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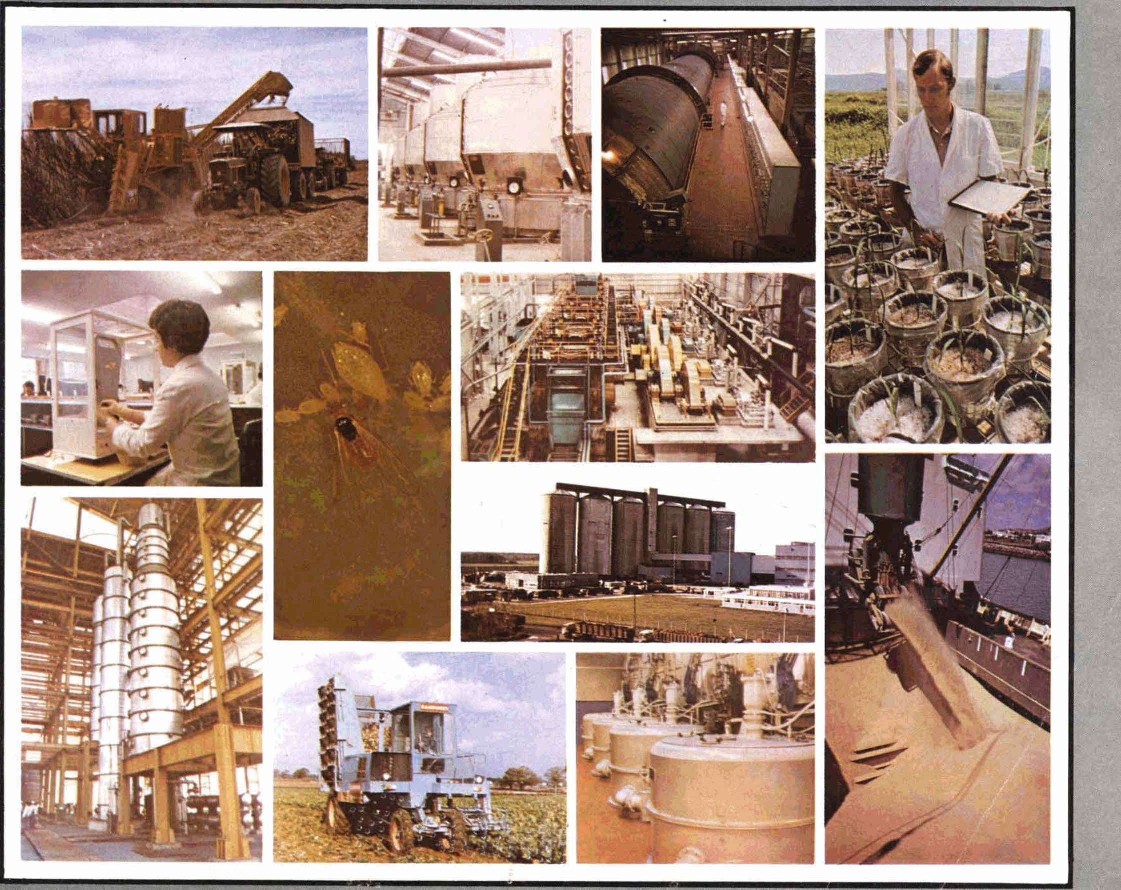

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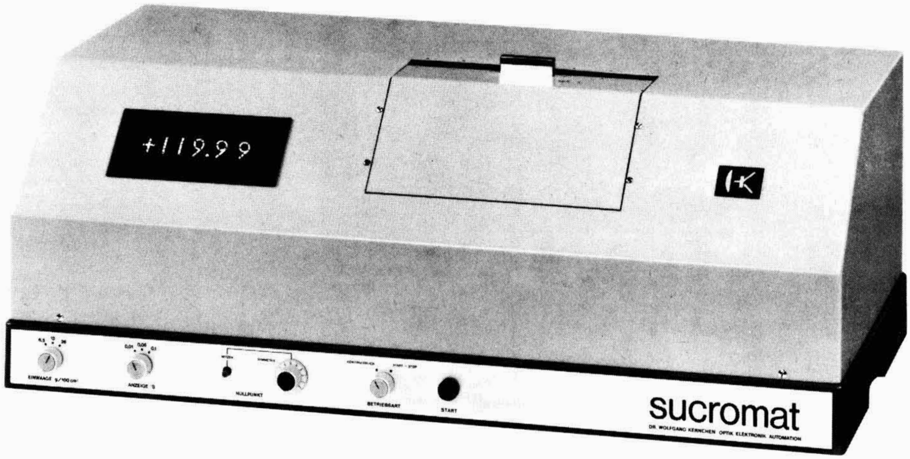
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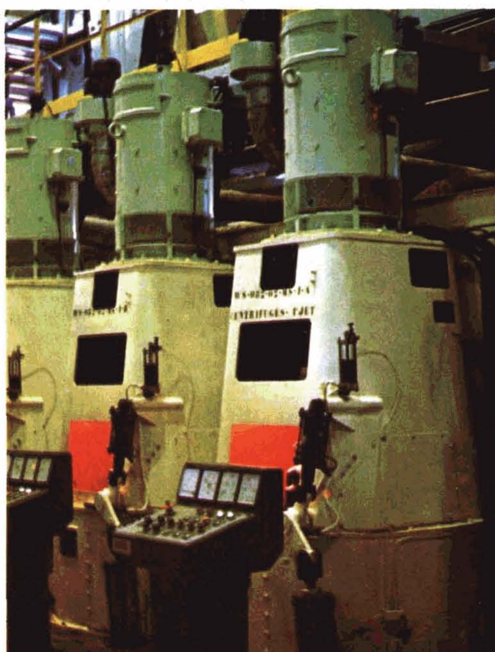

