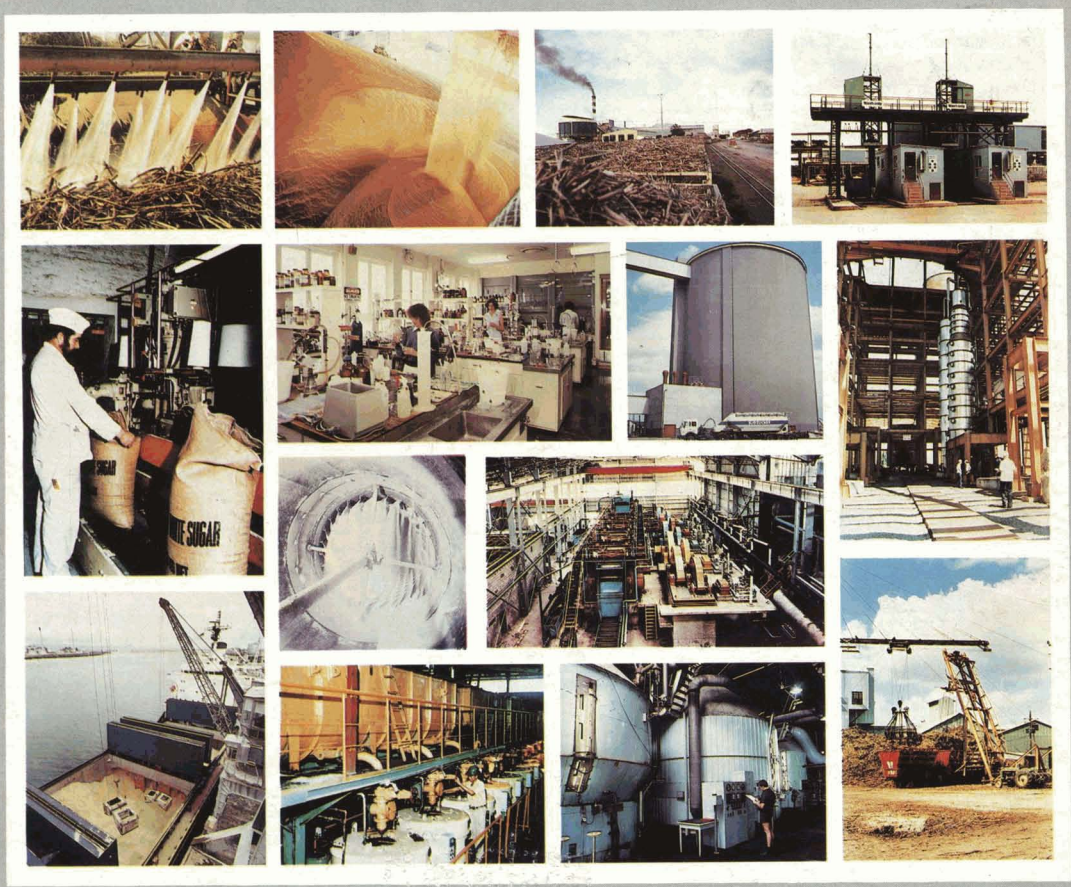
INTERNATIONAL SUGAR JOURNAL



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NOVEMBER 1984

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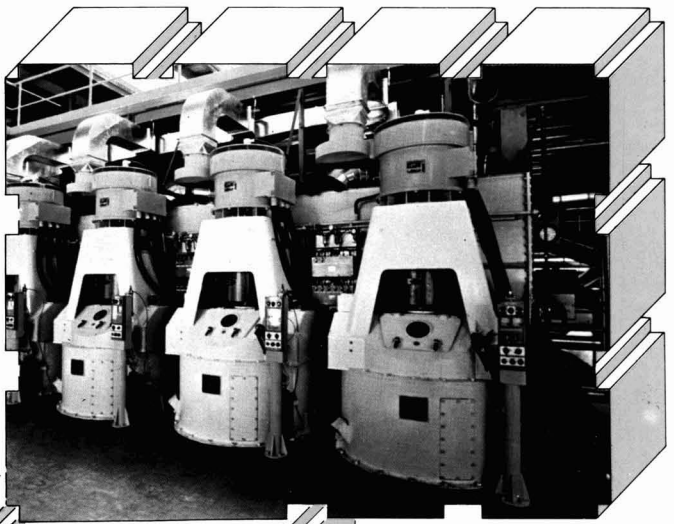

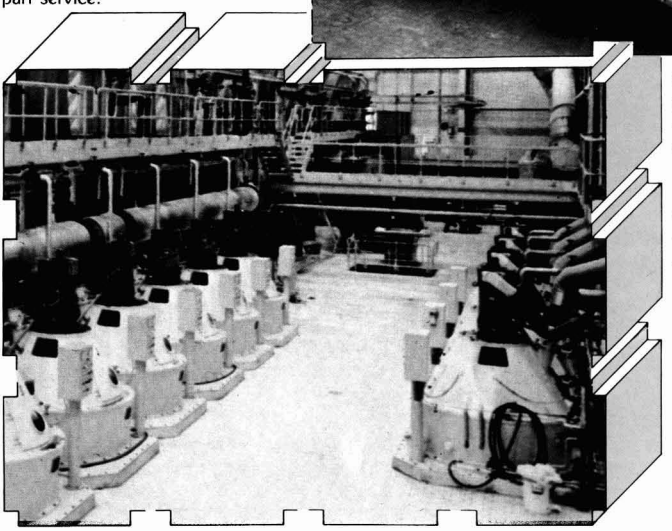

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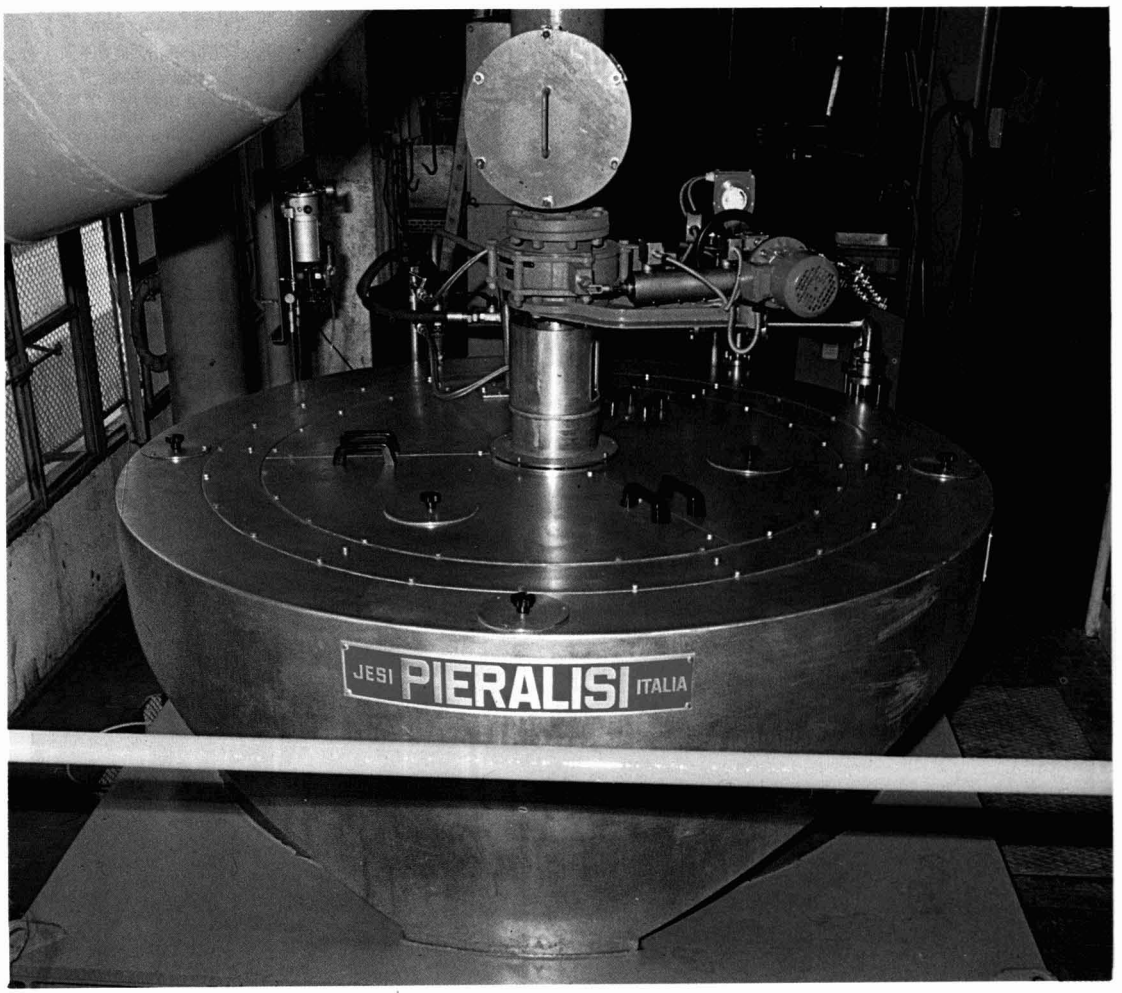

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Notes and comments

World sugar prices

The upward movement in prices at the end of August came to an end with a LDP peak of $125.50 per tonne on September 5 after starting the month at $122. Raw sugar values fell away in spite of rumours of Russian purchases, and the LDP reached $105 on September 18. This was appreciably caused by the strengthening of the US dollar against other currencies, however; for instance the sterling LDP on September 18 was £86 against £98 on September 5 so that the falls were £12 and $20.50, respectively. Fears that a large tonnage of sugar would be delivered into the spot October contract in New York proved unfounded and improved prices then began to appear, so that the LDP reached $116 and £94 on September 28, the last trading day of the month.

White sugar prices were not so volatile as those for raw sugar and the LDP(W) did not sink so far nor so rapidly as the LDP. Consequently, while the premium over raws started the month at $41 [an LDP(W) of $163], it rose to $51-$57 during most of the month, ending the month at $48.50. The LDP(W) reached $170 on September 5 but after falling to $164.50 on September 10, purchases by Egypt, Nigeria and India helped it to rise to $173 by September 13. Thereafter it slipped, to reach $158 on September 25, but recovered partly to $164.50 at the end of the month.

International Sugar Organization

When the 1977 International Sugar Agreement terminates on December 31 of this year, contributions to the I.S.O. Stock Financing Fund will no longer be payable on sugar traded by members after that date. Up to then, however, requirements to present certificates of contribution and to purchase and affix I.S.O. sugar stamps to them will remain in force, and a notice to this effect has been circulated to sugar traders. Contributions at the rate of $1.65 per tonne, raw value, are payable on all free market imports to member-countries and exports to non-members or unknown destinations until the Agreement lapses. The I.S.O. notice provides details of procedures for refunds of double payments and for unused sugar stamps.

European beet sugar production 1984/85

F. O. Licht GmbH have recently published their first estimate of sugar production from the coming beet sugar campaign in Europe[1] although they emphasize that it is too soon to project outturns with a high degree of accuracy. Results of beet tests have been published in most West European countries, as well as areas sown to beet, and these indicate that the crops are not in a very good condition but that this is likely to be more than balanced by a larger beet area. In Eastern Europe, an expected fall in the USSR crop would bring production down by some 6.3% and the overall result may be a modest 1% increase in European sugar output. The figures, and those of 1983/84 and 1982/83, appear below:

	1984/85	1983/84	1982/83
		tonnes, raw value	
Belgium-Luxembourg	924,000	850,000	1,201,000
Denmark	511,000	376,000	584,000
France	4,340,000	3,870,000	4,833,000
Germany, West	2,880,000	2,725,000	3,591,000
Greece	228,000	323,000	322,000
Holland	967,000	807,000	1,229,000
Ireland	217,000	214,000	242,000
Italy	1,360,000	1,352,000	1,282,000
UK	1,300,000	1,155,000	1,543,000
EEC	*12,727,000*	*11,672,000*	*14,827,000*
Austria	489,000	385,000	612,000
Finland	126,000	156,000	116,000
Spain	1,245,000	1,338,000	1,226,000
Sweden	411,000	300,000	389,000
Switzerland	125,000	124,000	120,000
Turkey	1,728,000	1,770,000	1,860,000
Yugoslavia	815,000	772,000	712,000
W. Europe	*17,666,000*	*16,517,000*	*19,862,000*
Albania	39,000	40,000	42,000
Bulgaria	145,000	110,000	180,000
Czechoslovakia	810,000	725,000	885,000
Germany, East	650,000	610,000	810,000
Hungary	505,000	493,000	587,000
Poland	1,900,000	2,141,000	2,012,000
Rumania	630,000	540,000	652,000
USSR	7,900,000	8,760,000	7,400,000
E. Europe	*12,579,000*	*13,419,000*	*12,568,000*
Total Europe	30,245,000	29,936,000	32,430,000

Sugar speculation diasaster for Cuba[2]

A massive but highly speculative operation by Cuba to reverse the collapse of the sugar market has cost it up to $100 million over the past twelve months, according to London sugar trade sources. Several London commodity brokers also lost money in the operation. The sources say the venture has left Cuba, one of the world's biggest sugar producers and exporters, with some 300,000 tonnes of sugar, mostly bought at between two and three times the current world price.

Cuba began to go heavily long on the futures markets last autumn, when the price was around 11 cents/lb; since then it has tumbled to barely 4-5 cents, the lowest real price since 1945. The sources said that Cuba bought 300,000 tonnes in October and November at 11.5 cents/lb and then the same amount this spring at between 6.5 and

1 *International Sugar Rpt.*, 1984, **116**, 461-465.
2 *The Times*, August 3, 1984.

7 cents/lb. By the early summer it was clear that the sugar market was collapsing way below any price at which traders thought it would recover. The Cubans then realized that they could not support the market and sold the contracts back to the brokers at the original price even though sugar prices were now much lower. The transactions cost the brokers money because they had had to finance the carrying charges on the actual raw sugar.

South African sugar industry rationalization[1]

The South African sugar industry intends to rationalize production and introduce a multiple pricing system by the beginning of the 1985/86 season, according to the General Manager of the South African Sugar Association. It should result in the less economical elements in the industry reducing cane production. Under the proposed pool system, which has not been finalized, farmers will be allocated a quota in an A-pool with a guaranteed price. The A-pool would cover the domestic market – about 1,300,00 tonnes or 55% of production in a normal year – and probably about half the export sales. Other production would become B-pool stock and the farmers' B-pool sugar would get the world market price. At present, all export sales are subsidized by the Association to cover the farmers' production costs and S.A.S.A. has borrowed heavily to meet its needs. The new pricing system could well lead to a reduction in export production if world market prices continue at present low levels.

US sugar supply quota, 1985

On September 14 the US Department of Agriculture announced the initial sugar supply quota for fiscal 1985 at 2,550,000 short tons, raw value. This was a reduction from the 1984 quota which had originally been set at 2,940,000 tons but later increased by 100,000 tons. The quota for Nicaragua was again cut to 6000 tons and the amount of the cut (47,340 tons) redistributed to Costa Rica, Honduras and El Salvador. Malawi received an amount of 10,000 tons additional to her quota as a percentage of the overall quota. In addition, the group of small exporters, referred to as the "basket countries" had their amounts cut to 12,500 tons each, against 16,776 in the revised 1984 figures. In total, the quota plus "basket" supplies amount to 2,676,840 tons because of additional amounts of 80 tons of specialty sugars allocated to 23 countries.

C. Czarnikow Ltd. report[2] that: "The initial consensus in the market considered the allocation somewhat too high, especially since under present regulations something approaching 300,000 short tons can be expected to enter the country in the form of mixtures and blends outside of the quota limitations." According to F. O. Licht[3], however, the US Cane Refiners Association criticized the import quota level, saying that quotas are doing irreparable damage to the refining industry and to the nations of Central America, the Caribbean and the rest of Latin America, from which the US imports most of its sugar. The refiners said the import quota depresses the world sugar market and has worsened the world debt crisis.

The USDA Secretary, however, said the quota level reflects an analysis of the sugar needs in the US. A recovery in domestic sugar production, coupled with reduced demand for cane and beet sugar, were major factors leading to the reduced quota level. The quotas are as tabulated.

	1983	1984
	short tons, raw value	
Argentina	109,220	130,806
Australia	210,820	252,486
Bolivia	20,320	24,336
Brazil	368,300	441,090
Canada	27,940	33,462
Caricom*:		
Barbados	17,780	21,294
Belize	27,940	33,462
Guyana	30,480	36,504
Jamaica	27,940	33,462
St. Kitts	12,500	16,776
Trinidad	17,780	21,294
Colombia	69,960	73,008
Congo	12,500	16,776
Costa Rica	52,302	62,415
Dominican Republic	447,040	535,392
Ecuador	27,940	33,462
Fiji	17,780	21,294
Gabon	12,500	–
Guatemala	121,920	146,016
Haiti	12,500	16,776
Honduras	50,017	59,514
India	20,320	24,336
Ivory Coast	12,500	16,776
Madagascar	12,500	16,776
Malawi	35,400	29,294
Mauritius	27,940	33,462
Mexico	12,500	16,776
Mozambique	33,020	39,546
Nicaragua	6,000	6,000
Panama	73,660	88,218
Papua New Guinea	12,500	–
Paraguay	12,500	16,776
Peru	104,140	124,722
Philippines	342,900	410,670
El Salvador	74,561	89,163
South Africa	58,420	69,966
Swaziland	40,640	48,672
Taiwan	30,480	36,504
Thailand	35,560	42,588
Uruguay	12,500	16,776
Zimbabwe	30,480	36,504
Specialties	1,840	2,000
	2,676,840	3,175,150

* Caricom – the Caribbean Community – is considered as having a global quota in which a shortfall by one member-country is allocated to one or more of the others.

Sugar for Portugal

Portugal is solely an importer of sugar although there have been suggestions that a beet sugar industry could be established in the country. However, supplies used to come from the former colonies in Africa and three refineries have remained in operation, nowadays obtaining supplies from the world market, to the extent of about 300,000 tonnes a year. Portugal has applied to become a member of the EEC and has asked that the ACP levy-free supply quota under the Lomé convention be raised by 300,000 tonnes so that the refineries will continue to operate.

Since the Community already produces a surplus, exporting members would prefer that Portugal's supplies would come from within the EEC although, naturally, the ACP sugar producers are in favour of the Portuguese request. In the event, the EEC Foreign Ministers, meeting in Luxembourg at the beginning of October, agreed that the ACP countries' entitlement would be raised for supply to Portugal, but only by 70,000 tonnes a year, at a reduced rather than zero rate of import levy and for a term of seven years.

1 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 456.
2 *Sugar Review*, 1984, (1719), 174.
3 *International Sugar Rpt.*, 1984, **116**, 515.

Micro-processor and computer control of cane sugar factories

By E. G. Sheppard

(Booker Agriculture International Ltd.)

Introduction

BAI are concerned mainly with cane sugar industries in developing countries, where labour is relatively cheap, and the use of high factory manning levels is sometimes desirable in order to alleviate general unemployment. In these areas factory automation is often kept at a low level and is normally only used for the control of important parameters concerned with plant safety, or where manual control to the desired accuracy is not possible.

However, if labour costs in a particular area are high or in short supply, it is necessary to think in terms of a high degree of factory automation. The developments in microprocessors and mini-computers in recent years have made automation on a large scale more reliable and versatile than ever before.

Typical manning levels in raw cane sugar factories may be as high as 250 men per shift in developing countries. These manning levels may be reduced to 20 to 30 men per shift in a highly automated raw cane sugar factory.

Typical system

A typical system to achieve these low manning levels may consist of micro-processor-based local operator's panels located at and controlling key plant areas such as:

Cane unloading, preparation and milling;
Boiler and power plant;
Juice clarification and evaporation;
Sugar boiling, centrifugalling and drying, etc.

These local operator's panels allow the plant operator a complete over-view of the section of plant under his control via a graphics display screen and also provide annunciation if any plant condition is abnormal.

The local operator's panels may be connected to a central control panel which can be linked to a computer. The central control panel provides the senior plant operator with information and displays of the complete factory operation and can allow him to take control of the local operator's panels, if necessary. Print-out facilities and mass information storage for management reporting, etc., may also be included at this station. The central computer can also be used to provide accounting documentation for cane payment if it is linked to the cane weigh-bridge and cane testing laboratory, etc.

Complexity and maintenance

Although highly complex control systems may be produced, most of the complexity lies within the microprocessor or computer system itself. The associated input and output devices (process transmitters and control valves etc.), though large in number, may be of fairly standard design. Because measurement signal characterization and conversion into engineering units is carried out within the microprocessor system, the external equipment may be of much simpler construction than with conventional systems, e.g. the standard requirement for square root extraction on a differential pressure flow measurement device is done away with as the square root extraction can be performed internally. This makes calibration of the external equipment much easier and allows characterization to be performed with digital precision. Few instrument maintenance staff are required to maintain a far more complex system than with conventional equipment. However, owing to the internal complexity and programming knowledge required, their skill level should be higher than with conventional equipment.

Reliability

The general reliability of microprocessor and computer control systems is very good as most manufacturers use only high quality components which are subjected to thermal cycling, and carry out detailed testing prior to despatch. In addition, many systems carry out self-diagnostic programs when in operation, so that if a fault should occur, the operator is alerted at the earliest opportunity. Back-up facilities may also be incorporated so that should a failure of any part of the system occur, operation is immediately transferred to another section, e.g. if a local operator's panel should fail the central system or a standby system will take over control immediately. Communication between sections of the system is normally carried out via a data highway which is often a simple coaxial cable. It is normal for the data highway to be duplicated with the cables being run via separate routes so that should an accident occur which cuts one highway the system will still be fully operational.