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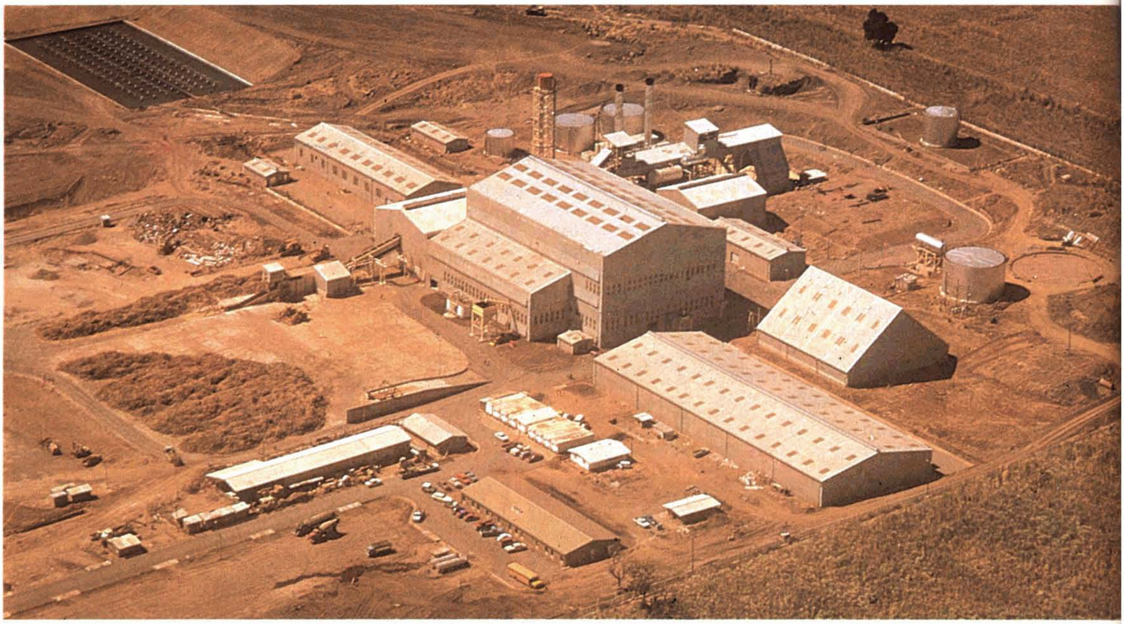

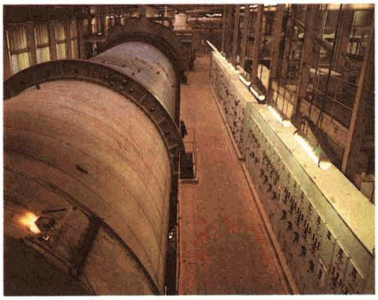

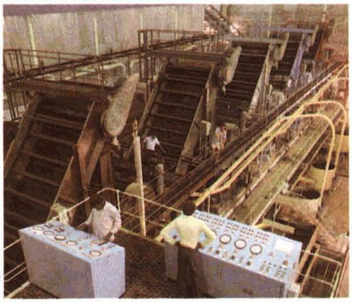

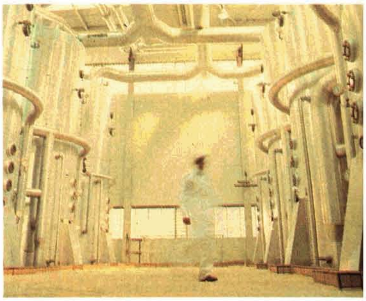

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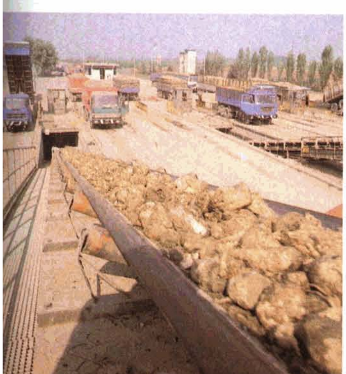

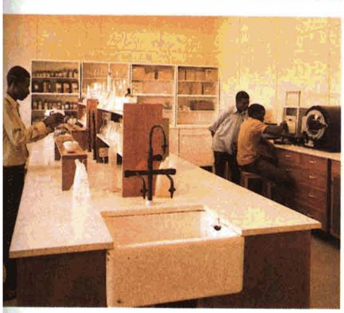

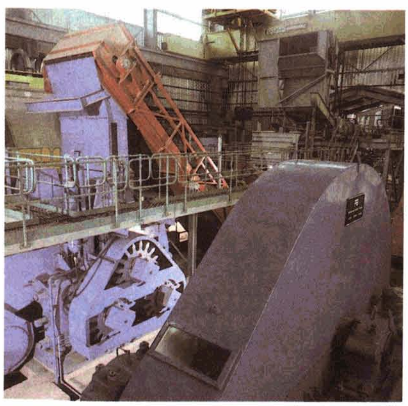

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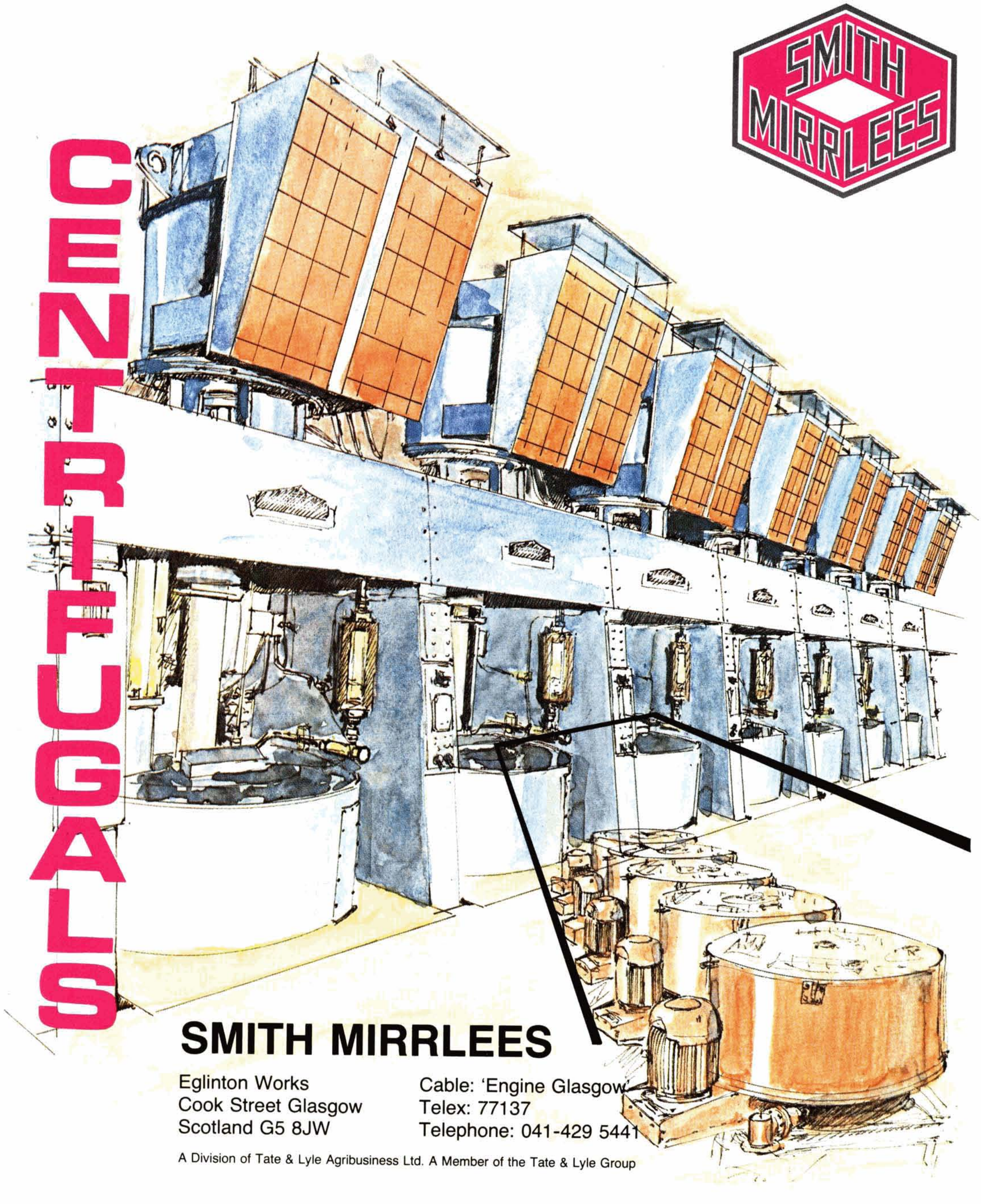
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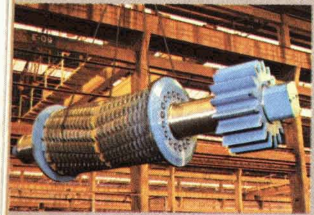

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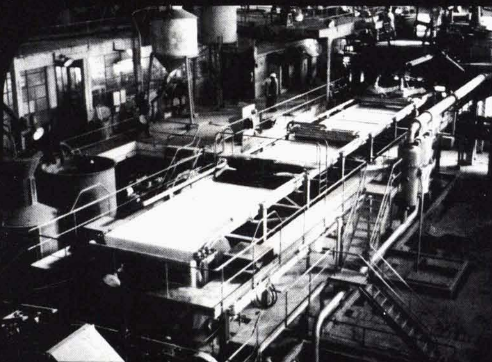

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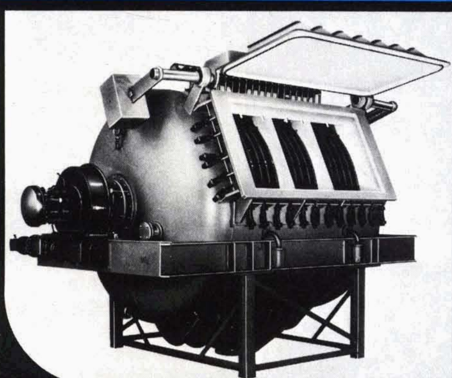
160m2 universal pressure filter, with cake washing, used in the sugar industry for filtration of cloudy liquors from first carbonatation.



140m2 AUTODISC pressure filter for filtration of syrups

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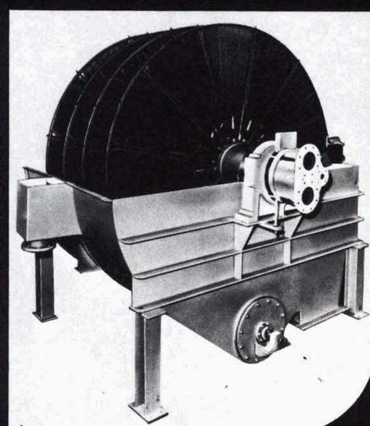

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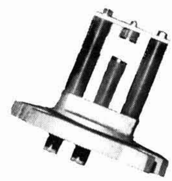

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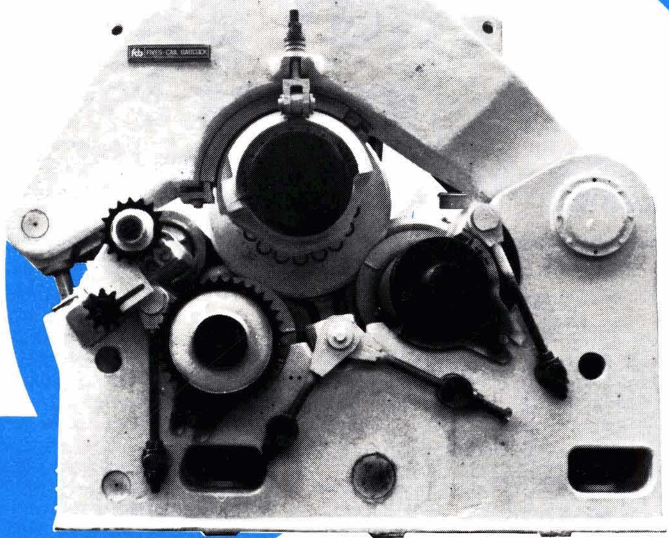


NOTES AND COMMENTS

World sugar prices

During August there was a steady increase in the London Daily Price for raw sugar from £287 per tonne on August 1 to £334 by August 13. On August 18 a gentle slide began and by the end of the month the LDP had fallen to £310. The separate assessments of likely production deficits for the crop year starting in September strengthened the market at first, as did news of buying by a number of former exporting countries, hurricane damage in the Caribbean (although not to the 1979/80 crops which have finished), and disappointing beet test results in Europe.