Use in developing countries

So far we have dealt with advanced control systems being used for labour saving, but an equally important aspect is the improvement in plant performance which is possible with such systems. As an example of this I would like to describe how a microprocessor-based system can be used in an existing factory in a developing country, to optimize the operation of the cane feeding and milling operation.

The traditional method of controlling cane carriers is by arranging a fixed speed ratio between carriers so that the carriers nearest the first mill run faster than the carriers nearest the feed table. This prevents choking at transfer points, but unfortunately also passes any unevenness in the cane supply on to the first mill, making control of cane feed difficult. The operator's reaction to this is to keep the cane level in the first chute low in order to avoid choking. This results in loss of throughput and reduced extraction. The same operator reaction also tends to happen at successive mills. It can be seen therefore that if the cane feed can be evened out, control of the milling operation will be made much easier. Cane feed can be evened out by sensing the load taken by the heavy duty knives and controlling the first carrier speed to maintain a constant loading (suitable where the knives are situated near the discharge of the carrier). At the same time, it is also necessary to keep some form of speed relationship to the second carrier to prevent cane piling at transfer points.

Paper presented to the British Society of Sugar Cane Technologists, October 1983.

Other factors involved are overload protection on leveller knives and shredders, etc., first mill chute level, the chute levels in successive mills, control of turbine speeds and the imposition of turbine speed maximum and minimum limits. When all the required inputs for control are counted they may total up to 17 measurements and several contact closures, and obviously will require considerable control equipment to produce the required results. It is here where a programmable control system is very suited to the application and will allow close control of the cane feeding and milling operation.

To sum up, microprocessor and computer control systems have a lot to offer the cane sugar industry from both the labour saving and better control of plant aspects, and their use is not only confined to sugar industries in developed countries.

A water-soluble polysaccharide from stand-over cane

Part IV. Studies on the physical properties and origin of sarkaran

By J. D. Blake and M. L. Clarke

(Sugar Research Institute, Mackay, Qld., Australia 4740)

Introduction

In this part of our study[1], the physical size of the polysaccharide and some properties in relation to sugar production are described. Attempts to trace its origin are also reported.

Experimental and results

In Part III, a survey of stand-over cane in the Central district revealed that one area had high concentrations of sarkaran. Accordingly, a 30 kg sample of cane selected from this area and in generally poor condition was treated, as reported in Part I, to yield ethanol-precipitable material at 0.13% on cane. The criteria for poor condition were a high degree of splitting in stalks and the obvious colour difference that distinguishes a stool of vigorous healthy cane from that which is struggling.

Enzymic assay indicated 108% sarkaran while analysis of the digest on a Waters' dextrose column using HPLC gave a relative composition of 2% G_2, 55% G_3, 41% G_4, and 6% G_5. Subscripts indicate the degree of polymerization of the maltodextrin series.

The final product was obtained after decolorization (DEAE-cellulose) and chromatography on an 80 x 5 cm column of Sephacryl S-200 superfine resin. Specific optical rotation was 167.4° which compares favourably with previous preparations. The sample did, however, contain a trace of arabinogalactan but was considered pure enough for examination of some of its bulk properties.

J. D. Blake

M. L. Clarke

(a) Molecular size

Sephacryl S-300 superfine and Sepharose CL-6B columns were calibrated against dextrans of known molecular weight (AB. Pharmacia, Uppsala, Sweden) and were then used to measure the molecular weights of sarkaran and a reference pullulan (Hayashibara Biochemical Laboratories, Okayama, Japan).

Fig. 1A shows the upward elution profile from a 93.5 x 1.6 cm column of Sephacryl S-300 at 0.6 ml/min in 3 ml fractions while Fig. 1B is the chromatogram from a 97 x 2.6 cm column of Sepharose CL-6B under comparable conditions. The sample (2 ml) was prepared at a concentration of 2% glucan.

(b) Use of bacterial α-amylase for depolymerization of sarkaran

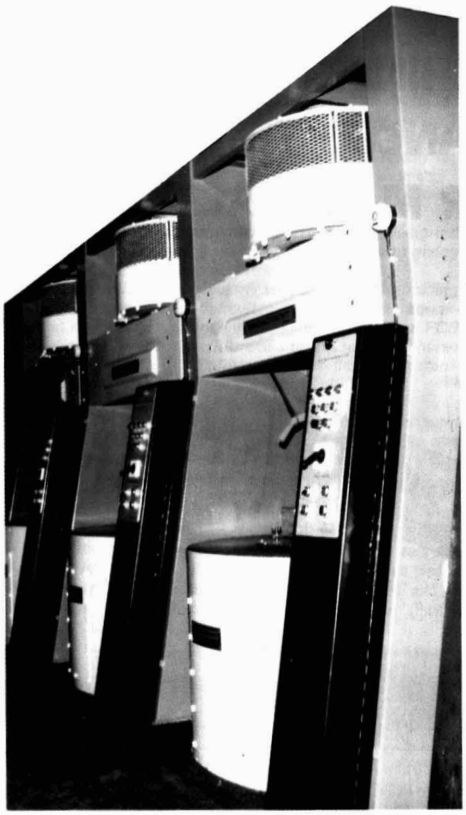
Termamyl liquid 60 enzyme (Novo Industries, Denmark) was chosen in an attempt to reduce the effects of sarkaran on processing by its depolymerization. The enzyme is sold commercially for degradation of starch; it is obtained from *Bacillus licheniformis* and has the very desirable property of high temperature stability[2].

Sarkaran solution (50 ml) was prepared at a concentration of 1.5 mg/ml in 0.02M citrate at pH 5.5, and equilibrated at 70°C before addition of enzyme (5 μl). No measurable change in reducing activity or viscosity (Ubbelohde) was noted in a 60-minute period.

A large excess of enzyme (1000 μl) was then added to exaggerate any change the

1 See also *I.S.J.*, 1984, **86**, 222-226, 235-240, 255-259.

2 Norman *et al.*: *Novo Inf. Bull.*, 1973, (A 404 8).



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The main feature of the FCB self-setting mill is that the top roller is solidary with top housing members acting as lever arms and having the top roller describe an arc of a circle when setting the feed opening. This particular design incorporates the following advantages among others: easy setting of mill ratio; constant mill ratio; increased capacity; higher extraction; reduced power peak; higher permissible roller wear; etc.

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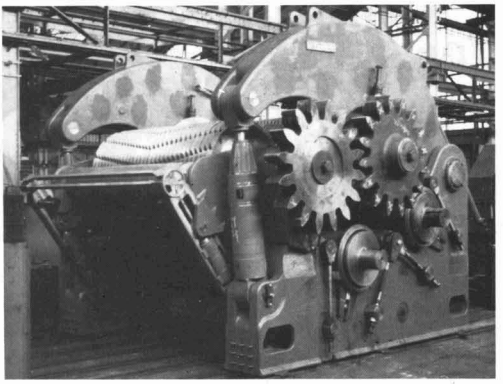
The self-setting mill which was originally designed with 3 rollers, now exists as a 4-roller version giving 3 significant integrated pressures.
This version is particularly well suited to the milling of canes which are difficult to crush. Generally speaking, with the same milling capacity, a line of four FCB 4-roller mills with reinforced imbibition can achieve an extraction rate at least equal to that of six traditional 3-roller mills with standard imbibition.

For the drive of their mills, FCB offer an elaborate range of steam turbines, reducers and transmission gears. FCB are also specialized in the drive of mills by electric motors. (Brochures N° 21091 and 21114 upon request).



FCB 4-roller self-setting cane mill for Wang Kanai, Thailand.

- "COMPACT" automatic batch centrifugals are mainly used for processing high-purity products. They are constantly updated through the incorporation of state-of-the-art features (e.g., microprocessors allowing complete automation of crystallisation shops). They are produced in 3 versions with basket sizes 48" x 30", 48" x 42" and 54" x 42" and respective load capacities of 700, 1000 and 1300 kg. (Brochure N° 21100 upon request).
- "FC" continuous centrifugals are suitable for almost all massecuite curing operations:

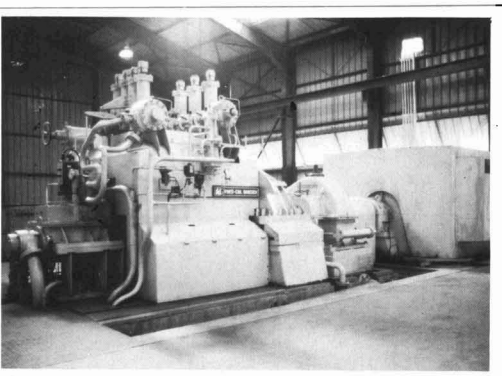
– The FC 1000 series (basket dia. 1000 mm) is fitted either with 34° basket for low-grade massecuites, or with 30° basket for affination and B massecuites, or with 25° basket (runoffs separation) for beet 2nd strike massecuites, cane B strike affination and A strike.
To avoid crystal breakage, the FC 1000 can be equipped with 3 m, 4 m or 5 m dia casings. It is also possible to adapt, on centrifugals with 30° and 25° baskets, a device allowing almost instantaneous sugar melting.
– The FC 1250 series is equipped with a 1250 mm dia., 34° basket. Centrifugals of this series are high-capacity units used for beet 3rd strike and affination and cane C strike and affination. (Brochure N° 21108 upon request).

Centrifugal station of the N'Koteng, Cameroons, cane sugar factory. In the foreground, four "COMPACT 411" centrifugals. In the background, five continuous "FC 1000" centrifugals.

About one thousand FCB turbo-generator sets are in operation in sugar factories in the whole world. They offer to the users the following main advantages:
– High efficiency
– Low installation and operating costs
– High reliability.

The FCB turbo-generator sets are suitable for any type of operation:
- Single back-pressure with controlled or non-controlled distribution pressure
- Condensation with controlled or non-controlled extraction
- Possibility of connection with the mains
- Possibility of operation in parallel with other turbo-generators.

FCB manufactures turbo-generators up to 25 MW per unit. (Brochure n° 27008 upon request).



7000 kW turbo-alternator, of the condensation with regulated extraction type, at the Berotou-Koro cane sugar factory, Ivory Coast.

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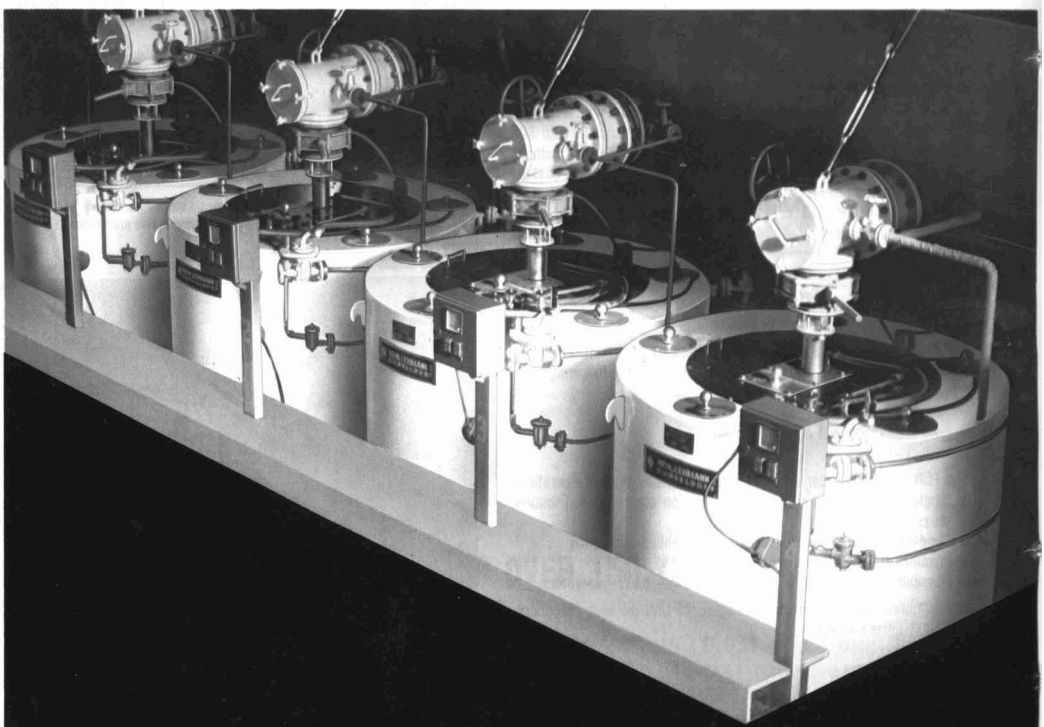

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enzyme could induce. In 25 minutes the concentration of reducing sugars had increased but little change in viscosity was detectable. The enzyme at the initial concentration used was demonstrated to be highly active towards a potato starch substrate.

In the course of these studies, samples were taken to observe the changes in the elution profile on gel permeation chromatography on Sephacryl S-300 superfine; the results are shown in Fig. 1C.

(c) Effects of sarkaran on measurement of pol

A sample of first expressed juice was filtered to remove suspended matter, and portions (0·5 ml) of sarkaran solution (15 mg/ml) were added to the filtrate (25 ml). The final volume was adjusted to 30 ml by addition of an appropriate volume of water. Each solution was clarified by the dry lead method[3] before determination of pol and Brix. The relationship between pol and sarkaran concentration is illustrated in Fig. 2.

Table I. Yield and relative composition of material precipitable in 75% aqueous ethanol from isolates from deteriorating cane

Sample Type	Incubation time (days)	Yield (mg/ml)	Monosaccharides		
			Mannose	Galactose	Glucose
Fungus 1	5	0.66	74	5	21
	21	0.55	76	13	10
Fungus 2	5	0.38	88	2	10
	21	0.36	79	8	10
Yeast 1	5	0.59	79	1	20
	21	0.75	91	1	9
Yeast 2	5*	–	–	–	–
	21	0.63	82	1	17

* This isolate was not growing at the initial sampling.

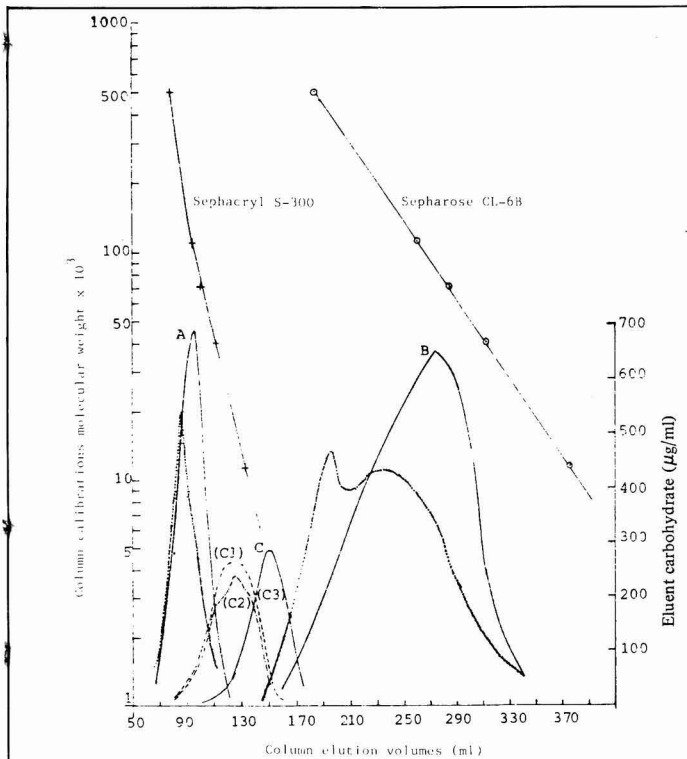


Fig. 1. (A) Gel permeation chromatography (Gpc) of sarkaran (. . .) and pullulan (– –) on a 93.5 x 1.6 cm column of Sephacryl S-300 calibrated with dextrans of known molecular weight; (B) Gpc of sarkaran and pullulan on a 97 x 2.6 cm column of Sepharose CL-6B calibrated with dextrans of known molecular weight; (C) Gpc of sarkaran on Sephacryl S-300 (1) initially (2) 50 minutes after enzyme addition (3) 25 minutes after 200-fold increase in enzyme addition

(d) Studies on the origin of sarkaran

Cultures taken from billets incubated at 30°C (Part III) were dominated by two yeasts and two fungi. These were separately inoculated into synthetic cane juice medium[4] in one-litre flasks at 30°C. Subsamples (50 ml) were taken at 5 and 21 days. After clarification by centrifugation (27,000*g* for 30 minutes at 20°C), polymeric material was precipitated in 75% aqueous ethanol and recovered after exhaustive dialysis by lyophilization. Monosaccharide composition was determined by gas chromatography of the alditol acetates. Samples were assayed for sarkaran (Part III) but results proved negative. Results are given in Table I.

Discussion of results

It was noteworthy that clarification of juice, using synthetic flocculant to assist in

3 "Laboratory Manual for Queensland Sugar Mills", 5th Edn. (Bureau of Sugar Experiment Stations, Qld.), 1970, p. 97.

4 Tilbury: *Ph.D. Thesis* (Univ. Aston, Birmingham), 1982.

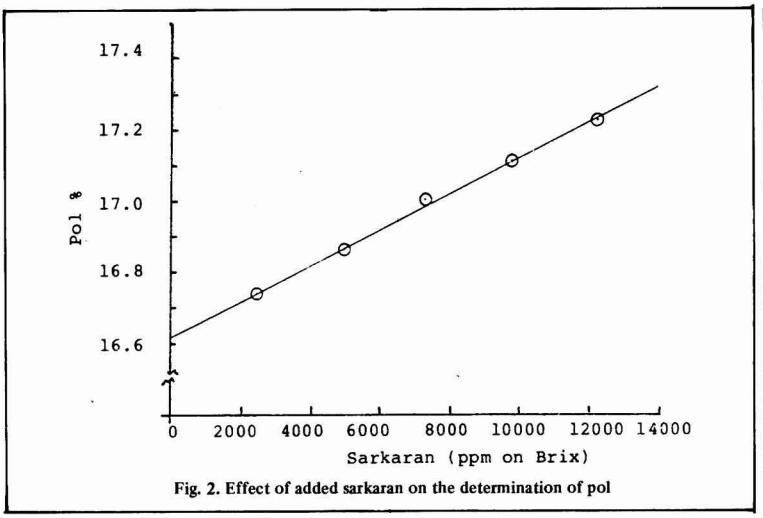


Fig. 2. Effect of added sarkaran on the determination of pol

the removal of protein, enabled preparation of ethanol-precipitable material that was subsequently more water-soluble and easier to purify than experienced in previous field studies.

One property of the glucan is demonstrated in the linear relationship between pol and added sarkaran concentration (Fig. 2). Clearly the polysaccharide is not adsorbed during the dry lead procedure for determination of pol. Thus, a concentration of 4500 ppm on Brix will produce an increase of a quarter of a unit of pol.

A note of caution is warranted in interpreting this change in terms of analyses made in the factory. Nothing is known at present about the biosynthesis of sarkaran and it is quite conceivable that other optically active compounds may be produced either to enhance or to depress this effect. It does emphasize, however, the need for more specific measurement of sucrose in juice.

In studies on the biosynthetic origin of the polysaccharide, Bruijn[5] failed to isolate a microorganism responsible for its production and concluded that it was produced by the plant in response to dehydration and harvesting. His plating techniques for juice from deteriorated cane led to colonies which produced extracellular polysaccharides but none of these was digestible by pullulanase. Results in Table I somewhat parallel those experiments, demonstrating that microorganisms from the ends of deteriorating cane billets synthesize mannans. These organisms were dominant in synthetic cane juice but failed to produce a polysaccharide substrate for pullulanase enzyme over a 21-day period. The possibility still exists that conditions necessary for biosynthesis of sarkaran in these organisms were not established or were totally unsuitable for growth of a separate sarkaran-producing organism.

While Bruijn produced the first reports on the purification and structural analysis of sarkaran, there is little doubt that the polysaccharide was first described by Nicholson & Lilienthal[6] who used periodate oxidation to define quantitatively the linkage types of the glucan. In reporting it as an abnormal dextran, they noted its development during delay periods before crushing, usually late in the milling season and after rain. They determined that it was located in the nodal regions of the stalk but later spread to the internodal zones in smaller concentrations. They suggested that the polysaccharide may be formed either by the priming action of dextran from dextran sucrase upon another polysaccharide-synthesizing system or by plant enzymes alone.

The effects of humidity are uncertain. Bruijn concluded that drying-out of cane was essential for synthesis of the polysaccharide[5] while Nicholson & Lilienthal observed that its presence is usually associated with rain[6]. Results presented in Part III of this series indicated more rapid development of the glucan under humid conditions. Allied to this was the production of a different pattern in the maltodextrin composition. Maltotriose accounted for 50-60% of the glucan in billets stored under ambient conditions and was of the same order of magnitude in sarkaran recovered from stand-over cane. Bruijn also reported similar results. In contrast billets incubated at 30°C and high humidity produce a sarkaran containing 30-40% maltotriose.

The question of biosynthesis as a plant response or microbial activity must remain unanswered at this time. Contrary to the suggestions of a plant reaction, the following observations should be considered.

Sarkaran is randomly distributed in stand-over cane throughout a district experiencing similar conditions of a tropical summer and monsoonal rainfall. For a climatic effect on the plant, a more uniform distribution could be expected; the randomness found is more in accord with outbreaks of microbial infection.

The variation in assembly pattern of maltodextrin sub-units found for different conditions of deterioration would more likely be the response of a microorganism than a plant to environmental change. The relatively long induction period for the appearance of sarkaran seems an unlikely response mechanism of a plant.

These are speculative ideas but pullulan-type polysaccharides are the products of metabolism of fungal yeasts and the report of such a glucan synthesized by *Tremella mesenterica*[7] after an extended growth period is noteworthy.

In addition to attempts to establish the origin of the glucan, a brief study was made on its removal from process by enzymic means. While bacterial α-amylases

5 Bruijn: *Ph.D. Thesis* (Univ. of Natal, Durban), 1973.
6 *Aust. J. Biol. Sci.*, 1959, **12**, 192.
7 Fraser & Jennings: *Can. J. Chem.*, 1971, **49**, 1804.

show very limited activity towards sarkaran, the high-temperature stability of some make them ideal for food processing where operation at lower temperatures may encourage microbial infection.

Fig. 1C shows clearly that bacterial amylases have no role in process removal of sarkaran. It took 25 minutes with an economically impossible concentration of enzyme to reduce its molecular weight from 20,000 to 4000. Until development of heat-stable pullulanases or amyloglucosidases occurs, problems of processing stand-over cane will have to be endured. The best approach currently employed involves judicious blending with new season cane.

The molecular weight of sarkaran was estimated by gel filtration on columns equilibrated with B-512 dextran fractions of known molecular weight. Since this can only be a valid method when comparing polysaccharides of similar hydrodynamic properties in solution, and this has not been established for dextran and sarkaran, the results obtained can only be described as tentative. Sarkaran returned figures of 185,000 and 200,000 on Sepharose CL-6B and Sephacryl S-300, respectively. Commercial pullulan under similar conditions measured 86,000 and 100,000, respectively. A small peak in Fig. 1B, corresponding to molecular weight 410,000, may be arabinogalactan impurity.

The low-molecular weight sarkaran profiled in Fig. 1C probably reflects the thermal treatment that the sample underwent during n.m.r. spectroscopy (Part I).

Bruijn[5] calculated a molecular weight of 50,000 for sarkaran eluted from Sephadex G-200 and calibrated against dextrans similar to those used in this study.

This variability reflects either the isolation and treatment of the polysaccharide during purification or conditions of biosynthesis or both. By analogy with pullulan, Catley[8] reported that variation in molecular weight occurs but a figure of 200,000 was a fair approximation for its general synthesis. A similar figure was proposed by Miura *et al.*[9] who studied the effect of sucrose concentration on molecular weight in the biosynthesis of pullulan.

Acknowledgements

The authors wish to thank Dr. K. McNeil for the preparation and classification of the major organisms isolated from the stored cane.

Summary

Measurements of the molecular weight of sarkaran from stand-over cane by means of gel filtration, gave values of 185,000 to 200,000, with a small fraction of M.W. 410,000. This must be compared with the value of 50,000 estimated by Bruijn for sarkaran isolated from deteriorated cane. The discrepancy indicates differences in the isolation and treatment or in the process of synthesis. Sarkaran was not obtained from cultures of two yeasts and two fungi isolated from the cane so that its origin is thus uncertain.

Un polysaccharide hydrosoluble provenant de canne laissée en champs. Partie IV. Etude des propriétés physiques et de l'origine du sarkaran

Des mesures (par filtration sur gel) de poids moléculaire du sarkaran isolé de canne laissée en champs montraient des valeurs de 185,000 à 200,000 avec une faible fraction d'un P.M. de 410,000. Cela doit être comparé à la valeur de 50,000 estimée par Bruijn pour le sarkaran isolé de canne déteriorée. Cette comparaison met en lumière des différences soit dans l'isolement et le traitement soit dans le processus de synthèse. On n'a pas obtenu du sarkaran aux dépens de culture de deux levures et de deux champignons isolés de la canne. Son origine est donc incertaine.

Wasserlösliches Polysaccharid aus "Stand-over"-Rohr. Teil IV. Studien über die physikalischen Eigenschaften und die Herkunft von Sarkaran

Messungen des Molekulargewichtes von Sarkaran aus "Stand-over"-Rohr mit Hilfe einer Gelfiltrationstechnik zeigten Werte von 185 000 bis 200 000 mit einem kleineren Anteil von 410 000. Im Vergleich dazu wurden von Bruijn 50 000 ermittelt, für Sarkaran aus alteriertem Rohr, was entweder auf Unterschiede der Trennung und Behandlung oder auf die Synthese zurückzuführen ist. Sarkaran wurde nicht in Kulturen zweier Hefen oder zweier Pilze, die aus dem Rohr isoliert wurden, gefunden; deswegen ist seine Herkunft unbekannt.

Un polisacarido soluble en agua encontrado en caña restante de la zafra anterior. Parte IV. Estudios sobre las propriedades físicas y el origen del sarkaran

Por filtración sobre material gelatinoso del sarkaran, aislado de caña restante de la zafra anterior, se obtienen medidas de peso molecular de 185,000 a 200,000, con una fracción pequeña de P.M. 410,000. Esto tiene que compararse con el P.M. de 50,000 estimado por Bruijn para sarkaran aislado de caña deteriorada; la desemejanza indica diferencias o en aislamiento y tratamiento o en el proceso de síntesis. No obtuvo el sarkaran de culturas de dos levaduras y dos hongos aislados de la caña de modo que su origen es incierto.

8 "Microbial Polysaccharides and Polysaccharases", Eds. Berkeley, Gooday & Ellwood (Academic Press, New York), 1979, p. 72.
9 *Hakkokogaku Kaishi*, 1977, **55**, 80; through *S.I.A.*, 1977, **39**, Abs. 77-1307.

Brevities

Sudan rehabilitation program[10]

The World Bank has agreed a $60 million credit to help finance the sugar rehabilitation program in the Sudan which has been under discussion for more than two years. It covers rehabilitation of the four state-run schemes – Hajar Assalaya, Sennar, El-Guneid and Khashm-el-Girba. Total project costs are put at $181 million with co-financing from West Germany of $15.6 million, and Arab fund sources of about $67.2 million, part of which has still to be finalized. The five-year project aims to increase production at the four factories to about 330,000 tonnes a year, which compares with the current theoretical capacity of 360,000 tonnes but actual output of 180,000 tonnes. Work will include renovation of the irrigation systems, improvements to the factories, purchase of equipment and spares and provision of training and management consultancy. Work at Guneid and Khashm-el-Girba has already started.

10 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 383-384.

Developments in the Indonesian sugar industry

By Ir. Budi Aristanto

(PT Agriconsult International, Jakarta)

Introduction

The sugar industry in Indonesia is presently in the stage of development, directed towards expansion of its production capability, basically located on the islands outside of Java.

The overall objective of these development efforts is clearly to endeavour to attain self-sufficiency in sugar supply for Indonesia's steadily growing population.

Since the early sixties the Government of Indonesia has undertaken efforts to establish production units on the islands outside of Java, which have resulted in the construction of one sugar factory in Aceh province and another in South Sulawesi province, while projects on the islands of Seram and Lombok have been abandoned.

During the 1970's the number of sugar factories increased to 59, including one sugar factory in West Java, one in East Java (replacement), and one in Lampung. During this period also, a number of factories were rehabilitated and their milling capacities increased.

The Java sugar industry

Before going into the development efforts of the Indonesian sugar industry, it would seem appropriate to briefly look at some highlights of the history of this industry, which before 1940 had proven its potential.

Even at the beginning of the 19th century more than 150 sugar mills were operating, and towards the end of that century, the production level was some 550,000 tonnes.

From the beginning of the 20th century up to 1940, efforts to improve yields were successful, achieving an increase of about 100%. Total production in 1930 reached a record 2,915,000 tonnes. (See Table I). As elsewhere in the world, the economic crisis of the 1930's also affected the sugar industry and production was cut back to a level of some 509,000 tons (1935), with some 40 factories operating.

After 1936 production capacity was increased again, achieving about 1,587,000 tons in 1940; 85 sugar factories were operating. During the period 1942-1945 the sugar industry was almost non-existent, but as conditions improved rehabilitation of some of the sugar factories was undertaken and, by 1947, nine factories were operating again. Continued efforts increased the number of operating sugar factories and, by 1957, when the Indonesian government took over the industry, 52 factories were operating (see Table II).

Table I. Sugar production in Java, 1930-1940

Year	Number of factories	Cane area, ha	Cane, tonnes/ha	Sugar, tonnes/ha	Rendement, %	Sugar produced, tonnes
1930	179	198,642	129.4	14.68	11.34	2,915,866
1931	178	199,305	132.3	13.84	10.46	2,776,165
1932	165	171,630	133.7	14.92	11.16	2,560,182
1933	77	68,275	132.6	15.55	11.78	1,372,585
1934	50	38,811	135.2	16.39	12.15	636,104
1935	40	29,453	139.8	17.30	12.38	509,659
1936	37	35,150	138.4	16.05	11.60	574,710
1937	81	85,710	141.1	16.10	11.44	1,379,924
1938	80	85,309	139.0	16.12	11.61	1,375,510
1939	84	95,468	137.2	16.37	11.93	1,562,462
1940	85	91,836	135.7	17.28	12.74	1,587,364

Table II. Sugar production in Java, 1950-1960

Year	Number of factories	Cane area, ha	Sugar, tonnes/ha	Sugar produced, tonnes
1950	31	30,352	10.11	277,091
1951	46	43,016	9.70	427,059
1952	46	47,600	9.10	460,264
1953	50	46,105	12.20	619,429
1954	53	49,256	12.00	717,742
1955	54	51,495	12.80	851,012
1956	52	50,077	12.90	735,434
1957	52	52,265	12.80	828,250
1958	53	52,627	10.78	770,213
1959	54	55,903	11.66	855,695
1960	54	57,142	9.91	671,911

Developments after 1957

The first decade of the sugar industry after the take-over in 1957 was not an easy one, and should be considered as a survival period, during which efforts were concentrated on consolidation of the structure, organization and management of the industry. The industry, aware of its role within the overall objective of the Indonesian government, moved towards improving its capability.

An important step in this regard was the undertaking of an overall assessment study concerning the industry, aimed at understanding development potential on Java as well as on the outer islands. In consequence of this study, steps in preparation of development activities, such as cane trial fields at various locations on the outer islands, were undertaken. Furthermore, consideration was given to the rehabilitation and expansion of the Java sugar factories and establishment of new sugar-producing units on the outer islands, including large as well as the so-called miniplants.

The sugar industry development plan prepared in 1979 indicated optimization of the production in Java through intensification and extension of cane areas, and rehabilitation of the factories to increase capacity from an average of 95,583 tcd to 109,809 tcd with an extended milling season of 160 days.

This program was also directed towards conversion of estate-grown to farmer's cane.

Planned establishment of additional production units outside of Java included

Paper presented to the British Society of Sugar Cane Technologists, October 1983.

Table III. Cane area and sugar production

Year	PTP (State-owned)	Non-PTP (Private)	Total	Cane area, ha
	tonnes			
1970	613,618	113,283	726,901	81,700
1971	710,497	112,630	833,127	83,700
1972	761,091	133,838	894,929	88,200
1973	695,604	123,617	819,221	99,800
1974	863,766	165,676	1,029,442	106,800
1975	884,518	152,912	1,037,430	105,000
1976	908,675	151,074	1,059,749	115,700
1977	955,003	167,545	1,122,548	121,600
1978	964,449	196,000	1,160,449	144,400
1979	1,043,862	148,022	1,291,884	167,700
1980	998,408	250,808	1,249,216	n.a.
1981	1,038,263	169,792[1]	1,208,055	193,100
1982	1,312,229	270,364	1,582,593	258,685[3]
1983[2]	n.a.	n.a.	1,661,241	n.a.

1 Excluding Gn. Madu sugar factory.
2 Estimated.
3 Estimated.

56 200 tcd plants, 3 3000 tcd plants, 20 4000 tcd plants, and 5 6000 tcd plants, as well as an ultimate cane area of 402,600 ha.

Adjustments and revisions of this program specifically as regards the 200 tcd plants, were necessary, owing to the problems encountered with the operation of the three plants established in West Sumatra, Aceh and Kalimantan.

Rehabilitation and expansion of the Java sugar factories was started in the early 1980's and is scheduled for completion in 1984. Basic principles for this program are crushing capacity to be increased from 87,713 tcd in 1980 to 113,355 tcd in 1984, and season extended from 147 milling days in 1980 to 176 in 1984.

The development program for outside Java initially considered establishment of 22 sugar factories with a capacity of 3000-4000 tcd.

After subsequent revision the program now covers development of 18 new production units, shown in Table IV.

Table IV

Completed: North Sumatra	1. Sei Semayang I	(4000 tcd)
Under construction:		
North Sumatra	1. Sei Semayang II	(4000 tcd)
South Sumatra	2. Cinta Manis	(4000 tcd)
Lampung	3. Ketapang	(4000 tcd)
West Java	4. Subang	(3000 tcd)
South Sulawesi	5. Caming	(3000 tcd)
	6. Takalar	(3000-4000 tcd)
South Kalimantan	7. Peleihari	(4000 tcd)
Under consideration:		
South Sumatra	1. Baturaja I	(4000 tcd)
Lampung	2. Gula Putih Mataram	(4000-5000 tcd)
North Sulawesi	3. Paguyaman	(4000 tcd)
East Timor	4. Los Palos	(4000 tcd)
Proposed additional sites:		
South Sumatra	1. Baturaja II	
South East Sulawsi	2. Ladongi	
Irian Jaya	3. Nakias	

For the Muna island site a 600 tcd plant is also under consideration.

The Government of Indonesia has now offered implementation of the projects "under consideration" to the private sector, as most probably will also be the case with the "proposed additional sites".

In addition to the development of sugar cane areas and processing factilities, alternative sources of sweeteners are also being considered, viz high fructose syrup on a cassava starch base, and liquid sugar on a molasses base.

Projected production figures are as follows:

1983 – 10,000 tonnes
1984 – 10,000 ,,
1985 – 63,000 ,,
1986 – 63,000 ,,
1987 – 120,000 ,,
1988 – 120,000 ,,

More in-depth studies as regards development of these alternatives would seem necessary.

Brevities

Research on alcohol from bagasse in Japan[1]

Kyowa Hakko Kogyo K.K. of Japan has begun work on what its managing director claims could be the largest continuous production and recovery plant for agricultural fuel-grade alcohol in the world. When completed in 1986, the facility will produce 200 litres/day of anhydrous alcohol from some 720 kg/day of rice straw or bagasse. The project is being carried out jointly with Toyo Engineering and Kurita Water Industries and is part of a government program aimed at reducing Japanese dependence on imported oil and run by the Ministry for International Trade and Industry (MITI). The first stage involves cellulose pretreatment, cellulose production, saccharification and enzyme recovery, while the remainder includes fermentation, ethanol recovery and waste treatment. The fermentation employs *Saccharomyces cerevisiae* yeasts entrapped in calcium alginate beads. In earlier tests the system was kept running for 4000 hours, maintaining a yield as high as 95% of the available sugars. This high stability was possible through the addition of sterol and unsaturated fatty acids to the mixture before immobilization and by supplying small quantities of air to the broth. By maintaining pH at 4 with sulphuric acid, it was possible to prevent bacterial contamination. The process is claimed to be 20 times more productive per unit volume than conventional batch fermenters.

1 *Chemistry & Industry*, July 16, 1984.

Economics and energy balances of ethanol from sugar cane and sugar beet

By Bert Mouris

(Laboratory for Chemical Technology, Delft University of Technology, Julianalaan 136, 2628 BE Delft, Holland)

The rise in energy prices, particularly in the case of oil and natural gas, has stimulated the interest in alternative sources of energy in the industrialized world as well as in the developing countries. The impact of the higher prices on the balance of payments and on economic growth has been severe in many countries. There have been high rates of inflation, less investment (having consequences for the labour markets) and low consumption rates.

In contrast to the rise in oil prices, commodity markets in various countries are overflowing with the products at relatively low prices. These situations combine to cause a clear danger for the population in developing countries and these lower the existing standards in developed countries.

Renewable energy can substitute for oil in a variety of sectors, such as transport, the chemical industry and the production of electrical power. On the basis of present knowledge, the following energy resources have long-term possibilities:

(i) renewable energy resources – for example, solar radiation, water power, wind power, tidal energy, geothermal energy (heat flows), photochemical energy stored in plants (food, wood and vegetable refuse) and animal refuse

(ii) coal conversion – gasification and liquefaction

(iii) nuclear fission using breeder reactors

(iv) nuclear fusion.

The past has already shown that it is possible to convert sugar crops into ethanol. This may be a solution for energy problems as well as for reduction of overcapacities in the sugar industries.

However, the choice between the alternatives for producing ethanol from sugar juice (cane or beet) and electrical power from bagasse cannot be based on consideration of just a few elements. There must be a well-reasoned analysis of a complex set of conditions. These conditions include many aspects of and interrelations between agriculture, sugar cane and beet transport to the factories, manufacturing processes, market behaviour and consumption patterns and – maybe most important of all – the influences of political statements and regulations by the EEC, Lomé and GATT conferences. It is not possible to discuss all relevant aspects, so a selection has to be made. Apart from political influences, energy balances and economic calculations seem to be determining factors in the decision to produce ethanol from sugar cane and beet.

Basic materials

The basic materials are sugar cane and sugar beet, each grown under different conditions. Cane is cultivated in tropical and sub-tropical regions. Sugar beet grows best in cooler latitudes, but it will adapt to many climatic conditions. As a practically identical product – sugar juice – is the basic material for crystallized sugar or ethanol production and it comes from different plants, global dispersion of the industry has been made possible.

Therefore, sugar cane and sugar beet compete with other commodities for use of land. This is particularly true for sugar beets in developed countries. Sugar is produced now in more than 100 countries. Some produce primarily for the domestic market while other countries produce primarily for export. Annual outputs range from less than 10,000 tonnes to roughly 10 million tonnes per annum[1].

About 100 million tonnes of sugar are produced every year worldwide. Fifteen million tonnes are sold on the so-called world sugar market, at prices ranging from £0.04 to £0.70 per kilogramme[2]. In the case of overproduction and low sugar prices, part of the crop can be used to make ethanol.

Interpretation of these low sugar prices may lead to the conclusion that sugar cane is available at £10 to £15 per tonne. For sugar beet at C-sugar prices, the EEC guaranteed (intervention) price for 1983-1984 has been fixed at £15.25 per tonne. Whatever the price of the basic material, renewable energy resources will always be in competition with oil prices. In Fig. 1,

Paper presented to the Biotechnology Group of the Society of Chemical Industry, March 1984; *Chem. & Ind.*, June 18, 1984.

1 "Sugar yearbook 1982" (International Sugar Organization, London) 1982, pp. 1-79.
2 Bruhns: "Zuckerwirtschaftliches Taschenbuch 1983/84", (Bartens, Berlin), 1983, p. 27.

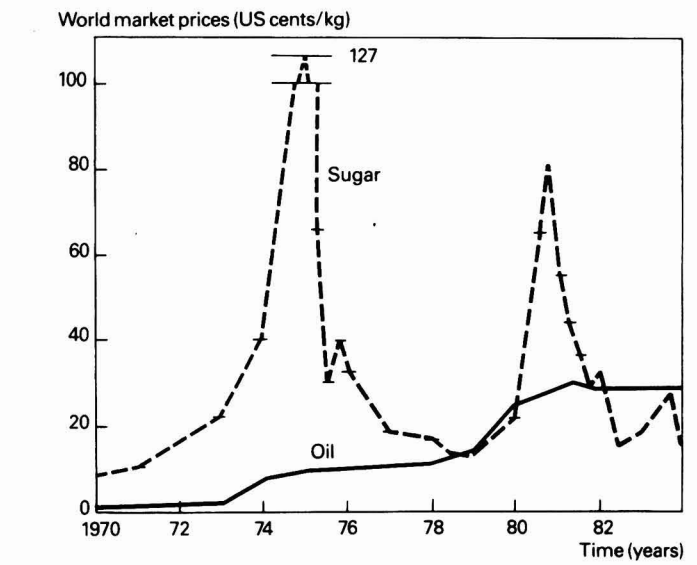


Fig. 1. Comparison of world market prices for crude oil and sugar

ISJ Abstracts

Cane sugar manufacture

Passing too much water through the condensers?

Anon. *BSES Bull.*, 1984, (5), 5.

The adverse effect of rise in temperature of water used to condense evaporator and pan vapours is discussed. Under Australian conditions, the ambient temperature rises as the season progresses, resulting in a rise in cooling water temperature, regardless of the source; this in turn means an increase in the quantity of water needed for the condensers. If the temperature rise is so high that the amount of water required cannot be obtained from the available supply, the vacuum available from the condenser will be adversely affected. A fall in the condensing efficiency will cause a rise in the approach temperature between vapour and outlet water, causing still further increase in cooling water requirements; the approach temperature should not exceed 5°C, and a table is given of cooling water:vapour ratios at approach temperatures of 0°, 5°, 10° and 15°C and cooling water temperatures of 20°, 25°, 30° and 35°C, assuming a condenser operating at a vacuum of −87 kPa.

Extending roller life effectively

M. P. Sa-Onoy. *Sugarland*, 1983, **20**, (3), 15-16.

Details are given of the "morse code" method of rebuilding the worn surfaces of cane mill rollers using a Stoody 21 hardfacing electrode. It is so called since the graphite coating is applied in the form of intermittent dots and dashes. Since the treatment can be carried out while the mill is in operation, there is no time loss involved. The beneficial effects of treatment at a sugar factory are reported.

Application of membrane separation to cane juice clarification and concentration

H. T. Cheng and J. F. Tong. *Rpt. Taiwan Sugar Research Inst.*, 1983, (101), 15-31 *(Chinese)*.

Experiments were conducted on ultrafiltration and reverse osmosis of clarified juice. Three membranes were tested: Romicon LTCX XM300, Romicon LTCX XM100 and DDS GR61P, having cut-off values of 300,000, 100,000 and 20,000, respectively. In treatment of juice that had been clarified by simple defecation, the membranes removed 57, 60 and 67% of the initial colour in the order as given above. Application of GR61P membrane to sulphitation juice removed 66% of the colour at a flux which was approx. double that with the other two membranes. The sugar manufactured from this juice was comparable to plantation white sugar from the conventional carbonatation process. Subjection of juice of approx. 15°Bx to concentration by reverse osmosis using a cellulose acetate membrane resulted in a sharp fall in flux once the permeate concentration had reached 20°Bx. While both processes are technologically interesting, they are considered economically unattractive at present.