The reduction of EEC minimum stocks, with the possibility of increased supplies to the world market, were a depressing influence in the second half of the month, while the large releases of sugar by the Brussels authorities (no less than 165,750 tonnes on August 27) helped to push white sugar prices down even more. The LDP(W) had started the month at £319 per tonne and had climbed to £339, but the readier availability of whites as against raw sugar caused the differential to fall so that at the end of the month it was only £2 per tonne, and the LDP(W) stood at £312 against £310 for the LDP.

Indian sugar crop reduction

The Indian Government has stated that sugar output in the 1979/80 season fell by 32.4% to 3.95 million tonnes, tel quel, as against 5.84 million tonnes in 1978/79[1]. The main reasons for the very poor crop have been drought and other bad weather in conjunction with smaller sugar cane plantings. It was the acute domestic shortages created by this severe crop shortfall which forced the government to take the unprecedented step of importing 200,000 tonnes of white sugar to meet local requirements.

The Minister of State for Agriculture told Parliament that the scheme of voluntary price regulation for free-sale sugar had not worked because of the lack of statutory control over the movement of sugar to deficit states. The government has therefore decided to take a tougher line by excluding those factories which did not cooperate from the scheme of incentives for early crushing.

Turning to the future, the Minister said that favourable monsoons and an increased cane area had improved prospects for the 1980/81 crop. The Indian Sugar Mills Association considers, however, that without suitable incentives, sugar outturn will not exceed 4 million tonnes[2]. The Association expects the government to waive the existing purchase tax on cane for early and late crushing (before October and after May), while other measures believed under consideration are excise duty exemption on excess production of each factory, imposition of a dual price policy on khandsari, and parity in the excise levy structure for sugar factories and non-centrifugal sugar manufacturers. These measures, especially a dual price policy for khandsari as already applies to white sugar, would mean availability of khandsari at lower prices and its producers would be likely to offer farmers less for their cane so making it easier for white sugar producers to obtain cane supplies.

Cuban-Japanese contract talks failure[3]

After three weeks of talks, Cuba and Japan have failed to agree on a new long-term sugar supply contract to replace the present agreement which expires at the end of 1980. The Cubans had originally hoped that the high quality of their sugar would provide adequate incentive for Japan to double her purchases to 600,000 tonnes a year over the period 1981/85. In the event the Japanese were not as willing to buy as the Havana delegation had expected. Cuba therefore lowered both time span and tonnage for the proposed new agreement to three years with annual commitments of between 400,000 and 600,000 tonnes, but even so, the talks ended inconclusively.

According to the head of the Cuban Sugar Corporation, price was the main stumbling block; Japanese trading houses were apparently looking for a discount from the London price (on which Cuba bases its quotations) in order to make the imports more competitive with sugar from the Philippines and Thailand. However, Cuba refused to offer such discounts, arguing that the likely tightening of world supplies in the next two years made any such discount unrealistic.

Meanwhile, Japanese trade sources involved in the negotiations said that part of Japan's reluctance to take up Cuba's five-year sugar offer resulted from predictions that the country's sugar import requirements would fall over the next few years. Japan is stepping up domestic sugar output and is also using a larger proportion of high fructose corn syrup. This will inevitably reduce demand for imported sugar and import requirements for 1980 are now put at 2.42 million tonnes as against a 1979 level of 2.98 million tonnes.

Sugar production in China[4]

Cane sugar is produced in South and Central China, in the provinces of Guandong, Fuijan, Zhejiang, Guanxi, Jianxi, Hunan, Yunnan, Sichuan, Hubei and some smaller provinces. Guandong has always been the most important cane sugar producing area and development of the crop in this province is crucial for the total level of sugar output in China. Guandong suffered adverse weather conditions during the 1979/80 growing season, suffering typhoons and drought. The crop of 6.7 million tonnes of cane was processed to yield not more than 820,000 tonnes of sugar, against 1 million tonnes in 1978/79.

In Fujian the cane area was raised by 1606 hectares to 42,955 ha, some old mills were improved and four new factories were put into operation. As a result the season was shortened by 15 days while production was raised from 330,000 tonnes in 1978/79 to 360,000 tonnes in 1979/80. Total cane sugar production is estimated at slightly over 2 million tonnes in 1979/80, against 2.1 million tonnes in the previous season.

Beet sugar production in China is of recent origin, dating from about 24 years ago. The three major beet areas are Heilongjiang, Jilin and Inner Mongolia. Three new factories were built in Heilongjiang last year and six more are planned, while three new factories started production in Inner Mongolia in 1979/80, bringing the number in that province to 17. Total beet sugar

[1] *Public Ledger,* July 3, 1980.
[2] F.O. Licht, *International Sugar Rpt.,* 1980, **112**, 470.
[3] *Public Ledger Commodity Week,* August 9, 1980.
[4] F.O. Licht, *International Sugar Rpt.,* 1980, **112**, 437-439.

production in Inner Mongolia in 1979/80, bringing the number in that province to 17. Total beet sugar production is estimated at 470,000 tonnes, white value, against an estimated 400,000 tonnes in 1978/79.

Total sugar production in 1979/80 is placed at 2,480,000 tonnes, white value, slightly less than the figure for the previous crop year. The authorities have the ambitious goal of making the country self-sufficient in sugar; apparently imports of roughly 1.2 million tonnes a year are thought to be too burdensome for the country's budget. It was recently reported that the government is encouraging the main sugar beet growing areas of North China to increase production. The aim of self-sufficiency does not seem to be totally unrealistic in view of the influx of technical know-how and capital from the West. However, when bureaucracy is involved, progress is usually slow.

Japan sugar refining industry[1]

Japanese sugar producers are studying plans to trim surplus production through mergers, regroupings and either scrapping or mothballing some facilities over five years, according to their association. The plans call for firms to cut total annual production capacity by about 20% to 3,250,000 tonnes from the present 4,020,000 tonnes. Finalized plans will require industrial concensus and government support to help with financial and tax aspects; the plans, if put into force at a date yet to be decided, are unlikely to affect Japan's raw sugar imports, currently 2.3 – 2.4 million tonnes and mainly from Australia, Cuba, South Africa, the Philippines, Taiwan and Thailand.

Eleven major Japanese sugar refiners (Taito, Meiji, Toyo, Nippon Tensai, Nippon Sugar, Ensuiko, Fuji, Dainippon and Shinko) are suffering cumulative deficits totalling nearly 50,000 million yen, owing to higher-priced raw sugar imports and falling domestic market prices. Japanese sugar industry leaders are urging parliamentarians to back implementation of a special measures law for sugar price stabilization for a further three years from September. The law allows the government to levy import surcharges and subsidize domestic producers to help protect them from low-priced imports and stabilize sugar market prices.

Reduction in EEC minimum sugar stocks[2]

Sugar producers have to hold minimum stocks, currently amounting to 10% of their individual basic quotas or, where production in the previous years has been less than the basic quota, 10% of actual production. In the case of refiners of ACP sugar the stock has to be established at 10% of the quantity refined in the previous year. Community sugar producers have frequently complained about the need to keep such high stocks which they felt to be not only statistically excessive but also representing an unwarranted and growing financial burden.

Perhaps responding to this pressure to some extent, but also no doubt reflecting the much higher level of production within the Community than when the measure was first introduced, the Commission has secured authority for the minimum stock level to be reduced from 10% to a figure to be decided but which must be within the range from 5 to 10%. A reduction from 10 to 8% has already been agreed and came into force on August 26. Notionally this will reduce the minimum stock which producers must hold from 913,600 to 730,88 tonnes, though it must be borne in mind that there is no obligation on producers to reduce their stocks should they for whatever reason consider it inappropriate.

As the year progresses the Management Committee will continue to keep the internal and external supply situation under review and will make further adjustments in the level of minimum stocks as they consider they are warranted. It should be noted that although it is possible for the Committee to call for an increase in the level of minimum stocks, this would certainly create anomalies in cases where some producers had already made arrangements for the disposal of supplies under earlier authorizations. For this reason it must be expected that any reduction to the final 5% would only be made when the Committee felt quite sure that the supply situation for the remainder of the year was in no possible danger.

In principle this measure is being introduced for one year only; in practice, however, it is expected to be continued, with the minimum stock level restored to the full 10% each year at some date immediately after the end of the sugar campaign.

US sugar production[3]

According to the revised figures for 1979 issued by the Crop Reporting Board of the US Department of Agriculture, production of sugar beets in 1979 totalled 22.1 million short tons (20.0 million tonnes), 14% less than the 25.8 million tons (23.4 million tonnes) produced in 1978. Growers harvested 1,120,000 acres (455,000 ha) in 1979, 11% less than the previous year. The average yield was 19.6 tons per acre (44.0 tonnes. ha^{-1}). Of the total harvested, 21.6 million tons (19.6 million tonnes) were sliced and sugar production amounted to 2.88 million tons (2.61 million tonnes), raw value, down 12% from the 1978 campaign.

The total cane processed to sugar amounted to 25.4 million tons (23.1 million tonnes), 2% above 1978, and harvested from 690,000 acres (279,000 ha), the yield averaging 36.8 tons per acre (82.8 tonnes. ha^{-1}). In Florida, sugar production amounted to 1,047,000 short tons, raw value, while those of Hawaii, Louisiana and Texas were 1,060,000 tons, 500,000 tons and 93,000 tons, respectively, giving a total of 2,700,000 tons (2,450,000 tonnes) 3.4% up on 1978.

Australia – China long-term contract[4]. – Details were released in July of a long-term contract under which Australia is to supply about 250,000 tonnes of raw sugar to China during each of the next three years. Subsequently it was stated that Australia has long-term contracts over the period to 1984 for the export of over 4.7 million tonnes of sugar. These arrangements give to Australian sugar producers a high degree of assurance about the levels of future export earnings while providing buyers with a guaranteed supply of high quality sugar. A 5% expansion in the current assigned Queensland cane area has been approved.

UK sugar consumer safeguards committee. – The Minister of Agriculture, Fisheries and Food and the Secretary of State for Trade have received the third annual report of a committee set up by the then Ministers in June 1977, following the merger of Tate & Lyle Refineries Ltd. with Manbré & Garton Ltd., to investigate specific complaints from actual and potential trade customers of the Tate & Lyle Company relating to the supply, price, quality and delivery of sugar, starch and certain other products. No complaints had been received in the year up to June 1980 and the Ministers have decided that the committee is no longer needed. The appointments of the Chairman and members expired on June 8, 1980; they will not be renewed.

1 *Reuter Sugar Newsletter,* May 8, 1980.
2 F.O. Licht, *International Sugar Rpt.,* 1980, **112**, 502.
3 *Lamborn,* 1980, **58**, 84.
4 C. Czarnikow Ltd., *Sugar Review,* 1980, (1503), 151-152.

Cane sugar factory steam balance and turbine operation

By RICHARD A. FRANCIS
(Peter Brotherhood Ltd., Peterborough, England)

Whilst accepting that each individual sugar factory has its own peculiarities, the basic layout of the major items of equipment is similar throughout the world.

It is usual for sugar estates to grow by phased expansion but the factory must always be chronologically ahead of cane production. This situation can extend over quite a long period and the resultant difference between factory design capacity and actual crushing rate creates an imbalance in the steam system.

A situation similar to this occurred at a sugar estate in Mauritius and the problem was resolved simply and cheaply by using a coaxial gearbox. The problem is clearly identified in Fig. 1.

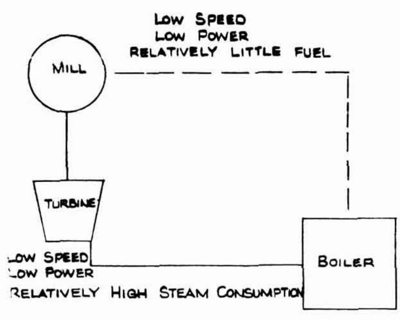
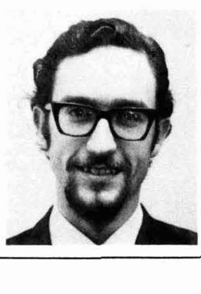


Fig. 1

The amount of bagasse available to the boiler is a function of the crushing rate and since the mills operate at low speed a relatively small amount of fuel is available. The mill drive turbines are required to provide power under low speed/part load conditions and it is this "off-design" condition which results in a relatively high steam consumption. This point is not always appreciated by the factory operators.