A trial on concentration of syrup by falling-film evaporation

C. H. Chen and R. Y. Chang. *Rpt. Taiwan Sugar Research Inst.*, 1983, (101), 33-38 *(Chinese)*.

Details are given of a pilot plant-scale falling-film evaporator of 4.5 m^2 heating surface developed for experiments in the 1982/83 campaign, and trial data are tabulated. In 16 runs out of 24, the Brix of the syrup was raised from approx. 50-60° to >90° at a retention time of only 1 minute. Brix of the discharged syrup was easily controlled and fairly stable. The overall heat transfer coefficient rose with syrup flow rate. The evaporator was simple to operate.

An overview of computer applications in the sugar industry

E. M. Hine. *Sugar y Azúcar*, 1984, **79**, (2), 24, 28-30, 62.

The value of computers for systems control and calculation of e.g. materials balances within the sugar industry is discussed. Contrast is made between manual, pneumatic and computerized measurement of the filling rate of a syrup tank as an example, and the laborious and very time-consuming task of solving equations involving five unknowns by a trial-and-error method to calculate a pan station solids balance is compared with the 10 minutes needed for a computer to perform 48,000 iterations to produce a balance. Advice is given on gradual introduction of requisite computer hard- and software for data handling and control purposes.

Material balance of a milling station

T. Soemohandojo. *Majalah Gula Indonesia*, 1983, **9**, 887-894; through *S.I.A.*, 1984, **46**, Abs. 84-292.

On the basis of a series of simple equations relating the weights and volumes of cane, bagasse and juice, a method is developed for calculating the material balance for each mill of a tandem; reabsorption factor is taken into account. As an example of its use, calculations are shown in detail for the 1st and 2nd mills of a tandem, using factory data for throughput and for Brix and pol of incoming and outgoing streams. Application of the data to evaluation of mill performance is shown.

Extraction

D. J. L. Hulett. *Saccharum STAB* (Brazil), 1980, **3**, (11), 44-46; through *S.I.A.*, 1984, **46**, Abs. 84-294.

Brix-fibre-water calculations show that, with pressing to 50% moisture and 25% imbibition on cane, three pressings theoretically give 97.5% extraction if residual juice in bagasse is perfectly diluted by imbibition water. Since perfect dilution does not occur, and bagasse often contains more than 50% moisture, São Paulo factories achieve only about 90% extraction using 4-6 mills. The "moisture" situation can be improved by better cane preparation, higher hydraulic pressure, slower roller speed, force-feeding and using rollers with rough surfaces grooved for drainage. Dilution can be optimized by continuous uniform application, as hot as practicable, in a compound system, i.e.

only bagasse entering the last mill receives water. Other important factors are the mechanical condition and protection of rollers and conveyors, regular stoppages for maintenance, adequate pressure monitoring, bagasse analysis and cleaning.

Balance between production and steam consumption

–. Mashudi. *Majalah Gula Indonesia,* 1983, **9**, 871-876; through *S.I.A.*, 1984, **46**, Abs. 84-305.

A mass flow diagram of the steam system of a cane factory is shown. The objectives to be achieved by optimizing the system are stated. Common defects in operating practices are described, with advice on improvements which would contribute to optimization of the system; particular attention is paid to utilization of exhaust steam and of condensates.

Discharge of effluent gas

A. Sakdowoh. *Majalah Gula Indonesia,* 1983, **9**, 850-852; through *S.I.A.*, 1984, **46**, Abs. 84-309.

Advantages of flue gas discharge by natural draft or by forced draft are compared, with reference to the bagasse-fired boilers at Tasikmadu factory, and information about the forced-draft fans is given.

Control of micro-organisms in mills

D. Morgan. *Australian Sugar J.*, 1984, **75**, 515-516.

A representative of Buckman Laboratories describes the various Buckman products available for use in the sugar factory, including Busperse 49 anti-scale agent and pan boiling aid, Busan 881 bactericide, Busan 30 fungicide, Busperse 47 (which acts as a penetrant in NaOH solutions used for evaporator boiling-out) and Busperse 59 for use in keeping bagasse furnace nozzles free from soot when fuel oil is used (because of bagasse shortages) and in maintaining fuel tanks and strainer discs in fuel lines free from gum and sludge; mention is also made of Buckman flocculants for fresh and waste water treatment.

Pollution at sugar factories and alcohol distilleries

A. V. Viotti. *Saccharum STAB* (Brazil), 1981, **4**, (12), 26-30; through *S.I.A.*, 1984, **46**, Abs. 84-465.

Effluents can be dangerous to fish owing to their pH, BOD, suspended solids and high temperature. Guidelines for effluent treatment are given. Physico-chemical parameters (BOD, temperature, suspended solids, volume/tonne of cane) are shown, and processes and plant for restricting the pollution arising are described for: vinasse; cane wash water; water from barometric columns; ammoniacal condensates; and water from washing of floors and plant.

The effects of trash on evaluating the milling quality of sugar cane varieties

B. L. Legendre. *J. Amer. Soc. Sugar Cane Tech.*, 1984, **3**, 40-42.

A study to compare the milling quality of four varieties (in terms of normal juice extraction, fibre content and varietal correction factor) showed that trash milled together with the cane had an adverse effect by comparison with one of the varieties, CP 65-357, milled without leaf trash, i.e. that still attached to the stalks after removal of the tops about 10 cm above the stalk apex. It is concluded that the absolute milling quality of a variety cannot be evaluated unless account is taken of the effects of trash.

The effect of furnace cleaning on gas consumption in Louisiana sugar factories

W. Keenliside. *J. Amer. Soc. Sugar Cane Tech.*, 1984, **3**, 61-65.

A survey of furnace performances was carried out in nine sugar factories in 1981, covering a total of 36 units, 25 of which were of the horseshoe type and the rest having spreader stoker systems. The absence of air heaters had a noticeable effect on efficiency, reducing it by 7% in the case of the horseshoe furnaces and by 4% with the spreader stoker furnaces (in which most of the bagasse is burnt in suspension, so that combustion is less influenced). All the factories investigated required the use of natural gas as supplementary fuel to produce the requisite amount of steam. A correlation was found between furnace temperature and cleaning method; the temperatures in horseshoe furnaces cleaned manually were significantly lower than those in the same type of furnace cleaned by a a semi-automatic method. The effect of variation in furnace temperature on steam production and combustion efficiency is discussed.

Molasses exhaustion – 1981

R. S. Patterson and P. H. Petri. *J. Amer. Soc. Sugar Cane Tech.*, 1984, **3**, 66-73.

Results of a survey of molasses exhaustion at 22 Louisiana sugar factories (as well as the Texas sugar factory and some factories in Florida) are reported and comparison made with results obtained in 1980[1]. The data are tabulated for two periods (October 26 – November 1 and November 30 – December 6). Despite lower reducing sugars: ash ratios, the molasses from the Texas and Florida factories tended to have true purities closer to target purities than the Louisiana molasses, although both apparent and true purities were inclined to be higher than with the Louisiana molasses in the first period and were about the same in the second period. Photomicrographs of molasses samples from Louisiana revealed a marked number of crystals, some of them large enough to suggest that they had passed through a tear in the centrifugal screen or through a gap in a poorly fitted screen. Small crystals passed through the centrifugal screen apertures, while in some cases the molasses purity would seem to have been sufficiently high for further crystallization to have occurred on standing. Analysis for glucose, fructose and sucrose by HPLC showed 50-100% more fructose than glucose in all cases; possible reasons for this are suggested. Detailed analyses showed that the pattern of K, Ca, Na and Mg contents was about the same as in 1980.

1 Matic & Wong: *I.S.J.*, 1984, **86**, 116.

Beet sugar manufacture

Operational experiences and description of five anaerobic reaction vessels. The Anamet process

L. Huss. *Zuckerind.*, 1984, **109**, 133-136, 143-147 *(German).*

Further details are given of the performance and layout of the Anamet anaerobic-aerobic plants at Euskirchen and Jordberga sugar factories[1]. It is stated that the use of stirred reaction vessels permits treatment of calcium-rich effluents; the precipitated $CaCO_3$ can be maintained in a mixture with the activated organic sludge. Mud withdrawn from the material recycled to the anaerobic tank from the segmented aerobic tank is kept in equilibrium with the mud produced in the anaerobic tank; since both muds have the same ratio of inorganic to organic dry solids, there is no lime accumulation.

Operational experiences and description of five anaerobic reaction vessels. The Philipp Müller system of treatment by mud contact

P. Kanow and L. Kirchheim. *Zuckerind.*, 1984, **109**, 136-138, 143-147 *(German).*

The title process is outlined, and experimental results obtained at Offstein are briefly indicated. Thorough mixing of the contents in the reaction vessel is brought about by gently recirculating some of the gas formed; this ensures the absence of deposition and permits treatment of effluent containing organic solids. Fermentation and phase separation are carried out in two quite separate units. At a BOD load of approx. 10 kg/m^3 per day, degradation of 90-95% was achieved with a gas yield of about 0.4 m^3/kg BOD degraded.

Operational experiences and description of five anaerobic reaction vessels. The BIMA process

R. Manahl. *Zuckerind.*, 1984, **109**, 142-147 *(German).*

The BIMA reaction vessel comprises three separate sections connected for water and gas flow: a central tube used for substrate prehydrolysis, the area around the tube which acts as the main fermentation compartment, and a conical-based section at the top of the vessel into which the top of the central tube protrudes – this acts as an after-fermentation compartment and has a central tube section which descends over the top section of the lower central tube but is slightly wider than it. The gas formed in the main fermentation section is used to circulate and mix the vessel contents. Advantages of the vessel are listed, and details are given of trials conducted at Schladen sugar factory. Results for a 50-m^3 vessel in the 1982/83 campaign showed a maximum degradation of 90% at a feed concentration of 14,500 mg BOD/litre and a maximum daily load of 4 kg BOD/m^3.

Assessment of the technico-economic results obtained at Ropczyce sugar factory in the 1981 and 1982 campaigns

M. Rogowska. *Gaz. Cukr.*, 1983, **91**, 176-177 *(Polish).*

Some performance data for the 1981/82 and 1982/83 campaigns at Ropczyce sugar factory (the largest and newest in Poland, having a daily slice of 6000 tonnes of beet) are discussed.

Some technological problems in juice purification and sugar crystallization

E. Walerianczyk. *Gaz. Cukr.*, 1983, **91**, 169-170 *(Polish).*

The adverse effect on colloid removal of inadequate control of preliming temperature, pH and time is discussed, and the need to consider the liming conditions, particularly the amount of lime added, within the context of the individual factory (e.g. according to beet juice quality and diffusion performance) is emphasized. The differences between the amounts of invert degraded in a given time at different factories, all adding the same quantity of lime and employing the same preliming temperature, are demonstrated as an example of the need to adjust to given sets of conditions. The benefits of flocculants in juice settling are indicated; with regard to supplementary alkalizing of intermediate products, it is stressed that any additive will be of an intervening nature and contribute to a reduction in sugar output. Brief mention is made of inadequate low-grade massecuite processing at some factories, with insufficient molasses exhaustion, of excessive pulp and molasses losses, and of differences between sugar colour contents at different factories.

Possibilities of improving the preliming process in trough-type vessels

E. Walerianczyk and I. Oglaza. *Gaz. Cukr.*, 1983, **91**, 187-189 *(Polish).*

Problems experienced at some Polish sugar factories in the operation of preliming vessels are indicated, and requirements of a suitable design of prelimer are discussed. Trials on a horizontal vessel divided into seven compartments of differing length are reported. The pH of the juice was progressively raised from 8.0-8.4 at the feed end to 9.2-9.6 in the third compartment and to 11.0-11.3 on discharge. Residence time was 20-25 minutes, and the temperature was >50°C; the mixing system rotated at 18-20 rpm.

Selection of new surfactants for the requirements of the sugar industry

H. Gruszecka. *Gaz. Cukr.*, 1983, **91**, 190 *(Polish).*

Mention is made of tests conducted on non-commercial and commercial anti-foam agents of various types with the aim of finding a suitable product of Polish manufacture. The mechanism of foam formation is discussed, including the effect of pressure in bubbles and of surface tension, and experiments to determine the foaming potential of sugar factory intermediate products on the basis of their surface tension are reported. The surface tension of a number of model solutions of various sugars, amino-acids, anti-foam agents, albumin, dextran and detergent was also determined, with 0.1N NaCl solution

1 See also Huss & Reinholdtzon: *I.S.J.*, 1983, 85, 243.

of known surface tension used as standard. Results of the measurements carried out weekly on intermediate products at Michalow factory in 1982/83 showed a gradual fall in surface tension for most solutions as the campaign progressed.

New domestic chemicals for beet disinfection

K. Mossakowska. *Gaz. Cukr.*, 1983, **91**, 190-191 *(Polish)*.

Trials conducted on three disinfectants added to flume water showed that two of them, chloramine B and CF-VI (based on a chlorophosphate), were affected by increase in pH, the former becoming completely ineffective at pH 10.8. Spraying of 4 ppm of CF-VI onto the beets before the slicer reduced the bacterial count in cossettes by about 30% within 10 minutes, while 8 ppm had the same effect when applied in diffusion, compared with a 48% and 74% increase in the counts in cossettes and raw juice when no disinfectant was used. The third disinfectant, 2-IC (based on isocyanuric acid) was comparable to the other two in performance when used to treat water of higher initial bacterial counts than that treated by the other disinfectants.

Trials and investigations of a prototype sugar dryer at Swidnica sugar factory during the 1982/83 campaign

J. Dulny and H. Waclawski. *Gaz. Cukr.*, 1983, **91**, 191-192 *(Polish)*.

Details are given of a Polish-built granulator of 15-20 tonnes/hr rated throughput which in tests confirmed the designed moisture content reduction to 0.03%. Advantages of the dryer are indicated, and its parameters are compared with those of a Dunford & Elliott granulator.

Tests to determine the effect of CM chlorophore on the quality of sugar factory waters

B. Zalicka. *Gaz. Cukr.*, 1983, **91**, 192 *(Polish)*.

Chloromelamine added to flume water at 1 ppm (increased to 2-3 ppm towards the end of the campaign) reduced the bacterial counts. Laboratory tests on waste water treatment with the disinfectant at 5 mg/dm^3 showed a 95% reduction in COD and a 98% reduction in BOD_5 (from initial COD values of 2860 and 2620 mg/dm^3 and initial BOD_5 values of 1460 and 1980 mg/dm^3).

Fields of thermo-physical parameters of boiling massecuites

V. R. Kulinchenko and A. A. Andryukhin. *Izv. Vuzov, Pishch. Tekh.*, 1983, (6), 88-92 *(Russian)*.

The temperature profile in boiling massecuite is discussed on the basis of earlier investigations, with results plotted for a range of crystal contents at a given pressure and heat flux. It is re-stated that the film of superheated massecuite in the immediate vicinity of the heating surface, where the effective thermal pressure is greatest, will expand with increase in the crystal content, while thermal resistance to the rising massecuite will remain relatively high; as a result, all the heat will be transferred from the heating surface by molecular means, leading to the formation of steam bubbles. A mathematical function is presented to define the effect of mass transfer on heat transfer, from which change in the thermo-physical parameters accompanying change in temperature with height is hypothesized. Experimental data are examined in regard to the theories of boiling, and the possibility of intensifying the crystallization process and improving the quality of the resultant sugar by increasing circulation, e.g. by injecting steam into each heating tube, is suggested. Another method suggested is crystallization in a thin film of massecuite undergoing gravity flow.

The use of diffused reflected light for control of crystal formation

B. A. Miroshnik and V. G. Tregub. *Izv. Vuzov, Pishch. Tekh.*, 1983, (6), 92-96 *(Russian)*.

The suggested use of the relationship between increase in the brightness of reflected light on the one hand and increase in the crystal mass and reduction in the size of the crystal particles on the other as a means of controlling nucleation is discussed, and mathematical analysis of experimental data explained. The range of conditions under which such a system could be applied is defined. On the basis of the laboratory experiments, a system was developed on the principle of a turbidity meter, in which the bridge circuit incorporated two photo-resistors. The effect of crystal formation on reflected light was investigated using the device with and without light filters absorbing light at 600-630 nm. Application to nucleation control resulted in improvement in the crystal structure of the massecuite and 1% increased crystal yield.

Optimization of preliming

L. P. Reva, V. E. Yakovenko, V. M. Logvin and G. A. Simakhina. *Izv. Vuzov, Pishch. Tekh.*, 1983, (6), 96-100 *(Russian)*.

Data from the literature and from experiments conducted by the authors on the kinetics of albumin coagulation and reducing matter degradation in preliming were subjected to mathematical analysis. Non-linear programming using a computer provided simple approximation formulae for calculation of optimal values of temperature, alkalinity and juice residence time as the major controlling factors.

Molasses desugaring by the Quentin process

M. Asadi and P. Kadlec. *Listy Cukr.*, 1984, **100**, 35-41 *(Czech)*.

The theory of the Quentin process is explained with some references to the literature. Details are given of laboratory trials conducted on *B*-molasses using Wofatit KS 10 ion exchange resin. Results confirmed the possibility of recovering 0.3-0.4% sugar on beet under optimum conditions. Regeneration with 8% $MgCl_2$ at a 1:1 regenerant:resin ratio gave best

results in terms of Na and K exchange and was better than use of 8% $MgSO_4$. The molasses should be of 60-70% solids concentration and treated at a molasses: resin volume ratio of 2-2.5:1.

Use of milk-of-lime with calcium chloride added for preservation of stored sugar beet

J. Zahradnicek. *Listy Cukr.*, 1984, **100**, 41-43 *(Czech).*

Tests are reported in which daily pol losses in beet stored for 61 days were reduced by an average of 19.3% by treatment with 6°Bé milk-of-lime. The losses were reduced still further, by a total of 31.1%, when 3% (w/v) $CaCl_2$ was added to the milk-of-lime and the solution sprayed at 8-10 litres per tonne of beet under a pressure of 0.3-0.5 MPa. The respiration rate was reduced by one-third as a result of the treatment.

Molasses decomposition during storage

M. Friml and A. Livers. *Listy Cukr.*, 1984, **100**, 43-44 *(Czech).*

Spontaneous degradation of stored molasses and its chief causes are discussed, and means of preventing it indicated.

Effectiveness of thick juice treatment by carbonatation

M. I. Daishev, T. P. Trifonova, L. G. Skuina and L. M. Bochko. *Sakhar. Prom.*, 1984, (3), 24-25 *(Russian).*

Since non-sugars adsorption on $CaCO_3$ follows a geometric progression, so that there is a level of lime addition beyond which the purification efficiency rises only very slightly with further liming, it is considered more sensible to defer liming beyond the critical point until a later stage in the overall process. However, the extra quantity of lime should not be added to the normal amount introduced before 2nd carbonatation in the system developed in the USSR in 1979 unless it is to correct any imbalance created by 1st carbonatation juice recycling to main liming. On the other hand, the surplus lime could be suitably added to evaporator thick juice, as carried out experimentally some years ago at Novokuban sugar factory in the combined treatment of thick juice and remelt liquor at a time of high juice colour (resulting from poor beet quality); the treatment considerably reduced juice and sugar colour as well as lime salts while raising purity.

Method for manufacturing an edible sugar syrup

L. S. Danchuk, N. A. Arkhipovich and N. I. Shtangeeva. *Sakhar. Prom.*, 1984, (3), 26-27 *(Russian).*

Details are given of a process for manufacture of an edible syrup from unfiltered 2nd carbonatation juice which is boiled and filtered to reduce the Ca^{++} content and prevent formation of $CaCO_3$ sediment during storage. The juice is treated with active carbon, filtered and passed through a cation exchange system, after which its pH is 4.5, at which there is minimal monosaccharide degradation and generally no amide decomposition. At this stage, the syrup has a purity of 92.4, a reducing matter content of 10.24% and a colour of 3.62°St. It is finally concentrated to 68-70% solids, further treated with active carbon and filtered. Experimental investigations of the KU-2-8 cation exchange resin used for calcium adsorption are described. The overall reduction in lime salts content brought about by treatment of the syrup is 92%.

Device for treatment of sugar beet with chemical preparations

V. E. Ryzhikov. *Sakhar. Prom.*, 1984, (3), 32-33 *(Russian).*

Details are given of a system for spraying piled beet with the sodium salt of maleic hydrazide as a means of preventing sprouting and hence reducing sugar losses.

Measurement of pressure loss on screens of a (diffusion) tower

A. F. Makhlai. *Sakhar. Prom.*, 1984, (3), 33-34 *(Russian).*

A differential manometer system for checking pressure loss across the screens of a tower diffuser and thus monitoring the cleanliness of the screens, i.e. their freedom from blockage, is described.

Preparation of feed water for a diffuser

K. N. Savchuk. *Sakhar. Prom.*, 1984, (3), 34-40 *(Russian).*

A scheme is described in which diffuser feed water is heated by condensate in a direct-contact heater and then treated with SO_2 to pH 6.7-6.8 in water-jet ejectors. Introduced at a number of factories, the system has reduced steam and power consumption; the financial savings, based on trials, are indicated.