Prime movers are not by nature very flexible machines: in fact, the steam turbine is better than most but it still suffers during operation under 'off-design' conditions. Turbine efficiency is a complex combination of many factors, including nozzle efficiency, velocity ratio of blading, aspect ratio of blading, external leakage, internal leakage, disc friction, windage, wetness and gear efficiency.



R. A. Francis

Naturally some of these factors have a greater effect on efficiency than others. Also, some factors are affected by speed change, others by load change, and others by steam condition change. The problem outlined above combines two changes of condition, part load and part speed.

Part load performance can be largely controlled by maintaining nozzle efficiency or, in other words, controlling the nozzle area available to the steam. This can be done by using overload valves (hand operated or automatic). The turbine rotating element and all auxiliary services still have to be designed for the maximum or future condition which consequently makes the mechanical losses (governor drive, oil pump drive, bearings, etc.) a larger percentage of the total output when running at reduced load. But this effect is small. Looking at a typical Willans Line for a single-stage turbine we can see the effect of an overload valve.

Fig. 2 shows that a turbine can be designed to operate efficiently at 50% load and, when required to operate at 100% load, there is only a marginal loss in efficiency. Comparing this lower line with the top line which represents a single valve turbine designed to run at 100% load and throttled back to 50% load, the increase in steam consumption is ΔQ. We can overcome the problem of reduced load by introducing overload valves, which is, of course, common practice.

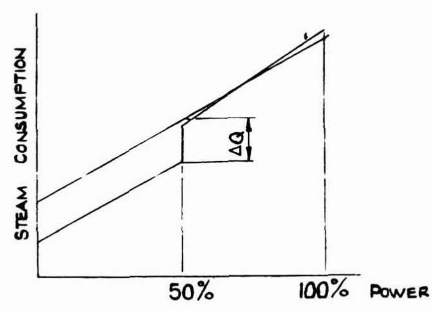


Fig. 2

The problems arise when the turbine is running at below design speed. One of the most important factors which account for the efficiency of the turbine is the 'velocity ratio'. This is a ratio of blade speed to steam speed (μ/Co). The choice of velocity ratio is critical, as can be seen from Fig. 3.

With a speed reduction of 50% we get an increase in steam consumption of 54%. It is this imbalance which is shown in Fig. 1.

To put the steam system into balance we must maintain the design speed of the turbine.

This situation can be achieved quite obviously with any kind of speed reducer but our experience in

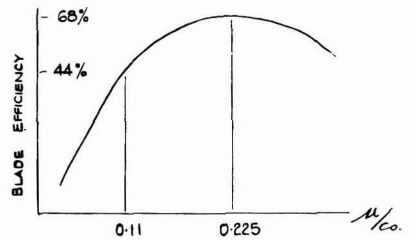


Fig. 3

Mauritius suggested that a coaxial box would be far superior to a side-by-side or stacked box since the secondary reduction gear unit and the turbine were secured to concrete foundations. Steam and exhaust lines were run carefully for minimum distortion and to move either piece of equipment would require major work (Fig. 4).

It is envisaged that as the milling train increased in speed the blading efficiency of the turbine would remain fairly constant since we would operate over the flat top of the velocity ratio curve. As soon as the steam rate worsened to a point where the system was out of balance, the coaxial box would be removed and replaced with a carden shaft without disturbing the foundations.

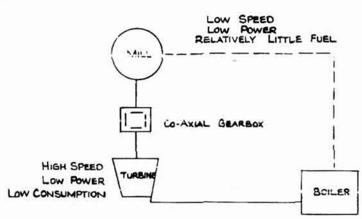


Fig. 4

Considering a theoretical case let us examine the costs and economics, where the turbine and gear train design are as shown in Fig. 5.

Steam consumption for 600 BHP is 17690 $lb.hr^{-1}$.

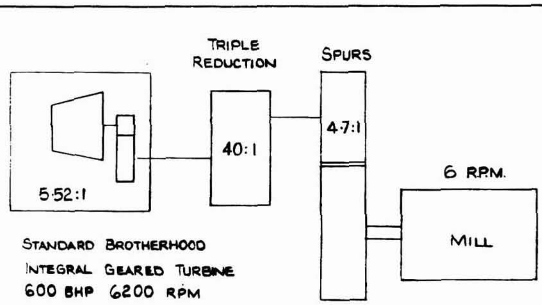


Fig. 5

The initial design (pre-factory expansion) is as shown in Fig. 6.

Here, steam consumption for 350 BHP is 10730 $lb.hr^{-1}$; without the coaxial gearbox steam consumption would be 13700 $lb.hr^{-1}$.

If we assume that the shortfall in bagasse is made up by firing heavy fuel oil then 230 lb of oil per hour would be necessary to get the required power from the turbine. Today's price for heavy fuel oil is approximately £85/tonne, while the cost of coaxial gears and coupling is approximately £7,000. Thus, the unit pays for itself in 800 hours or a little over a month of continuous operation.

This answer begs the question – why is it no one does this? Probably the simple answer is that, in the author's experience, the design factors of steam turbines and the effects on efficiency are not well enough appreciated in the sugar factories. Compromises such as turning down boiler pressure which is, in effect, adjusting the available enthalpy drop and consequently the velocity ratio of the blades, do help, but the design steam pressure may well be required by other steam users in the factory – e.g. the turbo-generator – and the steam pressure reduction could prove a nuisance.