Use of pan vapour to heat raw juice

Yu. S. Razladin, V. P. Shchutskii, V. A. Selitbovskii, V. N. Gorokh, B. F. Us and K. O. Shtangeev. *Sakhar. Prom.*, 1984, (3), 41-44 *(Russian).*

Details are given of a prototype heater which uses pan vapour to raise the temperature of raw juice by 5-18°C depending on its initial temperature.

A contribution to the chemistry of pulp pressing aids

M. Shore, J. A. Adams, N. W. Broughton, N. Bumstead and G. C. Jones. *Zuckerind.*, 1984, **109**, 215-221 *(German).*

See *I.S.J.*, 1983, **85**, 377.

A graph method for calculation of a boiling house scheme. I. General solution principles

V. Valter, F. Gerza and J. Gebler. *Listy Cukr.*, 1984, **100**, 49-55 *(Czech).*

The fundamentals of the vector diagram method devised by Hattink[1,2] for calculation of boiling schemes are explained, and the stages to follow in construction of the diagrams are described with the aid of 12 worked examples.

1 *Proc. 10th Congr. Alg. Syndicaat van Suikerfabrikanten in Ned. Indië*, 1928, 127.
2 van der Poel *et al.: Sugar Tech. Rev.*, 1982, **9**, 38-40.

The RT drum diffuser for beet sugar extraction

R. Hulpiau and R. Pieck. *Listy Cukr.*, 1984, **100**, 55-58 *(Czech).*

The design, operation and performance of the RT4 and RT5 rotary diffusers are described. (See also Withers & Pollard: *I.S.J.*, 1982, **84**, 195-200.)

Quality changes in sugar beets during frozen storage

J. Ivory, J. T. Ryan, M. LeMaguer and L. F. McGann. *Can. Inst. Food Sci. Technol. J.*, 1983, **16**, (4), 259-269; through *S.I.A.*, 1984, **46**, Abs. 84-331.

The effects of different freezing and thawing conditions on beet texture were measured. Each set of conditions resulted in a marked softening of beet tissue. The compressive stress at −10% strain was reduced from 65-85 N/cm^2 for raw beets to 2-10 N/cm^2 for beets which had been frozen and subsequently thawed. Beet samples were frozen at rates between 0.004 and 50°C/min prior to being stored at −10°C or −25°C. For every freezing method and storage temperature examined, frozen storage produced a negligible change in sugar content after 6 months' storage. Beets which were frozen, thawed and quickly refrozen also showed no loss of sucrose.

Contribution to the application of electroplasmolysis in the sugar industry

D. Culache and B. Mironescu. *Buletinul Univ. Galati, Fascicula VI*, 1982, **5**, 15-22; through *S.I.A.*, 1984, **46**, Abs. 84-334.

Tests of electroplasmolysis of beet cossettes showed that this process could be used instad of scalding before diffusion. Application of 160 or 200 V resulted in rapid plasmolysis (in 2.5 min), and would enable extraction of sugar with water at temperatures below 50°C; it also sterilized the extraction mixture. Juice extracted from electroplasmolysed cossettes was purer than that from cossettes plasmolysed by heat. The colloid content was lower, while the ash content was initially higher, but after 20-30 min was lower.

Production and testing of a flocculant for first carbonatation juice on the basis of starch derivatives

V. Mironescu. *Buletinul Univ. Galati, Fascicula VI*, 1982, **5**, 47-54; through *S.I.A.*, 1984, **46**, Abs. 84-344.

A starch phosphate for use as a flocculant was prepared by reacting maize starch with sodium tripolyphosphate in the ratio 1:1, 1:10 or 1:20, for 20-60 min at 120-140°C and pH 8-10. A mathematical model was constructed to find the optimum values of these parameters for the reaction. Tests on physical properties showed that, to obtain a good flocculant, the structure of the starch phosphate should be similar to that of native starch.

Separation of colloids from diffusion juice by electrofiltration

V. Mironescu. *Buletinul Univ. Galati, Fascicula VI*, 1982, **5**, 55-58; through *S.I.A.*, 1984, **46**, Abs. 84-348.

Tests on electrofiltration at a field strength of 40, 47 or 54 V/cm showed that the % removal of pectins was greater than that of proteins or polysaccharides. The % removal increased with field strength and decreased with increasing flow rate. Addition of bentonite led to poorer removal at 40 V/cm, but better removal at 47 or 54 V/cm.

Decolorization of sugar solutions and removal of by-products of technological treatment of sugar solutions

J. Jary, M. Marek, J. Bacilek and F. Svec. *Sb. Vys. Sk. Chem. Technol. Praze, Potraviny*, 1983, (E55) 43-48; through *S.I.A.*, 1984, **46**, Abs. 84-352.

The removal of HMF from invert sugar solutions and intermediates of sugar manufacture was studied. Batch and continuous tests were carried out using glycidylmethacrylate adsorbents modified with ammonia or ethylenediamine; results are tabulated.

Reducing the formalin consumption in Turkish sugar factories

T. Ulku. *Seker*, 1984, **30**, (114), 29-32 *(Turkish).*

While many sugar factories in Turkey maintain the formalin consumption in beet diffusion at 0.007% on beet, there are factories where more than 0.020% is consumed. Reasons for this are examined, starting with a survey of sources of infection (including the beets themselves, soil flume-wash water and press water) and indicating the pH and temperature requirements in cossette scalding and diffusion whereby infection may be minimized and the amount of formalin needed to inhibit bacterial activity over a given period of time kept at an optimum level. Formalin dosing equipment and rapid determination of the level of infection are discussed.

Start-up of methane fermentation. Comparative study of two techniques on an industrial scale

J. P. Lescure and B. Delannoy. *Sucr. Franç.*, 1984, **125**, 141-147 *(French).*

The first industrial-scale anaerobic plant for effluent treatment to be installed in France was set up at Thumeries sugar factory with the aim of conducting research on this type of treatment. Comparison is made between equipment and operations at Thumeries and at Genappe in Belgium[1]. Graphs are given of results achieved with the one digestion vessel at Thumeries and with the two digesters at Genappe (that at the former factory being designed to treat 16 tonnes of COD/day at a maximum rate of 120 m^3/hr). While the amount treated at Thumeries was, at 8 kg COD/m^3, almost double that at the other factory, there was also a noticeable leakage of insoluble COD (not monitored at Genappe). An aerobic nitrification plant to follow the anaerobic stage at Thumeries is still only at the pilot-plant stage.

1 Bausier: *I.S.J.*, 1983, **85**, 26.

Laboratory studies

The kinetics of sugar solution carbonatation

D. V. Ozerov and A. R. Sapronov. *Sakhar. Prom.*, 1984, (3), 27-30 *(Russian).*

The adsorption of impurities by calcium sucrocarbonates formed by saturation with CO_2 was investigated in the case of two raw juice samples to which, after preliming and mud removal, was added sucrose to adjust the Brix to 21° and 31°; both juices were then treated with varying quantities of lime in the range 0.56-2.60% CaO and gassed to pH 11 at 85°C. Samples were taken during carbonatation, filtered and the lime content determined. Results showed that, with rise in Brix, there was also increase in the amount of lime requiring saturation to provide a maximum quantity of stable calcium sucrocarbonate. Equilibrium between the components of the sucrocarbonate-colloidal $CaCO_3$ system was characterized by the presence in the sucrocarbonates of CO_3^{--} and HCO_3^- anions (forming carbonic acid) which were bound to the Ca^{++} and $CaOH^+$ cations in the calcium hydroxide. Gelling of the sucrocarbonates was associated with their high adsorptive capacity, but there was a simultaneous sharp fall in juice filtrability. Despite their relative stability with time, at maximum formation the sucrocarbonates were found to be unstable compounds, so that addition of lime at this point caused partial destruction of the gel-like structure with liberation of sucrose and colloidal $CaCO_3$. The sharp fall in lime content with gassing to pH 11 was a result of adsorption on colloidal carbonate simultaneous with change of the carbonate from a colloidal to a crystalline structure; the rate of impurities adsorption at this stage was lower than in the initial stage, when the sucrocarbonate gel played the dominant role.

Analysis of the trace element composition of white sugar

S. V. Grigorov, V. I. Tuzhilkin and A. P. Shcherenko. *Sakhar. Prom.*, 1984, (3), 44-45 *(Russian).*

Results are given of measurements of the Mn, Cu, Fe, Zn, Co, Ni, Cd, Mg and Ca contents (using atomic absorption spectrophotometry) of white sugar produced by the conventional method, of *C*-strike sugar and of white sugar obtained by boiling *A*-massecuite on a *C*-sugar footing. The tabulated data also cover purity, Brix, ash and colour contents. It is shown that the contents of the various elements in the white sugar boiled on *C*-sugar footing were all greater than the values for normal white sugar, by an average of 33.3%, while the ash content still conformed to official standards. Purity was also slightly lower.

Investigation of the surface tension of pure aqueous glucose solutions

G. A. Kimenov, A. I. Kostov and G. I. Popov. *Sakhar. Prom.*, 1984, (3), 50-51 *(Russian).*

Measurements were made of the surface tension of 80 purity aqueous glucose solutions at temperatures in the range 20-80°C and 20, 40 and 60% solids concentration. Results are graphed and equations derived from statistical analysis.

Separation of mono- and di-saccharides by high-performance liquid chromatography with a strong cation-exchange resin and an acetonitrile-rich eluent

T. Kawamoto and E. Okada. *J. Chromatogr.*, 1983, **258**, 284-288; through *Anal. Abs.*, 1984, **46**, Abs. 3C9.

Mixtures of sugars were analysed on a stainless-steel column (25 cm x 4 mm) packed with 10% cross-linked sulphonated HC095AA PS-DVB resin (9 ± 0.5 μm); elution was carried out with aqueous 80% acetonitrile at 0.8 ml/min, and detection was by refractometry. Resolution could be improved by changing the acetonitrile content of the mobile phase, viz. elution with 75% acetonitrile at 0.6 ml/min permitted separation of sucrose, maltose, lactose and raffinose in approx. 20 min. Use of flow rates up to 1 ml/min caused no loss of column efficiency.

Studies on the browning of technical sugar juices with particular reference to phenolic components

E. Reinefeld, K. M. Bliesener, V. Borrass and U. Poltrock. *Zuckerind.*, 1984, **109**, 222-230 *(German).*

See *I.S.J.*, 1984, **86**, 58.

Correlations between the growth kinetics of sucrose crystals and other crystals

V. Maurandi. *Zuckerind.*, 1984, **109**, 233-238.

After a brief account of current crystallization theories, comparison is made between the crystallization kinetics of sucrose in pure and impure solution and of lithium formate monohydrate and monodeuterate, calcium sulphate dihydrate (gypsum) and magnesium sulphate heptahydrate. The data show a marked influence of the surface structure of the various crystals, particularly gypsum, on the growth kinetics. No parabolic growth curve has been found for sucrose at 0°C nor for $MgSO_4$ at somewhat higher temperatures. The surface reaction appears generally to have a greater effect than mass transport at $\leqslant 50$°C. In the case of sucrose, increase in temperature causes an increase in mass transport; impurities show a similar effect, with the possible exception of raffinose. The activation energies of the surface reaction for magnesium sulphate and sucrose are of the same order, while calculations based on the BCF theory give lower values for the two formates.

High-performance liquid chromatographic separation of oligosaccharides using amine-modified silica columns

Z. L. Nikolov, J. B. Jakovljevic and Z. M. Boskov. *Starch/Stärke*, 1984, **36**, 97-100.

The successful application of HPLC using an amine-modified silica column for the separation of disaccharides in HFS and glucose syrups as well as other products

is described. The relative retention times and resolution values of seven disaccharides, including sucrose, separated by a Zorbax-NH_2 column are tabulated, and some chromatograms reproduced.

Topography of the chemical compositon of the sugar beet root. VIII. Spatial distribution of free amino-acids in irrigated and unirrigated beet – Domona variety

J. Zahradnicek, V. Svachula, P. Vratny and J. Zvanovcova. *Listy Cukr.*, 1984, **100**, 58-62 *(Czech)*.

Liquid chromatography was used to determine the contents of 19 free amino-acids in 16 morphologically and anatomically different sections of irrigated and unirrigated beets of Domona variety. The results are discussed.

Reactions for (detection of) reducing sugars without using silver nitrate

N. V. Egorov and I. A. Suslov. *Sovrem. Metody Khim.-anal. Kontr. v Mashinostroenii* (USSR), 1981, 136-137; through *S.I.A.*, 1984, **46**, Abs. 84-427.

Reagents and procedures are given for (1) detecting reducing sugars in the presence of sucrose and/or ascorbic acid, and (2) testing for ascorbic acid and, in its absence, revealing the presence of reducing sugars and/or sucrose. The first reagent comprises a special indicator ETOO, probably Eriochrome Black T, mixed with 100 or 200 parts NaCl and used with excess KOH; glucose, galactose or lactose will change its colour from red to yellow at 60-70°C, while ascorbic acid requires 1-2 min at 100°C and sucrose does not react. The second reagent comprises 8 drops of 10% KOH + 2 drops of 10% $CuSO_4$, to be mixed with 4 drops of sample. Ascorbic acid (0.1 mg or more) gives a yellow precipitate; in its absence, reducing sugar (1 mg) gives a dark blue colour, turning greenish at 40-50°C and giving a red CuO precipitate at 60-70°C (or 70-80°C with sucrose); sucrose alone gives a brown colour at 70-80°C.

Monitoring of carbohydrates with periodate in effluents from high-pressure liquid chromatography columns

P. Nordin. *Anal. Biochem.*, 1983, **131**, (2), 492-498; through *S.I.A.*, 1984, **46**, Abs. 84-428.

The use of periodate to detect carbohydrates in effluents from borate anion-exchange columns is described. The effects of temperature (40, 60, 80 or 100°C) and pH (5.0 or 8.6) on sensitivity were investigated. Alkaline conditions increase the sensitivity for some carbohydrates, including sucrose, owing to over-oxidation. Temperatures up to 100°C may be employed to detect less reactive sugars such as cyclitols. Peaks are detected by a decrease in absorbance at 260 nm with a HPLC detector. The reagent permits detection of a wide variety of carbohydrates: aldoses, ketoses, alditols, cyclitols and oligosaccharides, with sensitivities of less than 1 nmol.

Determination of lower organic acids in sugar factory intermediates

J. Copikova and B. Synacek. *Sb. Vys. Sk. Chem. Technol. Praze, Potraviny*, 1983, (E55), 29-42; through *S.I.A.*, 1984, **46**, Abs. 84-440.

A GLC method for the determination of lower organic acids in beet molasses and raw juice is described. The acids were isolated by passing the sample through two columns in series, containing a cation- and an anion-exchange resin. The acids were eluted from the anion-exchange column in the form of ammonium salts. After treatment, the eluate was evaporated and subjected to silylation. The silyl esters of the organic acids were separated on a GLC column packed with 3% OV-1 on Chromaton N-AV-HMDS. Retention times of 13 acids are given, and the contents of 7 acids (lactic, glycollic, oxalic, malonic, glutaric, aconitic and citric) found in 3 samples of molasses and 2 of raw juice are tabulated.

Chemical composition of the different types of vinasse from the Alagoas alcohol distilleries – season 1978/79

J. N. de Vasconcelos and C. G. de Oliveira. *Saccharum STAB* (Brazil), 1981, **4**, (14), 32-36; through *S.I.A.*, 1984, **46**, Abs. 84-487.

Composite samples of vinasse (50 from molasses must, 20 from juice must and 20 from mixed must) were anlysed for C, N, P, K, Ca, Mg, S, Zn, Fe, Cu, Mn, pH and residual acidity. Maximum, minimum and average contents, and results of statistical analysis for types of must and individual factories, are tabulated, and equivalent contents of mineral fertilizers (kg/m^3 vinasse) are indicated. There was wide variation, but molasses must gave the richest vinasse with regard to most elements.

Betaine determination

R. Detavernier, J. P. Ducatillon, G. Deruy and A. Bouxin. *Sucr. Franç.*, 1984, **125**, 129-130 *(French)*.

The ICUMSA official method for betaine determination[1] is considered too complicated and not always sufficiently reproducible, so that a search was made by a simpler method based on HPLC. Trials were made of a method using a 30 x 0.64 cm column of Lichrosorb-NH_2 (5 μm) as stationary phase, and a 83:17 acetonitrile:water mixture as mobile phase; lactose was used as internal standard. Tests were conducted on molasses, both the reference standard and addition methods being used. Sample calculations are used for each method. Since it is shown that the limit of detection makes the addition method unsuitable for evaporator thick juice analysis, a pretreatment stage is considered advisable, in which product to be analysed is passed through a cation-exchange resin in H^+ form; the betaine, amino-acids and metals are fixed on the resin and can be desorbed by elution with ammonia, after which concentration under vacuum will give a fraction containing all the betaine but little else. HPLC tests using this pretreatment are to be carried out, and the method is expected to be relatively easy.

1 Godshall & Roberts: *I.S.J.*, 1982, **84**, 154.

By-products

Effect of press mud on the yield and quality of sugar cane

M. A. A. Sarkar, S. C. Saha, S. B. M. F. Rahman and J. Hoque. *Bangladesh J. Sugarcane*, 1983, **5**, 20-22.

In trials involving Co 1158 cane, four fertilization treatments were compared: (1) application of N + P_2O_5 + K_2O at 120 + 90 + 110 kg/ha in three stages: 1/3 N + total P + 1/3 K at planting time in trenches, 1/3 N + 1/3 K as top-dressing 160 days after planting, and 1/3 N + 1/3 K as top-dressing 190 days after planting; (2) 10 tonnes of filter-cake per hectare at planting; (3) a combination of (1) and (2); (4) treatment (1) plus 5 tonnes of filter-cake per ha at planting and 5 tonnes/ha at the tillering stage. Results showed that (4) gave the highest cane yield, while (3) gave the highest sugar yield and cane sugar content.

Determination of the different bacterial strains contaminating beet juice and fermented wort in the distillery

M. J. Boudarel and A. Ramirez. *Ind. Alim. Agric.*, 1984, **101**, 5-10 *(French)*.

Of five agars tested for their suitability in determining contaminating bacteria in beet juice before and after fermentation, none was sufficiently selective to provide a break-down of a highly heterogeneous population into anaerobic, aerobic, lactic acid bacteria and *Clostridium* spp. The plate count agar (PCA) method, as the least selective, was applied to quantitative determination of the total bacterial counts and of the major groups. Results showed a marked presence of lactic acid bacteria *(Streptococcus* spp., *Pediococcus* spp., *Leuconostoc* spp. and *Lactobacillus* spp.) in both beet juice (47% of the total contaminants) and fermented bacterial wort (68.5%). Fermentation generally caused only changes in proportions of the groups; the only qualitative difference between the beet juice and the wort lay in the rareness of the bacilli in the wort. The physical conditions of the medium were not sufficiently different to cause change in the composition of the bacterial population; the temperature of the wort (32°C) favoured development of the *Lactobacillus* spp. and *Leuconostoc* spp., while the other bacterial groups developed as well at 4°C as at 32°C. The lack of oxygen in the wort inhibited bacillus growth. Any inhibition of contaminant growth during fermentation is attributed less to the alcohol concentration and more to the yeast count (10^8-10^9 per ml).

Anaerobic digestion of high-sulphate cane juice stillage in a tower fermenter

I. J. Callander and J. P. Barford. *Biotechnology Letters*, 1983, **5**, (11), 755-760; through *S.I.A.*, 1984, **46**, Abs. 84-485.

The anaerobic digestion of vinasse from cane juice fermentation was carried out in a continuous tower fermenter with addition of a flocculant. Stable and efficient treatment was achieved at relatively high loading rates (over 5 kg COD/m^3/day), but the loading rate was limited by the high sulphate content of the vinasse, resulting from the use of H_2SO_4 to adjust the pH before ethanol fermentation. Continuous addition of soluble iron improved digester performance, but would not be commercially practical owing to excessive precipitation of FeS, which increased flocculant requirement.

Treatment and agroindustrial utilization of vinasse. II. A new focus

G. M. de A. Silva. *Saccharum STAB* (Brazil), 1981, **4**, (17), 32-34; through *S.I.A.*, 1984, **46**, Abs. 84-488.

Vinasse clarification and reuse within a factory/distillery is particularly appropriate where irrigation cannot directly dispose of all or part of the vinasse produced. Adequate clarification occurs in 1.5 hr with 2.2 kg lime/m^3 and without phosphate addition. The best use for the clarified vinasse is as make-up water for cane washing; the water from this stage typically goes to a lagoon for clarification and possibly oxidation before being used for irrigation. Having been suitably diluted, the vinasse is no longer particularly corrosive and does not cause foul odour. Quantities involved in three real cases are indicated.

A modified method of nitric acid pulping of bagasse

M. A. El-Taraboulsi, M. M. Nassar and E. A. Abd El-Rehim. *J. Chem. Technol. Biotechnol.*, 1983, **33A**, (8), 387-396; through *S.I.A.*, 1984, **46**, Abs. 84-516.

Bagasse was successfully pulped by a rapid and mild nitric acid process to produce different grades of pulp. Nitric chemi-mechanical pulp was produced in a high yield (91%) by pulping depithed bagasse with 4% HNO_3 for 30 min at 80°C, followed by alkali pulping with 2% NaOH at 95°C for 30 min. The pulp had satisfactory strength and high opacity. On increasing the strengths of HNO_3 and NaOH to 7% each, a nitric semi-chemical pulp was obtained in 65% yield. The pulp had superior strength and high opacity, and was easily bleached to 71% GE brightness by the chlorination – alkali-extraction – hypochlorite sequence. With 15% HNO_3 and 8% NaOH, nitric chemical bagasse pulp was produced. This was easily bleached to a high brightness of 82% GE with one-stage hypochlorite. The pulp had higher strength than kraft bagasse pulp. A satisfactory newsprint paper was produced on an experimental machine with a furnish comprising 80% bleached nitric semi-chemical bagasse pulp, 10% bleached softwood pulp and 10% clay.