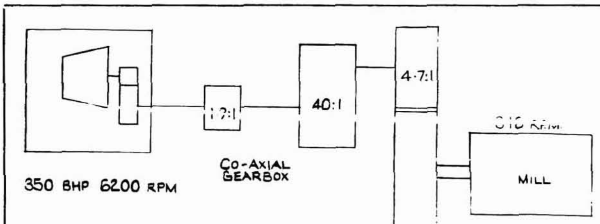


Fig. 6

The specific case in Mauritius was complicated by the fact that there were initial and future steam conditions and that the change from low pressure to high pressure was not necessarily coincident with the change of mill speed. Optimum design had to be thought out but the introduction of the coaxial gearbox gave us more options and consequently a far better overall performance.

Steam turbines are not the most flexible of machines but it is surprising how the design can be optimized when the designer is aware of the requirements of the sugar factory. All too often a simple request for a quotation for a mill drive turbine with a CMR point and an MER point is called for when on further investigation there are other factors in the steam system which should and could be taken into account before the machine is designed. Once the machine has been designed it is an expensive business to change the steam path.

Summary

Phased expansion of sugar factory production creates problems of imbalance in the steam system. One way of solving this problem which has been successfully employed is described.

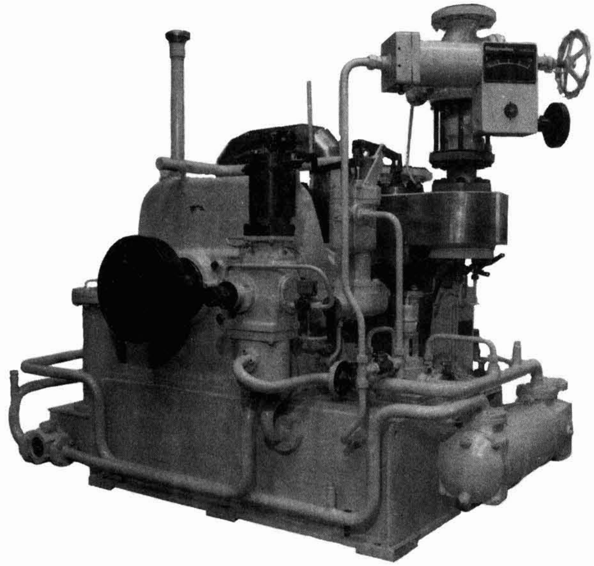


Fig. 7. Brotherhood 600 bhp single-stage mill drive turbine installed in a sugar factory in Africa

Bilan de vapeur et opération de turbines dans une sucrerie de cannes

L'augmentation à stades de la production dans une sucrerie occasionne des problèmes de déséquilibre dans le système de vapeur. Un moyen de résoudre ce problème que l'on a employé avec succès est décrit.

Dampfgleichgewicht und Turbinenbetrieb in einer Rohrzuckerfabrik

Die stufenweise Zunahme der Herstellung von Zuckerfabrikprodukten verursacht Probleme von Ungleichgewicht beim Dampfsystem. Ein Weg zur Lösung dieses Problems, der mit Erfolg angewendet wurde, **wird** beschrieben.

Balanza de vapor en un central azucarero y operación de turbinas

Expansión en etapas de la producción de un central azucarero ocasiona problemas de desequilibrio en la sistema de vapor. Un método de superar esta problema se describe que se ha empleado con éxito.

Steam turbine development in the beet sugar industry

By G.H. PLATT
(APE – Allen Ltd., Bedford, England)

Introduction

The beet sugar industry, in common with many other process industries, employs back–pressure turbo-alternator sets to provide economical electrical power as a by-product of the process steam being used. Because of the continuous nature of the process, it is very important that the turbo-alternator sets used have a high reliability and availability. Should the generating plant be shut down for maintenance or repair during the processing period, then the resulting plant down-time can be very expensive in terms of lost production.

The beet sugar industry has a very particular requirement for high reliability and availability because of the seasonal nature of the product refined. The 4 or 5-month harvesting period before deterioration of the crop takes place means that there is no time for maintenance or other shut-down condition. As the beet sugar industry is largely dependent on non-renewable fossil fuels for its energy supply, then a further premium is placed on high efficiency as well as reliability.

G. H. Platt

Back-pressure steam turbines have been used in the beet sugar processing industry since the early part of this century. Those early turbines were rated for relatively low steam conditions with boiler pressures of approximately 11 bar and for outputs of only a few hundred kilowatts. In such installations, a great deal of steam was required in the process which was rather inefficient thermally. The diffusion batteries in use operated at high draft. The vacuum pans had a high static head and small downtakes. The heating surfaces in the evaporation systems and in the juice heaters were rather small and, in consequence, a great deal of steam was sent to the condensers. This resulted in the loss of a great deal of the heat energy supplied. The steam rate of the turbines supplied at that time was of the order of 20 kg/kWh, and turbine outputs were generally below 1000 kW.

In the years following the second world war, there was a drive to reduce steam usage by improving process performance. Continuous diffusers were introduced of a much lower draft than previously so that less evaporation was needed. This, together with the introduction of greater heating surfaces, resulted in a considerable reduction in the amount of steam required. Boilers remained for a time between 11 bar and 17 bar rating, however. With slight increase in boiler pressure, steam inlet temperatures were also increasing, as also were the electrical loads. The abolition of flat belt drives and the introduction of more electric motors and high-speed centrifugals were the principal reasons for this increase in electrical load requirements and, consequently, for an improvement in steam rate from the steam turbines used. At the same time the crop yield per hectare was increasing, with consequential increase in throughput of beet in the factories. Total power requirement of the factories was therefore increasing rapidly and this was reflected in the ratings of the turbines installed.

Electrical demands

As well as the increase in power resulting from the increased throughput of beet in the factories, power-to-steam balances have also been affected very much by changes in the type of product. There has been a particularly increased demand for special sugars, such as icing or caster sugars, which require considerably more mechanical handling during processing. This additional mechanical handling has not only increased the need for electric motors and therefore additional power from the turbo-alternators, but removal of the dust created during handling has also increased the power used by the plant.

Domestic legislation in many countries has resulted in more stringent requirements being met for effluent treatment before discharge of water back into rivers. At the same time cooling towers have been introduced. These have motor-driven pumps and cooling tower fans, which again add to the requirement for electrical power in the plant. The introduction of plant for dried pulp nut production has again increased the power demand. Sugar quality has been improved with the use of pan stirrers, but the net result of all these additional power loads on the plant has meant that there is no possibility of obtaining a steam-to-power balance with 17 bar steam pressure boilers.