Problems of pressed pulp preservation in a silo and its utilization by animals

A. Giardini. *Ind. Sacc. Ital.*, 1984, 77, 7-12 *(Italian)*.

The benefits of pressed beet pulp ensilage for use as animal fodder are discussed, with advice given on optimum treatment and results reported of feeding trials with mixtures of pulp and other ingredients including maize, soya flour, molasses and vinasse.

Patents

UNITED KINGDOM

Clarification of hydrolysed starch

Tate & Lyle Ltd., of London, England. **2,075,510.** May 5, 1981; November 18, 1981; November 9, 1983.

A hydrolysed starch syrup is clarified by forming in it, at pH 3.5-6.5 (4-5, 4.5-4.7), a primary floc produced between Al ions [5-100 (20-40) ppm on syrup weight], OH ions and (>50 ppm) phosphate ions (the Al:PO_4 ion ratio being >1:1), aerating the syrup (with agitation) [or aerating some (10-50%) of the clarified syrup and adding it to the floc-containing syrup], distributing through it (1-20 ppm of) an anionic organic polymeric flocculant [an anionic polyacrylamide (of MW 5-10 x 10^6) having a charge density of 20-75% by weight of acrylate units] to initiate formation of a secondary floc, allowing the latter to grow and to segregate by flotation, and separating the flocculated solids from the clarified syrup.

(Dextran) Preparation and purification process

Fisons Ltd., of London, England. **2,079,290.** June 9, 1981; January 20, 1982.

A purified polysaccharide-producing enzyme is prepared by fermenting (at 20°-30°C) an appropriate organism, e.g. *Leuconostoc mesenteroides*, in aqueous sucrose solution (at pH 6.0-7.0, controlled by addition of NaOH), the concentration of which is maintained at between 1 and 10 g/litre (5-10 g/litre) throughout all but the last part of the fermentation (by addition of sucrose), and where the dissolved oxygen content of the fermentation is controlled [at between 100 and 40% (80-40%); at a higher level at the beginning and allowed to fall to a lower level as fermentation progresses]. The sucrose content is substantially used up during the last part of the fermentation. The broth is treated with 30% v/v aqueous alcohol to precipitate the enzyme and this purified (at <10°C) by adsorbing the mixture on a (diethylaminoethyl-substituted) anionic resin and the enzyme removed by elution with a (non-sucrose) sugar-containing eluent.

Purifying sugar cane juices

Rhone-Poulenc Industries, of Paris, France. **2,084,184.** September 18, 1981; April 7, 1982.

Cane juice is purified by putting it into contact successively with a hydrophobic adsorbent (A), a strong anion exchanger on a carrier (B) and, in either order, anion exchange (C) and cation exchange (D) resins, and then eluting the materials used. The adsorbent A is a cross-linked vinyl aromatic polymer or an inorganic alumina or silica carrier coated with less than 15 mg/m^2 of a film of cross-linked vinyl aromatic polymer and having a particle size of 50-5000 μm, a specific surface area of 5-600 m^2/g, a pore diameter of 60-3000 Å and a pore volume of 0.2-4 ml/g. B is an inorganic alumina or silica carrier coated with less than 15 mg/m^2 of a film of a cross-linked polymer obtained from epoxide, formaldehyde or vinyl monomer compounds and containing or carrying quaternary ammonium salt exchange groups, having a particle size of 4-5000 μm, specific surface area of 5-150 m^2/g, a pore diameter of 60-3000 Å, a pore volume of 0.2-4 ml/g and an ionic capacity of < 2 meq/g. Alternatively the juice may be treated with A, B and C, A carrying strong anion exchange groups in the form of quaternary ammonium salt groups on the vinyl aromatic polymer which gives A an ionic capacity <1.5 meq/g. The anion exchange resin C is a cross-linked vinyl polymer containing or carrying exchange groups that are primary, secondary or tertiary amines or quaternary ammonium salts; it has a particle size of 100-5000 μm and an ionic capacity of 0.5-4 meq/ml. The cation exchange resin D is a cross-linked

Abstracts of the following applications for UK patents have appeared in previous issues of this Journal and the applications have been granted subsequent to preparation of our abstract. The *ISJ* reference to our abstract and the date of granting of the patent are listed below.

2,030,127	*I.S.J.*, 1983, **85**, 189.	March 30, 1983
2,034,602	*I.S.J.*, 1983, **85**, 189.	May 11, 1983
2,036,791	*I.S.J.*, 1983, **85**, 190.	December 22, 1982
2,039,295	*I.S.J.*, 1983, **85**, 190.	December 15, 1982
2,046,121	*I.S.J.*, 1983, **85**, 316.	October 26, 1983
2,046,610	*I.S.J.*, 1983, **85**, 316.	January 26, 1983
2,048,938	*I.S.J.*, 1983, **85**, 317.	March 9, 1983
2,052,492	*I.S.J.*, 1983, **85**, 318.	June 29, 1983
2,055,050	*I.S.J.*, 1983, **85**, 318.	December 1, 1982
2,056,297	*I.S.J.*, 1984, **86**, 25.	February 9, 1983
2,056,637	*I.S.J.*, 1984, **86**, 25.	December 8, 1982
2,057,436	*I.S.J.*, 1984, **86**, 25.	October 12, 1983
2,058,554	*I.S.J.*, 1984, **86**, 25.	March 2, 1983
2,059,798	*I.S.J.*, 1984, **86**, 26.	July 6, 1983
2,059,988	*I.S.J.*, 1984, **86**, 26.	July 6, 1983
2,060,688	*I.S.J.*, 1984, **86**, 27.	October 19, 1983
2,064,351	*I.S.J.*, 1984, **86**, 27.	June 22, 1983
2,065,102	*I.S.J.*, 1984, **86**, 61.	July 6, 1983
2,065,634	*I.S.J.*, 1984, **86**, 27.	July 13, 1983
2,066,038	*I.S.J.*, 1984, **86**, 27.	February 29, 1984
2,067,454	*I.S.J.*, 1984, **86**, 27.	January 19, 1983
2,067,592	*I.S.J.*, 1984, **86**, 61.	December 7, 1983
2,068,763	*I.S.J.*, 1984, **86**, 61.	December 21, 1983
2,068,972	*I.S.J.*, 1984, **86**, 61.	April 13, 1983
2,068,974	*I.S.J.*, 1984, **86**, 61.	September 7, 1983
2,069,869	*I.S.J.*, 1984, **86**, 61.	July 27, 1983
2,070,022	*I.S.J.*, 1984, **86**, 62.	September 28, 1983
2,077,269	*I.S.J.*, 1984, **86**, 62.	September 28, 1983

In addition the following applications were withdrawn subsequent to preparation of our abstracts:

2,030,884	*I.S.J.*, 1983, **85**, 189.
2,038,654	*I.S.J.*, 1983, **85**, 190.

vinyl polymer containing or carrying carboxylic or sulphonic acid exchange groups, having a particle size of 100-5000 μm and an ionic capacity of 0.5-4 meq/ml. The juices are pretreated by adding a flocculating agent, centrifuging and filtering. Brix is 10-25°, pH is 5-12 and temperature 15-80°C. The quantities of A, B, C and D are 10-350 g/litre of juice. Alternatively the treatment may be applied to brown sugar liquors up to 66°Bx, using at least 5 g of A, B, C and D per litre. The treated juice or liquor is concentrated and sugar crystallized from it. Aconitic acid may be recovered by eluting the resin C with acid or base. Amino-acids may be recovered from resin D by elution with acid.

Evaporator entrainment separator

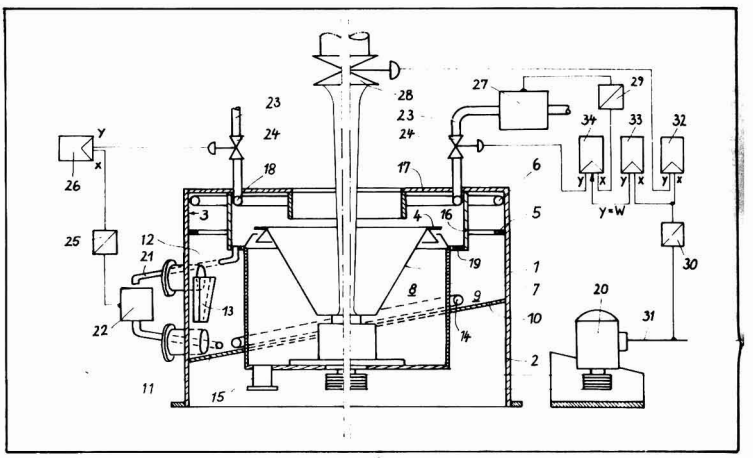
Envirotech Corporation, of Menlo Park, CA, USA. **2,084,884.** September 30, 1980; April 21, 1982.

See US Patent 4,262,411[1].

Constant density sugar solution

Hein, Lehmann AG, of Düsseldorf, Germany. **2,085,026.** August 27, 1981; April 21, 1982.

A magma delivered to the base of the conical basket of the continuous centrifugal 1 is separated into mother liquor, which passes through into chamber 8 and so leaves the machine through port 15, and sugar which is discharged over the ring 4 and strikes the annular baffle 16, causing crushing of the crystals. Water or unsaturated sugar solution is delivered through feed pipe 23 to a ring pipe 18 and mixes with the crystals to give a solution which passes over the annular ring 19 to fall into compartment 9. This has a sloping base and a steam heater pipe 14 to aid solution of the crystals. A sample of the sugar solution is withdrawn through pipe



21 and delivered to a density meter 22, the reading from which is sent by a transmitter 25 to a controller 26 which governs a valve 24 in the feed pipe 23 to ensure that the density is kept at a preset level.
The centrifugal is driven by a motor 20 and the current usage is measured by a transformer 30 connected to a controller 32 which governs the valve 28 in the magma feed. The current usage is also used by controller 33 which is connected to the water feed valve 24 through a signal transmitter 29 and flowmeter 27 and through a controller 34 to govern the water flow in proportion to the motor current and thus the flow of sugar.

Animal feed block

Uniscope Inc., of Johnstown, CO, USA. **2,086,707.** January 22, 1981; May 19, 1982; March 21, 1984.

The substantially solid animal feed composition consists essentially of a homogeneous dispersion of [1-2% (2-16%) (2.5-8%) (9%)] finely divided CaO and [20-90% (25-75%) (40%)] molasses in a ratio of 1:2-20 [1:2-12 (1:4-7) (1:10)] plus (30-70% on total weight of) additives including an insoluble P source [$Ca_3(PO_4)_2$], 0-20% potassium magnesium sulphate, 20% urea, 0-50% (3-20%) NaCl, [0-10% (0-5%) of] animal tallow, viatmins, minerals, etc. Some or all the CaO may be replaced by $Ca(OH)_2$.

High fructose syrup production

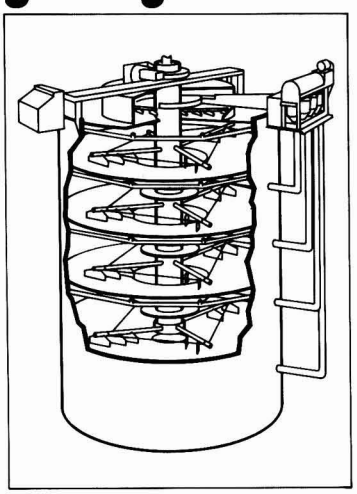
DDS-Kroyer A/S., of Copenhagen, Denmark. **2,087,400.** November 11, 1981; May 26, 1982.

Glucose syrup (of 95-98% purity) is mixed with a crystallization product containing dissolved glucose and fructose as well as glucose crystals. The mixture is converted to a homogeneous solution, isomerized by means of an enzyme, (evaporated to 75-80% dry matter), seeded with glucose crystals and cooled (to 15-30°C) to crystallize the glucose content. The crystallization product is separated and recycled at least in part (10%), while the syrup remaining is of high fructose content. During the crystallization, crystals may be separated by an intermediate filtration.

1 *I.S.J.*, 1984, **86**, 93.

RapiDorr 444.

The four-in-one combination you just can't beat.



Dorr-Oliver solves the problem of clarifying cane juice by simple arithmetic—divide by four. This unique system is essentially four clarifiers in one, each completely independent with its own separate feed, rake mechanism, overflow takeoff and mud withdrawal. By separating the systems the RapiDorr 444 eliminates big mud buildups and overloaded compartments which reduce speed of throughput. This combination unit also reduces the need for any chemical additives. Flocculators are not required although they can improve performance.

RapiDorr 444 gives you an imposing array of benefits. ☐ Flexibility ☐ Ease of control ☐ High Capacity—low retention time ☐ Good results even with bad juice ☐ Not dependent on costly, often unavailable flocculants ☐ Stability—not sensitive to bad conditions and overloads ☐ Large surge capacity ☐ Big mud-thickening area.

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DORR-OLIVER

the world market prices of crude oil and sugar have been compared.

Energy calculations and balances

Energy calculations and balances can be computed in many different ways. Questions related to the energy values of products and residues are often points of discussion. One rational method is as follows: the consumed energy is taken into account from the agricultural beginning of sugar cane and beet, through storage to sugar and its by-products or ethanol production. All energy produced is put to credit, whether it is in the form of sugar, ethanol or energy-valuable by-products. So, for example, this includes not only bagasse or wet pulp, but all possible feeds. The results can be expressed as balance differences or as energy ratios.

Energy ratios can be expressed by the following formulas. The total energy ratio (ER) is:

$$ER = \frac{\text{total energy output}}{\text{energy input (agricultural + process)}}$$

where inputs and outputs are expressed in kJ/ha.

The net energy ratio (NER) is:

$$NER = \frac{\text{energy output of ethanol}}{\text{energy input (agricultural + process)}}$$

The energy balance is positive if ER and NER are above 1 (or 100%) and negative when these are below 1 (or 100%).

The basic technology for producing ethanol from sugar plants is well known; it starts with agricultural activities and the cane and beet are transported to the factories after having been ripened and harvested. There, the sugar juice is sterilized and fermented. Ethanol is separated from the fermented solids by separators and later by distillation. Fig. 2 shows a simplified integrated scheme.

Energy balance for cane sugar

In principle, producing ethanol from sugar seems to be simple. However, sugar is not available directly, but is stored in plants. Therefore, the difference is already evident, for sugar cane (a grass) and sugar beet (roots) are totally different plants.

Table I shows the energy balances and

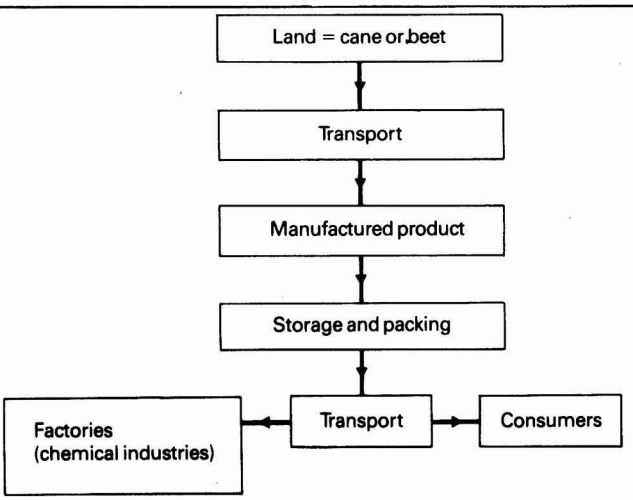

Fig. 2. Basic scheme for ethanol production from sugar plants

ER for one hectare of sugar cane. The energy ratio (ER) for sugar cane crops depends greatly on local situations such as country, climate, care, water supply and fertilizer rate. For example, when water is available from the mountains or directly from rivers or lakes, the energy consumption for irrigation will be saved. This means that the energy input ranges from 73.47 to 43 GJ/ha and the ER from 3.60 to roughly 7.5. In general, the ER can range from 3 to 11[3].

For sugar beet cultivation, these figures range from 4 to 8 because the climate is moderate and water (rain water) is available most of the time. The crops show less variation than in the case of sugar cane.

Transport

After the harvest the crops are transported to the factories. There are many possibilities for this purpose – ox carts, narrow gauge railways, small or large wagons or barges. Different calculations, including the energy consumption for manufacturing transport systems, have shown that 0.62 GJ of energy is consumed to transport 50 tonnes of cane or beet (the product of one hectare) from the fields to the factories.

Manufacturing process

It should be emphasized that sugar

3 Humbert: "The growing of sugar cane", (Elsevier, Amsterdam), 1968, pp. 6-122.

Table I. Agricultural balance for sugar cane

In	Energy (GJ)	Out	Energy (GJ)
Fertilizer	15.40	Sugar cane (50 tonnes)	125.47
Fieldwork	3.60		
Harvesting	3.20	Trash	35.82
Maintenance	2.00	Bagasse	102.98
Seed	13.78		
Sprays	4.50		
Irrigation	30.99		
CO_2	–		
Sun	–		
Rainwater	–		
Total	73.47	Total	264.27

Net result = 264.27 – 73.47 = 190.80 GJ

$$ER = \frac{264.27}{73.47} = 3.60$$

factories do not really manufacture sugar. This is synthesized in the cane and beet by natural processes and the so-called manufacturing process is essentially one of separating the pure sugar from the various materials with which it is associated in the cane or beet. At least two materials (bagasse and wet pulp) beside sugar have energy values. In this paper, energy calculations will be discussed.

Power and steam generation

In the process of converting cane and beet into sugar or ethanol, mechanical energy and steam are required for the following purposes:

(a) for extracting the juice from the cane or beet, and
(b) for converting the juice into sugar in the bag or ethanol in the tank.

Machinery is driven for both purposes – directly by steam turbines or indirectly with the energy of steam being converted into electrical power first (driven by electric motors). After the steam has provided the driving force and is discharged from the steam turbine, the exhaust steam can be used for heating, evaporation or distillation. The fresh, high-pressure steam is generated by burning oil, gas or coal (beet sugar factories) or burning bagasse (cane sugar factories) in a steam boiler.

Energy calculations for ethanol for cane

Normally, a raw sugar factory should not need more bagasse for fuel than that provided by the quantity of cane crushed. However, some calculations have to be carried out for ethanol manufacture to quantify the energy consumption or show the surplus of bagasse. The power required for extracting the raw juice has already been calculated many times. In general, for crushing 200 tonnes/hr of cane, assuming that the machinery is completely driven by electricity, the power consumers will be: two sets of cane knives using 900 kW; one shredder using 720 kW; and six mills using 3200 kW, a total of 4820 kW.

The power required for processing the raw juice into ethanol, including cooling water treatment, is calculated as 1000 kW, so that the total power required is:

$$4820 + 1000 = 5820 \text{ kW}$$

The steam rate is 11 kg/kW, so the steam consumption by the turbines is:

$$11 \times 5820 = 64{,}020 \text{ kg/hr}$$

This quantity will also be available as process steam for heating and distillation.

As all these considerations are expressed in tonnes of cane and GJ/ha, the factory calculation would be based on 50 tonnes of cane per hectare. Power and/or steam consumption for juice extraction will be:

$$(64{,}020/200) \times 50 = 16{,}005 \text{ kg/ha}$$

For processing the raw juice to ethanol, the steam consumption will be 3.5 kg steam to 1 kg ethanol[4]. Fifty tonnes of cane with a sugar content of 15% gives a quantity of sugar in the raw juice of 7500 kg and this will correspond (roughly) to 3750 kg of ethanol[5]. Steam consumption for the process will be:

$$3750 \times 3.5 \text{ kg} = 13{,}125 \text{ kg}$$

Comparing this figure with the quantity of exhaust steam produced by the steam turbine shows that plenty of process steam is available. The surplus of bagasse is also shown, because the steam generation from bagasse produced from 50 tonnes of cane will be up to 20 tonnes. In the case mentioned above, only 16 tonnes are required.

Energy calculation for ethanol from beet

In a beet sugar factory the raw juice is extracted by diffusion using various types of extractor. Before the process is started, the beets have to be cleaned and sliced. All machinery is electrically driven and power is generated by steam turbines.

The power required for handling 50 tonnes of beet to produce cossettes is 314 kW, and a diffusion tower uses 80 kW for this capacity. Because the residue (wet pulp) is to be pressed to give between 15

4 Paturau: "By-products of the cane sugar industry", (Elsevier, Amsterdam), 1982, pp. 226-243.
5 "Molasses and industrial alcohol", (Organization for Economic Development, Paris), 1979, p. 97.

Table II. Energy balance for sugar cane (50 tonnes) – ethanol

In	Energy (GJ)	Out	Energy (GJ)
Agricultural	42.75	Trash	35.82
Irrigation	30.99	Bagasse	102.98
		Sugar	125.47
Sub-total	73.74	Sub-total	264.27
Transportation	0.62	Transportation	–
Factory – fuel for ethanol	–	Factory – ethanol (3.86 tonnes)	96.64
Factory – fuel for lime (0.1 tonne)	4.16	Factory – bagasse surplus	31.58
Sub-total	4.16	Sub-total	127.22
Storage – ethanol	0.08	Storage – ethanol	–

$$ER = \frac{\text{output}}{\text{input}} = \frac{127.22 + 35.82}{73.74 + 0.62 + 4.16 + 0.08} = \frac{162.04}{78.60} = 2.07 \text{ or } 207\%$$

Table III. Energy balance for sugar beet (48.5 tonnes) – ethanol and wet pulp

In	Energy (GJ)	Out	Energy (GJ)
Agricultural	32.28	Leaves	14.01
		Dry substance	39.22
		Sugar	121.47
Sub-total	32.28	Sub-total	175.07
Transportation	0.62	Transportation	–
Factory – fuel for ethanol (1.22 tonnes)	51.02	Factory – ethanol (3.7 tonnes)	92.5
Factory - fuel for lime (0.18 tonne)	5.21	Factory – pulp (11.2 tonnes)	39.22
Sub-total	56.23	Sub-total	131.72
Storage – ethanol	0.08	Storage – ethanol	–

$$ER = \frac{\text{output}}{\text{input}} = \frac{131.72 + 14.01}{32.28 + 0.62 + 56.23 + 0.08} = \frac{145.73}{89.21} = 1.63 \text{ or } 163\%$$

and 20% dry substance, 60 kW is required. The power required for producing raw juice and pressed pulp is:

$$314 + 80 + 60 = 454 \text{ kW}$$

As before, the power required for processing raw juice into ethanol is taken as 1000 kW, when the total requirement of power becomes:

$$454 + 1000 = 1454 \text{ kW}$$

The steam consumption by a steam turbine with a steam rate of 11 kg/kW is:

$$11 \times 1454 = 15{,}994 \text{ kg}$$

In this case, the exhaust steam is also available for heating and distillation. With the same quantities of raw juice as in the case of sugar cane, the steam consumption is 13,125 kg. Because the diffusion process consumes process steam, the difference is:

$$15{,}994 - 13{,}125 = 2700 \text{ kg}$$

This quantity is sufficient for the process[6].

It has already been mentioned that oil or other resources should be used for steam generation in this case. For generation of 16,000 kg steam, 1.22 tonnes of oil are required. On the other hand, wet pulp has energy value and this should also be taken into account.

Storage and transportation

After the ethanol has been processed, the product has to be transported to the tank park and stored in tanks. For pumping and storage, 0.08 GJ is sufficient for the final product from one hectare of sugar cane or beet. The results of all considerations and calculations are shown as energy balances in Tables II and III.

Economics of ethanol production from sugar cane

The economics of ethanol production and use depend on a number of complex factors. The following variables are only some of these:

(a) ethanol can be produced potentially from a large number of other biomass materials
(b) the economic cost of other crops varies from country to country, depending on the availability of land and the fertilizer rate
(c) labour costs
(d) costs of manufacture, storage and rent
(e) political influences such as those of the EEC and the International Sugar Organization
(f) world market prices of sugar
(g) national production and consumption behaviour with regard to sugar products
(h) the economic price of gasoline (in the case of motor fuel) or ethanol as a substitute or as a feedstock for chemical industries.

Because these factors are different for so many situations, only two cases will be demonstrated. Table IV presents the economics of ethanol production from sugar cane. In this case, the price for sugar cane is set at £12.50/tonne, but when the price becomes £10.00/tonne – as has happened in the past – the price of ethanol will be lowered by 10%.

Table V shows the same calculation for ethanol from sugar beet. The price for the basic material is £14.80/tonne according to the regulations for C-sugar price level in EEC countries. The price of ethanol from sugar cane and beet gives satisfactory results in comparison with that from crude oil. In the case of plant capacities of less than 200 tonnes/hr for basic materials, the results will be doubtful at first. However, when unmarketable sugar is available at a low price in developing countries, it seems attractive to produce ethanol in order to reduce oil imports and hence save money for the balance of payments.

Table IV. Economics of ethanol production from sugar cane

Information: 200 tonnes/hr sugar cane at £12.50/tonne; operation days = 90 per year; investment £10,000,000 as part of factory

Feedstock: Sugar cane (15.2% sugar) = 90 x 4800 x £12.50	£5,400,000
Depreciation + interest (17%)	£1,700,000
Fuel costs	–
Labour 90 x (4 x 40 + 20) x £30.00	£486,000
Maintenance	£200,000
Chemicals	£100,000
	£7,886,000

Output: $90 \times 4800 \times 3.86 = 34{,}381$ tonnes; ethanol costs = $\frac{£7{,}886{,}000}{34{,}381}$

= £227.91/tonne or $\frac{£227.91}{1250}$ = £0.184 per litre = £0.83/gallon

Table V. Economics of ethanol production from sugar beet

Information: 200 tonnes/hr sugar beet at C-sugar price = £14.80/tonne; operation days = 90 per year; investment £10,000,000 as part of the factory

Feedstocks: sugar beet (15.2% sugar) = 90 x 4800 x £14.80	£6,393,600
Depreciation (lifetime of 20 years) + interest (17%)	£1,700,000
Fuel costs: $90 \times 4800 \times \frac{1.30}{48.5} \times £100$	£1,157,000
Labour 90 x (4 x 40 + 20) x £60	£972,000
Maintenance	£200,000
Chemicals	£100,000
	£10,522,600

Output: (Pressed pulp): $90 \times 4800 \times \frac{(100 \times 5)}{15} \times £12.50 = £1{,}800{,}000$

Ethanol: $90 \times \frac{4800}{48.5} \times 3.7 = 32{,}956$ tonnes; ethanol cost = £10,522,600 –

£1,800,000 = £9,722,600; ethanol cost per tonne = $\frac{£9{,}722{,}600}{32{,}956}$ = £295.01 or

$\frac{£295.01}{1250}$ = £0.236 per litre = £1/gallon

6 Mouris: "Energy analysis, heat economy and optimization of the beet sugar indusry", (University of Salford, Salford), 1979, pp. 42-52.

In the case of the developed countries, sugar beet is in competition with other crops. Sugar beet crops cultivated for the production of ethanol will not be successful. However, because the results of beet crops are unpredictable (variable weather conditions), returns may be 15% greater or less than the average crop. Therefore, ethanol production may be useful to regulate sugar stocks and sugar prices.

When the manufacture of C-sugar costs roughly £0.30/kg and this price is compared with a world market price of £0.10/kg or less, farmers and manufacturers will be more satisfied with ethanol production costing £0.25/litre. If the ethanol is mixed with motor fuel (for example, 3-5%), this may be a first step towards lead-free motor fuel. Therefore, the problems of EEC countries, caused by the strong reduction of milk production, can be avoided for sugar beet cultivation and the sugar industry by diversification of products.

Acknowledgement

This research in sugar technology is carried out in cooperation with Loughborough University of Technology in the UK.

Steam and power generation in the sugar industry

By Torsten Engberg

(ASEA STAL, Finspong, Sweden)

As cane sugar plants produce their own fuel as part of the sugar extraction process, they have the opportunity to cogenerate heat and electric power. This article tells about a promising example in Nicaragua.

The industrial sugar manufacturing process requires low-pressure steam; this might be generated in low-pressure boilers but instead steam is generated at a considerably higher pressure. It passes through a turbine generator, exhausts at the desired pressure and generates electric power as a by-product. This is the basic idea of cogeneration.

The concept can also be developed further. If there is a supply of cheap or no-cost fuel and temporarily no need for process steam, an additional condensing steam turbine can generate electricity from this low-pressure steam. The demand for low-pressure steam has given rise to a profitable combination of heat and power production.

ASEA STAL has decades of experience in this area. Cogeneration is the basis for thousands of installations of ASEA STAL turbines all over the world.

Just recently, ASEA STAL introduced a new series of industrial steam turbines – the VAX system. Covering the range from 4 to 60 MW, this series of *V*ersatile *AX*ial-flow steam turbines is used for a great number of applications in process industries.

With a system of turbine modules, the design can be adapted to give the highest efficiency for any chosen steam conditions. Having separate HP and LP modules and using gears, each of the turbines is selected to run at optimum speed.

The ASEA STAL geared axial-flow turbine design, illustrated in Figure 1, in itself offers a number of advantages. Some of these are:

- high efficiency at optimum speed and small leakage areas resulting from small diameters.
- low total weight and compact design by use of epicyclic gears
- cost efficiency through a high degree of standardization of components and systems.

Turbine generators from ASEA STAL have been installed in almost every kind of process industry, including sugar production.

Within the sugar industry, ASEA STAL has hundreds of installations all over the world. The first were installed at the beginning of the century but one of our most interesting applications was to be delivered in September 1984. This is for the state-owned sugar factory in Tipitapa, Nicaragua, where ASEA STAL delivered a VAX condensing steam turbine of the frame size LP 22 (the figure 22 refers to the size of the last stage in the turbine). The new sugar plant will be completed in 1985 and the concept of cogeneration has been applied to the process.

A simplified description of the steam balance in the plant appears in Figure 3. Steam is generated in the boiler. During the sugar season, bagasse is burnt and the steam generates electricity in the high pressure turbine before being used in the process from the 2.7 bar net. The surplus steam, when not all is used for the process, is led to the low pressure condensing turbine, also from ASEA STAL. The steam inlet conditions are as low as 2.7 bar and 180°C and large volumes have to be converted to electricity. Thanks to the VAX design, this is achieved with a high efficiency in this somewhat unusual application and the electrical output is 11.6 MW.

What is even more interesting about this sugar plant is that electricity will be generated all year round. In the spaces between

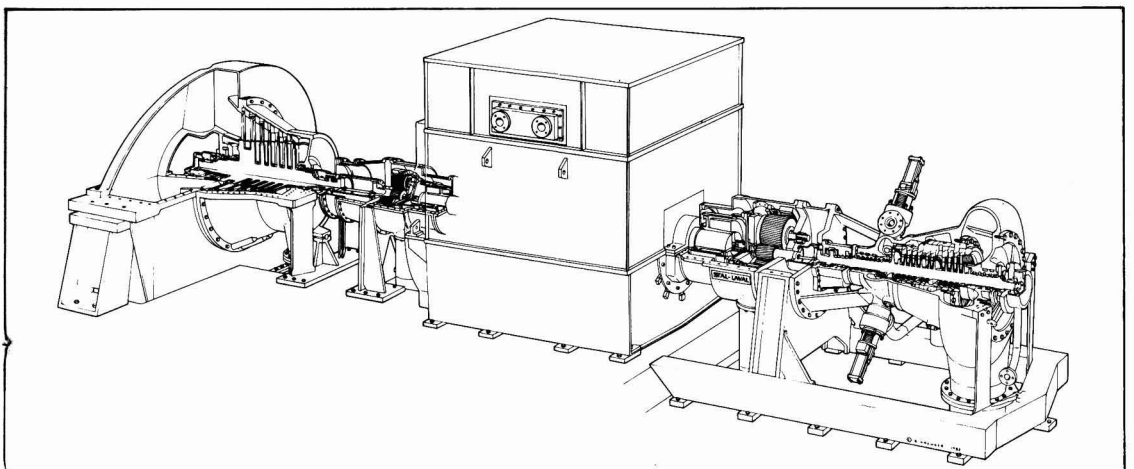

Fig. 1. Two-module configuration of the VAX series of industrial steam turbine generators

the irrigated sugar cane, a species of fast growing tree is planted. These trees provide fuel (biomass) to be burnt during the six-month off-season and give maximum utilization of the area.

In this way the equipment is used more effectively and electricity can be generated all year round, making a considerable economical gain if distributed to the grid outside the sugar plant.

Several other similar plants are being planned and, for Nicaragua, it is of great importance to be able to profit from domestic resources.

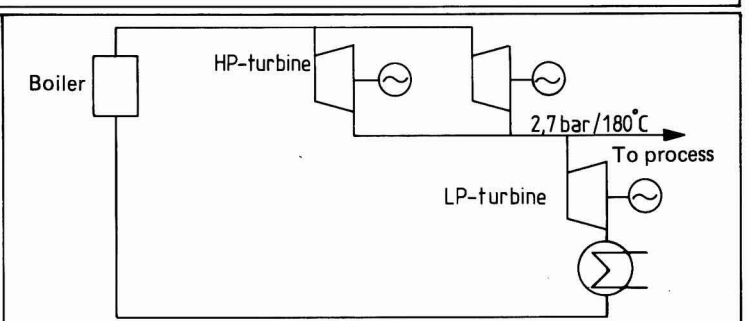

Fig. 2. Simplified steam/power system at Tipitapa sugar factory

Brevities

Zambia sugar and molasses exports[1]

The Zambia Sugar Company is reported to have processed export orders to Burundi and Zaire worth about 7 million Kwacha (approx. £4,350,000). This follows last year's bumper crop when the company recorded its largest production of 132,000 tonnes of raw sugar. Of the total to be exported, 5000 tonnes will be as white sugar and 10,000 tonnes as raws. Early in June, ZSC signed a contract for the supply of molasses valued in excess of 500,000 Kwacha (£300,000) to the drought-stricken area of Zimbabwe.

St. Kitts sugar production, 1984[2]

The 1984 cane crop in St. Kitts produced 29,965 long tons of raw sugar, of which 18,596 tons has already been shipped to the EEC and the USA, while a further 7643 tons is available for export.

New distilleries for Thailand[3]

In a program of modernization of the industry, Thailand is to install eleven new distilleries, to use cane molasses as raw material, according to Krupp Industriebau of Germany, who will be supplying the plant.

Spanish sugar industry contraction likelihood[4]

Spanish entry into the EEC on January 1, 1986 will mean that the smaller and less productive sugar factories will have to close. For instance, the Luceni factory, in the province of Zarogoza, owned by the Ebro Group, produced only 9342 tonnes of sugar in the 1983/84 campaign. Santa Eulalia, with a production of 12,428 tonnes, will also have to close, as will the smallest factory of San Isidro which produced only 3691 tonnes in 1983/84. This means that sugar beet production in the province of Zaragoza will fall below the present 90,000 tonnes from 3000 hectares. However, this should not cause any problems as the Aragon region is a rich farming region and there are many alternative crops. Industry sources placed 1983/84 production at 1,231,600 tonnes, white value, against a target of 1,120,000 tonnes, so that the target was once again exceeded. This is expected to occur again in 1984/85 but the administration will no longer bear any of the burden of excess production which must be exported without subsidies. For the 1983/84 campaign, 50% of the cost was still borne by the administration.

1 *Standard Chartered Review*, July 1984, 9.
2 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 382.
3 *Financial Times*, August 9, 1984.
4 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 431.

Beet piler protection by silicone fluid drives

The screens for dirt separation from sugar beets, fitted on large mobile conveyors used by Michigan Sugar Company for beet piling, are protected against damage from rocks and other foreign materials by a silicone fluid drive manufactured by the Link-Belt Drive Division of PT Components Inc., Philadelphia, PA, USA. The silicone fluid drive (SFD) provides protection against damage to the screens by slipping when large rocks cause a jam that could damage the screen and related components.

Michigan Sugar Company operates a total of 37 pilers at its receiving stations. These mobile conveyor units receive the beets, separate mud and rock waste, and deliver the cleaned beets to large piles for later trucking to the processing plants.

In operation, a truck pulls up to one of the pilers, after being weighed with its load, and dumps the load into one of two side conveyors. A drive-through platform-type unit is used for tandem trucks, while a swing-away unit accommodates the larger semi-trailer units. The side conveyors are used alternately, feeding beets from the truck to the main belt conveyor, where they are elevated to the screen area, generally around 20 feet higher. The screen separates the beets from the waste, holding the rock and other material for return to the truck as it pulls forward to a side conveyor from the screen area. Weighing the truck as it leaves gives a net weight of beets delivered. The beets themselves are carried via a large boom-type conveyor to the pile. The boom passes slowly from side to side, controlled by a limit switch attached to a paddle that senses the height of the pile. After each pass, the entire piler is moved backward approximately three feet to start another pass and continue building the pile.

Some of the firm's 37 pilers were originally built by outside manufacturers. However, these have been extensively reworked, and many of the current units were designed and built by Michigan Sugar personnel, who build about three pilers per year, in the off-season. Many features, such as the Link-Belt SFD units, have been added to make the machines more productive during the short but intensive harvest season.

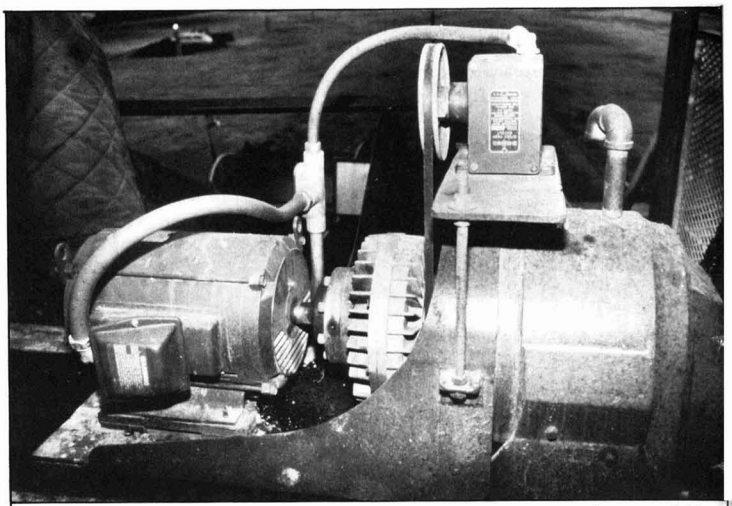

Fig. 1. The finned housing of the Link-Belt Silicone Fluid Drive can be seen in the centre of this screen on a beet piler at Michigan Sugar Co. A 10 hp motor (left) drives the SFD through a geared coupling, and the SFD provides overload protection against jamming while transmitting power to the screen rolls via the Link-Belt Motogear speed reducer at right. The cut-out above shuts off all drive motors when the speed drops below 600 rpm

Fig. 2. For unloading semi-trailers, Michigan Sugar personnel designed this special swing-away conveyor to feed the main belt. The Link-Belt Motogear speed reducer can be seen at left of unit. This is similar to a screen drive unit, but a silicone fluid drive is not required because of low potential for jamming

During a six to eight-week period, the pilers are often in operation from 16 to 18 hours per day, seven days per week, working under lights in the dark hours. The temperature must be below 10°C (below 50°F) to prevent beet fermentation in the

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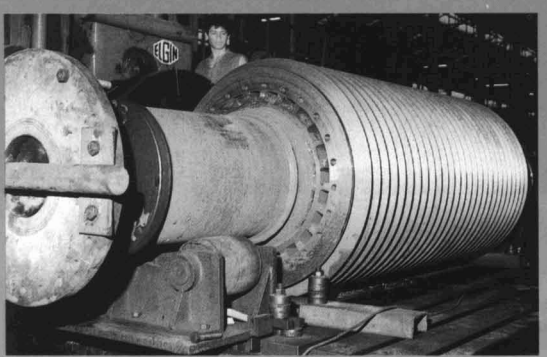

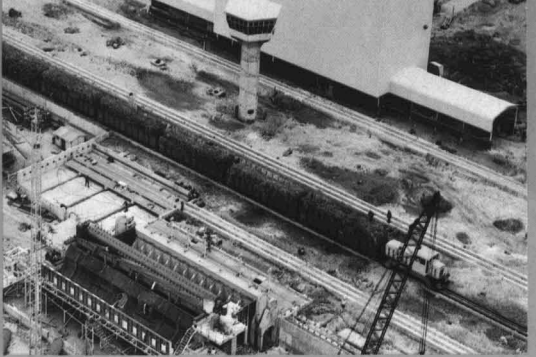

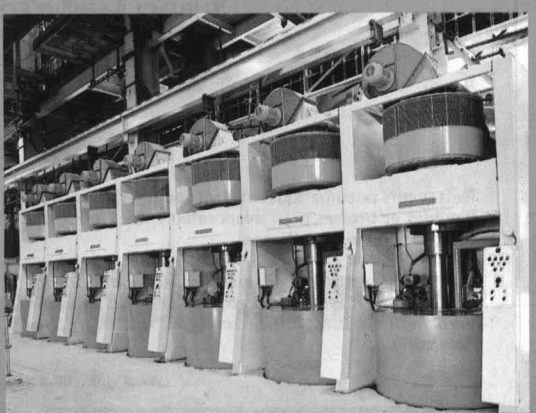

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huge piles and eliminate the need for internally venting the piles. In addition, rains can turn the fields to mud and delay harvesting, so weather factors can combine to make the available operating time requirements very intensive when conditions are right. If a rock jams the screen or causes damage, the downtime needed to clear and repair the machinery has a severe effect on operations. The Link-Belt Silicone Fluid Drive offers overload protection because the silicone fluid will shear above a torque that can be predetermined from the fluid viscosity and fill level. Michigan Sugar also uses a speed drop cut-out to shut down the feeding conveyor machinery. This cut-out operates when speed drops from the normal 1,700 to below 600 rpm. When a jam occurs, the SFD can operate while slipping without damaging itself, as opposed to some overload devices that would eventually fuse or be damaged and require replacement. When the jam is cleared, it is not necessary to reset the SFD, as the fluid automatically drives the unit when the torque limit is not being exceeded. Mechanical overload clutches generally require resetting before operations can begin again.

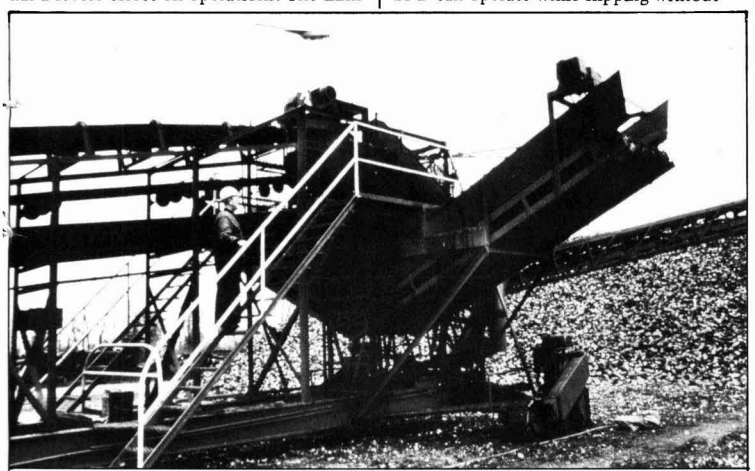


Fig. 3. Conveyor belt brings the beets from the left up to the screen at top. Dirt and rocks are separated and returned to the truck via a conveyor on either side, for weighing to determine net weight of beets brought in

Fig. 4. Individual electric motors and Link-Belt speed reducers drive the tracks that move the piler back to start another pass and build the pile of beets

The silicone fluid drive also provides a soft-start capability, owing to the cushioning action of the fluid. This feature prevents potential damage to piler components from shock loads on start-up.

The 10 hp electric drive motor for the screens is connected to the SFD unit by means of a geared coupling. The silicone fluid drive coupling is connected to a Link-Belt 10CDB 2 Motogear speed reducer, which transmits power to the screen rolls through Link-Belt RC80 and RC100 roller chain.

For standard applications where the potential for jamming is not as great as in the screen area, Michigan Sugar uses a variety of speed reducer designs to transmit power. The pilers now use seven drives, in such applications as the main belt drives, the truck unloading units, the dirt conveyors and the tracks used to move the entire machine. They have performed dependably despite the wide range of weather conditions in outdoor locations, dirt and dust, and demanding workloads.

Brevities

Peru sugar industry rehabilitation scheme[1]

The government of Peru has requested a World Bank credit to support a $200 million program to rehabilitate the entire sugar industry which is in a critical economic condition. The Minister of Agriculture has reported that the country's twelve cane sugar cooperatives could be rehabiliated through the scheme, the long-range aim of which is to reach a sugar production level of 1,000,000 tonnes by 1992. This would only equal the record level of production in the early 1970's, before the agrarian reform had its negative impact. Producers of sugar will receive technical assistance through the National Sugar Committee established in 1983 whose members include the Ministry of Agriculture and all cooperatives. In addition, a marketing committee was established by the cooperatives to improve the distribution of sugar for domestic consumption.

1 *World Sugar J.*, 1984, 7, (1), 27-28.

Trade notices

Free-flow plate heat exchangers for pulp-containing and viscous products

GEA Ahlborn GmbH & Co. KG, Voss-Strasse 11/13, P.O. Box 1180, D-3203 Sarstedt, Germany.

Up to now only shell-and-tube and spiral heat exchangers have been successfully used for the heating of raw beet juices containing pulp. However, such equipment offers only limited heat recovery and is fairly high in cost of investment and maintenance. The advantages of plate heat exchangers, such as high thermal efficiency, ease of maintenance, low weight and high performance, are widely known; however, owing to their metallic contact points between plates, conventional plate heat exchangers are unsuitable for liquids which contain pulp or are very viscous. Now special free-flow plate heat exchangers are available to the sugar industry; these strictly follow the construction of conventional plate heat exchangers and retain all their advantages compared with other types, but they have no metallic plate-to-plate contact but an open flow gap, of up to 13 mm, which ensures that pulp-containing liquids such as raw juice can be treated without any problem.

The free-flow plate heat exchanger consists of only a limited range of standardized parts including a frame with connexions comprising the fixed frame plate, follower plate, compression bolts and, most important, the plate pack. This pack consists of heat exchange plates, the number depending on the application, with inlet and outlet connexions for the two liquids involved in the heat exchange process. The plates are tightened to the outside and from each other by means of elastic gaskets which also ensure the flow direction of the liquids. In order to raise the flow velocities so that they mostly prevent fouling, the liquid connexions are generally at the fixed frame plates as well as the follower plate. Such units are called multipass units. Single-pass units are also available where all inlet and outlet connexions are at the fixed frame plate; this construction has the advantage that the heat exchanger can be opened for inspection or cleaning without the need to remove the connecting pipework. Four sizes of free-flow heat exchange plates allow for flow rates from less than 1 to more than 400 m^3/hr, and connexion sizes from DN25 to DN200 are available. Using such heat exchangers, raw juice may be heated from 25° to approx. 50°C by water with an inlet temperature of 52-55°C. It is quite common to treat up to 300 m^3/hr of raw juice in a single unit. Higher raw juice outlet temperatures may be achieved by using vapour or steam as the heating agent; in such applications there should be a pressure drop of about 25 mWG on the raw juice side. This rather large pressure drop is the reason for high velocities which occur owing to the multipass arrangements of the flow gaps. However, these high velocities ensure that fouling of the heat exchangers, and the need for cleaning during the campaign, are prevented.

Another application for free-flow plate heat exchangers is in the heating of magma which is able to pass through without any problems in spite of its viscosity. In addition to the high heat exchange coefficient, the free-flow plate heat exchanger has the advantage of an attractive price by comparison with other heat exchange equipment.

Bulk sugar weighing

Darenth Ltd., Unit 14, Belvedere Industrial Estate, Hishers Way, Off Crabtree Manorway, Bevedere, Kent, England.

A Darenth flexible intermediate bulk container (FIBC) weigher for filling 1-tonne bags with granulated sugar has proved highly reliable and accurate at the Thames refinery of Tate & Lyle Refineries Ltd. The equipment comprises a free-standing platform weigher which is accessible from three sides and carries an enclosed pneumatic transmitter on a stand to the rear. Once the bag is positioned, the start button is pressed and auto-taring carried out, after which sugar is fed at a fast rate. Towards the end of the feed, the sugar supply system operates intermittently until the target weight is reached. The entire filling sequence takes less than 40 sec. After weighing is completed, the digital display shows the nett weight and simultaneously prints the information, including batch number and date.

At Plaistow, a mobile weigher is used to weigh-fill 1.2-tonne bags with raw sugar. The pneumatic system used has a working accuracy of better than ± 0.2%. The control cabinet with clearly defined control buttons is located at the side of an eye-level analogue dial below which is the digital printer that provides a record and self-adhesive labels for bag identification. The average output of the system is 8 tonnes per 10-day.

At Millwall, two filling stations have been installed for feeding and gross weighing of 50-kg bags which are filled with brown sugar at the rate of 120 per hr. A vibratory feeder supplies the sugar via a chute to one of two lines serving the baggers – one line is given priority, while the other is for overspill, since the sugar forms a solid mass when not in transit. When filled, the bags are automatically released from the spout which is part of the weighing system, and dropped onto a slat conveyor which transfers them to the sewing head. Also installed at Millwall is a Darenth mono-rail intermediate bulk container weigher which checkweighs incoming 1-tonne white sugar containers before the contents are discharged into a mixer for processing to soft brown sugar.

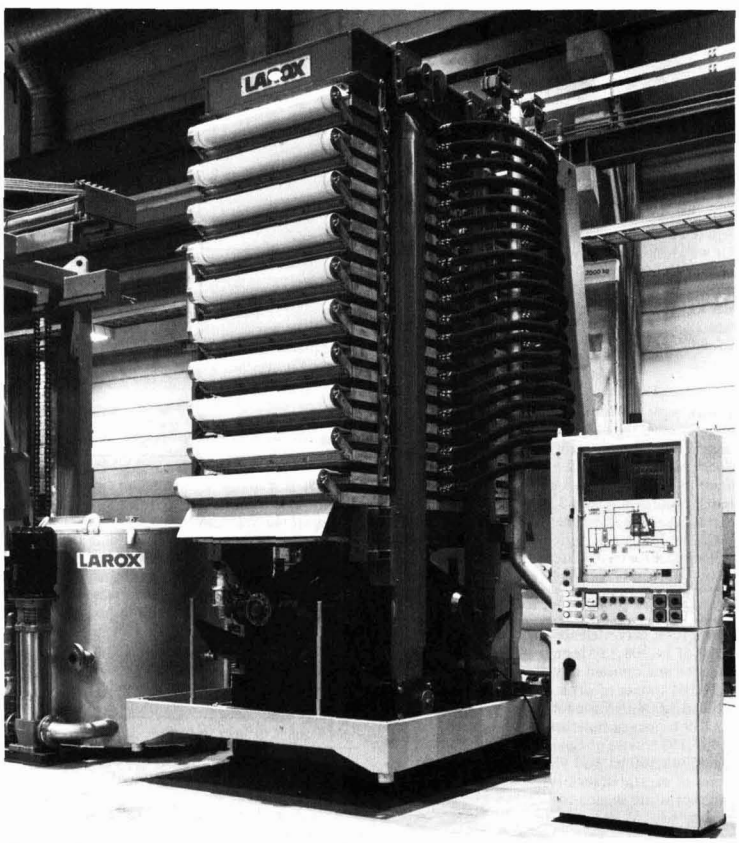
The Larox PF automatic pressure filter

Larox Oy., P.O. Box 29, SF-53101 Lappeenranta 10, Finland.

The Larox PF filter shown in the illustration combines vacuum filtration with pressure filtration to provide a drier filter-cake than with conventional filtration while giving better cake sweetening-off. According to size, the filter contains 2-20 chambers formed between the horizontal plates. These plates are brought together by a vertical closing device. The juice is pumped into a manifold from which it is distributed

evenly into each chamber. Pumping stops when enough solids have been collected in the chambers, after which water is fed behind the diaphragm in each chamber, and the diaphragm presses the cake. The third stage in the cycle is optional washing with liquid pumped into the chamber, after which it is discharged. The plates are parted, and the endless filter cloth moves in a zigzag path from one plate to the next, acting as a conveyor belt and dropping the cake on each side of the filter; the belt passes between water spray nozzles to be washed. The standard range of filter area is 2.55-31.50 m^2.

A filter of the largest size was installed in Turenki sugar factory in Finland for the 1980/81 campaign for carbonatation mud treatment. After 3 campaigns, a second filter was installed, and both have replaced the rotary filters previously used. Advantages of the new equipment over the rotary filters include: filter-cake that is easier to spread on fields, a smaller volume of wash water, reduced filter-cake losses, and easier handling of mud from frost-damaged beets.



Process and analytical instrumentation

Kent Industrial Measurements Ltd., Howard Road, Eaton Socon, Huntingdon, Cambs. PE19 3EU, England.

A small-format 38-page general catalogue gives details of the broad range of instruments and accessories available from Kent – indicators, recorders, controllers, meters, etc. – for measurement of a considerable number of parameters – temperature, pressure, level, flow, pH, conductivity, and so on – as well as more specialized equipment such as infra-red gas analysers, water analysers, etc.

Metering pumps and systems

Bran and Luebbe (GB) Ltd., Scaldwell Road, Brixworth, Northants. NN6 9EN, England.

A new brochure in full colour describes the Bran and Luebbe range of metering pumps and systems used in a wide range of industries for the batch and continuous blending of several fluid components.

Mixers and tanks

Neptune Mixer Company, Export Dept., 336 Fitzwater Street, Philadelphia, PA 19147, U.S.A.

A new Catalogue 1000-83 fully describes the complete expanded line of portable mixers and stainless steel mixing tanks for use in the food industry. The mixers range from light-duty stirrers with 1/15 h.p. motors to heavy-duty units with 1½ h.p. motors. The tanks range from 50 to 1500 US gallon capacities, and the catalogue provides a selection guide to show recommended equipment for specific requirements.

Flowmetering capability for liquids and gases

Bestobell Meterflow Ltd., Royston Road, Baldock, Herts. SG7 6NS, England.

A leaflet of this title provides details of the Sparling Meterflow range of meters which includes the *A 500 ultrasonic unit for obstruct*-ionless liquid flow measurement, a range of Doppler flowmeters, turbine flowmeters, insertion meters, etc., switches, recorders and control instruments. Illustrations and information are provided, the latter including sizes, flowrates, velocities, accuracy, etc.

ND Engineering in the sugar industry

ND Engineering Ltd., Newell Dunford House, Portsmouth Road, Surbiton, Surrey KT6 5QF, England.

ND Engineering has supplied more than 120 units for the drying and/or cooling of refined and raw sugars from cane or beet. Many of these are of the rotary louvre type for minimum crystal damage while others are of the cascade type for combined drying and cooling. A new brochure provides information on both types, as well as bagasse dryers and the remix unit for wet collection of dust. A reference list is included which details the sugar industry customers for ND Engineering's dryers.

Foster Wheeler coal-fired boilers at British Sugar

Two Foster Wheeler boilers, each generating 20.4 tonnes of steam/hr at 18 bar and 316°C (upratable to 62 bar at 510°C) have been installed in the Allscott factory of British Sugar plc ready for the 1984/85 campaign. To permit erection to be carried out in the relatively short time between the end of the 1983/84 campaign and the start of the next one, the travelling grates, economizers, grit arrestors and drum-convection bank-superheater modules were pre-assembled at the works and transported to site in one piece, the boilers then being lowered through the roof of the boiler house by crane.

Brevities

Pakistan 1984 beet sugar campaign

The 1984 sugar campaign in Pakistan was the shortest on record, lasting only 29 days and even this time was not fully operational owing to shortages of natural gas fuel. Only 178,022 tonnes of beet were sliced, against 205,812 tonnes in 1983, giving 15,145 tonnes of sugar, raw value. Throughput averaged 6792 tonnes/day against an installed capacity of 7350 tonnes/day, and the recovery was 8.51%. The beet area had been reduced to 7700 hectares because farmers were dissatisfied with the beet price. However, this was calculated on a recovery of 10% so that the factories were also dissatisfied. Beet growers pay little attention to modern practice and grow beet as an intercrop with cane, giving a yield of only 22.98 tonnes/hectare; further, they defoliate the beet while the roots are still in the ground.

Spanish sugar production, 1983/84[1]

Sugar production in Spain was 1.2 million tonnes, white value, (1.3 million tonnes, raw value) in 1983/84, 10% higher than the government's objective. About 32% of the 1983/84 total was produced by the Ebro Group, 20.6% by Cía. de Industrias Agrícolas S.A. and 20.3% by Sociedad General Azucarera.

Argentina sugar production, 1983[2]

From a total harvested area of 316,800 hectares, a total of 14,904,437 tonnes of cane was produced and crushed to yield a total of 1,537,184 tonnes of sugar, tel quel, which included 1,004,045 tonnes of white sugar and 533,139 tonnes of raws. In the 1982 crop, 14,437,163 tonnes of cane, harvested from an area of 308,500 ha, had yielded 1,530,683 tonnes of sugar, tel quel, including 1,059,080 tonnes of white sugar and 471,603 tonnes of raws.

Nicaragua sugar exports, 1983[3]

	1983	1982	1981
	tonnes, raw value		
Algeria	11,235	0	0
EEC	0	103	0
Iran	13,375	0	0
Mexico	28,088	28,065	15,738
US	48,036	57,043	73,026
USSR	11,593	11,840	0
	112,327	97,051	88,764

Philippines sugar production cut[4]

The Philippines is to cut sugar production in the 1985/86 crop year (September/August) to 1.8 million tonnes, tel quel, because of depressed world market prices, according to official sources. Output in 1982/83 was 2.45 million tonnes and, as at July 1, the 1983/84 crop had produced 2.16 million tonnes.

Vinasse disposal in fish farming[5]

A technology developed by Solar Aquafarms Inc. of the USA, capable of converting distillery effluent into food for raising fast-growing species of shrimp and fish, has been transferred to Vorion Chemicals & Distilleries Ltd., a firm in Madras, India, which is establishing an aquaculture project, 40 hectares in extent, at its Chingleput district distillery for treatment of the effluent. The technique enables disposal of the vinasse to avoid environmental damage while the biologically rich organic matter is converted by the shrimp and fish, which can be raised in brackish water on uncultivable lands.

Beet alcohol project in India[6]

The West Bengal government has decided to set up a pilot project for cultivation of sugar beet in the Sundaban area for the production of industrial alcohol and other chemicals.

EEC sugar imports, 1983[7]

	1983	1982	1981
	tonnes, raw value		
Austria	2,321	25,015	15,404
Barbados	52,808	44,503	45,000
Belize	42,281	42,566	43,000
Congo	5,821	5,326	0
Cyprus	0	0	7,310
Czechoslovakia	2,760	2,566	50
Dominican Rep.	4,771	0	0
Fiji	197,709	197,263	190,000
Finland	52	1,170	0
Germany, East	27,430	27,768	28,629
Guyana	167,584	160,158	184,000
Ivory Coast	1,855	3,015	4,932
Jamaica	130,513	120,305	124,000
Kenya	4,403	2	94
Madagascar	10,465	10,446	0
Malawi	21,031	20,725	21,000
Mauritius	560,797	570,309	486,000
Mozambique	0	5,222	5,217
Philippines	0	0	2,453
St. Kitts	0	21,945	15,000
Swaziland	136,473	126,927	123,000
Switzerland	8,522	804	746
Tanzania	10,167	9,793	0
Trinidad	62,649	51,891	67,000
Zimbabwe	29,924	19,530	0
Other	35,705	2,775	1,896
	1,516,041	1,470,024	1,364,731

Sudan sugar industry modernization[8]

As a consequence of the modernization of the four Sudan sugar factories, production has risen from 74,000 tonnes in 1981/82 to 417,871 tonnes in 1983/84 (somewhat below the target of 455,000 tonnes). The program will be finished in 1985/86 and a total of $140 million will have been spent. Total production is to reach 680,000 tonnes by 1988/89 against a consumption expected to reach 580,000 tonnes, leaving a surplus of 100,000 tonnes.

Indonesian sugar production and storage[9]

Sugar production in fiscal 1984/85 is expected to reach 1.8 million tonnes with a national buffer stock of 500,000 tonnes held by the State procurement agency. Inadequacy of storage facilities has caused some sugar to be destroyed and the government has agreed, therefore, to provide soft loans to sugar factories for the purpose of expanding their storage capacities.

1 *World Sugar J.*, 1984, 7, (1), 28.
2 "El azúcar argentino en cifras": La Ind. Azuc., 1984, (Supplement).
3 *I.S.O. Stat. Bull.*, 1984, **43**, (2), 29; (4), 28.
4 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 398.
5 *Indian Sugar*, 1984, **33**, 715.
6 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 534.
7 *I.S.O. Stat. Bull.*, 1984, **43**, (6), 15-16.
8 F. O. Licht, *International Sugar Rpt.*, 1984, **116**, 436.
9 *Standard Chartered Review*, September 1984, 34.

British Society of Sugar Cane Technologists

The autumn meeting of the B.S.S.C.T. was held in London on October 4, at the Royal Commonwealth Society. After a welcome and introductory remarks by the President, Dr. M. C. Bennett, Mr. Trevor Robinson, Head of Commodity Research for E. D. & F. Man Ltd., spoke on the world sugar market, its recent history and its relationship to the incomes of sugar exporting countries. Dr. B. C. Goodacre then presented a paper by herself, M. H. C. Bristow and M. R. Connor on a combined development program of Tate & Lyle Group Research and Smith-Mirrlees for the latter's continuous centrifugal for high-grade massecuites and magmas. This has been largely successful in providing the same results as a batch centrifugal, at lower and uniform energy consumption, although the problem of crystal breakage remains to be solved.

A paper, prepared by Mr. F. J. Soper, Chairman of the Queensland Canegrowers Association, was then read by Mr. G. Rossato; it described the investigation of attitudes toward sugar in two Australian cities and the publicity efforts made by the Australian sugar industry to counter hostile views. A second survey after some months indicated that the program had succeeded to some extent in changing public impressions of sugar, but this was not yet translatable into restoration of per caput consumption.

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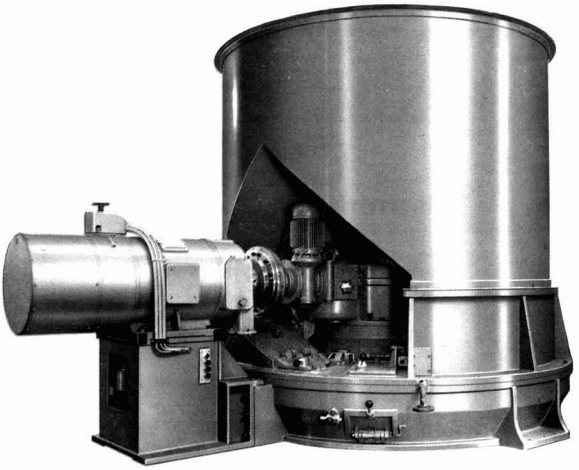

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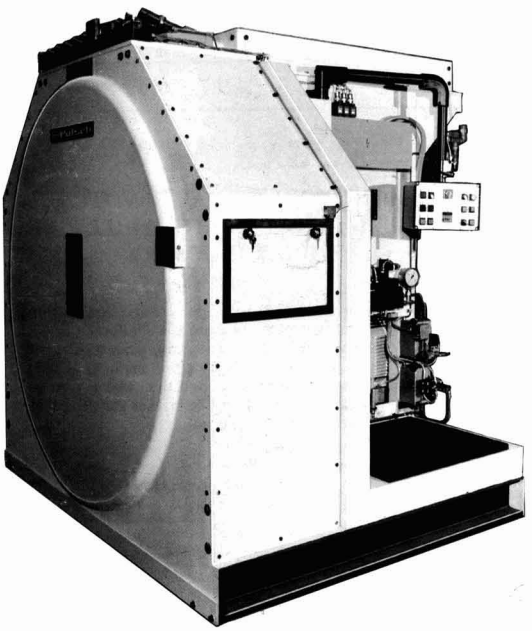

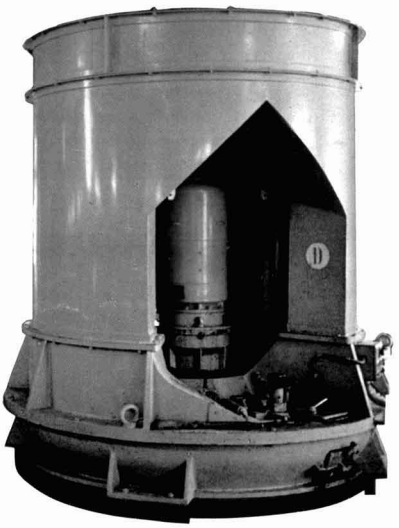

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