In consequence, therefore, boiler pressures have risen to 32 bar and even to 43 bar in order to maintain the balance between steam and power. Auxiliary services for higher pressure boilers also consume high levels of power. The steam to power balance has been further upset by the storage of juice during the harvesting and processing period for subsequent crystallization in the off-crop period. This latter feature of modern beet sugar factory operation has had a marked effect on steam to power balance. The changes in steam rate which have taken place are summarized in Table I.

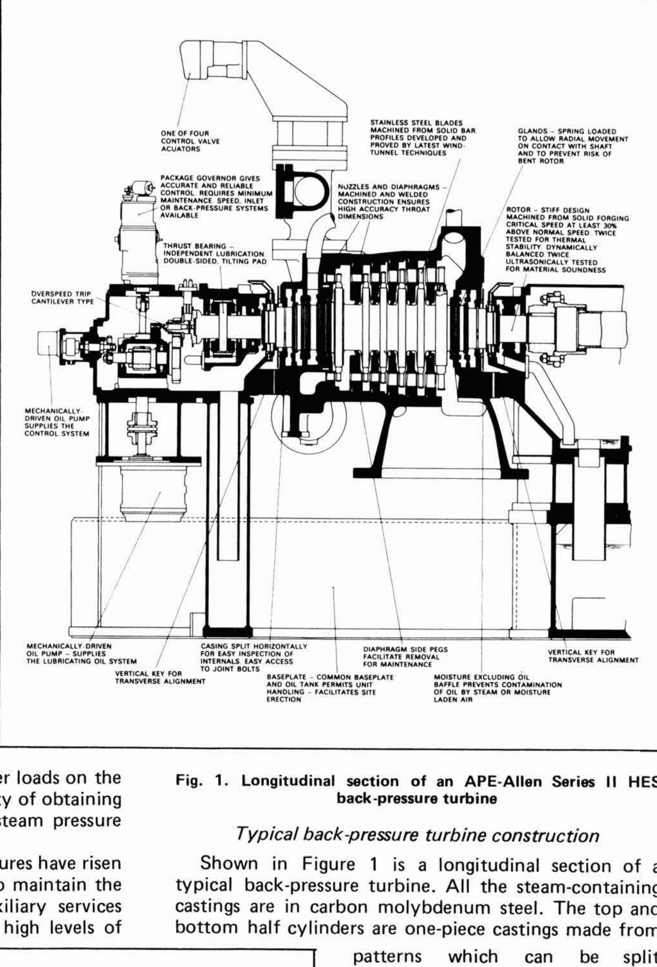


Fig. 1. Longitudinal section of an APE-Allen Series II HES back-pressure turbine

Typical back-pressure turbine construction

Shown in Figure 1 is a longitudinal section of a typical back-pressure turbine. All the steam-containing castings are in carbon molybdenum steel. The top and bottom half cylinders are one-piece castings made from patterns which can be split vertically to provide a top or bottom exhaust position. During manufacture, all castings are ultrasonically inspected and water pressure-tested to establish their soundness. The cylinder is supported at each end by two cast palm supports which are an extension of the main cylinder joint flange but raised vertically to give true centreline support. The transverse alignment of the cylinder and pedestals is maintained by a vertical key on the vertical centreline of each bearing pedestal. The casing is located axially by

Table I.

Turbo-alternator output, (kW)	Inlet steam pressure, bar	Inlet steam temperature, °C	Steam rate, kg/kWh	Approximate date of installation
1000	11.4	240	20.0	1940 to
2000	12.0	270	19.5	1949
2500	17.0	325	15.2	1950 to
3000	26.0	390	11.2	1959
2500	26.0	360	11.6	1960
4000	27.5	400	10.3	to
7500	27.5	380	8.8	1969
5000	43	415	8.4	1970
10000	43	410	8.0	1973
12000	44	450	7.5	1978

transverse keys of the exhaust end palms, which ensure axial growth of the cylinder towards the steam inlet end.

The turbine rotor is machined from a solid forging of 1% chrome molybdenum vanadium steel and is designed such that its first critical speed is well above any operating speed or overspeed. During the course of manufacture, the rotor is subject to many inspection procedures including ultrasonic investigation and is dynamically balanced during manufacture and also after works testing.

The journal bearings supporting the rotor are of the offset half type. The double-sided tilting pad thrust bearing is of the flooded type with chamber-to-shaft oil seals floating, spring-loaded and whitemetal-lined. The journal bearing oil baffles are triple knife-edged with catchers on the inboard side. Several throwers are provided on the turbine shaft and the outboard cavity of the knife-edge baffles is vented direct to atmosphere at both steam and exhaust ends.

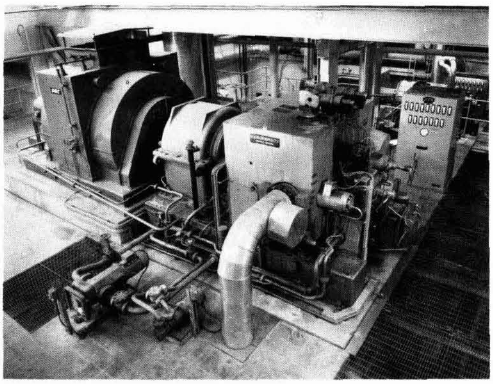


Fig. 2. A 12000 kW APE-Allen turbo-alternator installed in 1978. There are four control valves and the control system oil pressure is 100 bar. Inlet steam conditions are 44 bar, 450 °C. Just visible in the background is a 5000 kW Allen turbo-alternator installed in 1968

The turbine has four separate control valves and separate emergency valves. The turbine control system is the 100 bar arrangement described below. The diaphragms and nozzles are of conventionally welded construction, supported radially and transversely with keys and dowels on vertical and horizontal centrelines. Copper crushing pegs fitted to the inlet side of the diaphragms ensure easy removal from the cylinder grooves. All the diaphragms carry spring-loaded glands. Spring-loaded glands are also used on the main shaft labyrinths. The turbine and gearbox are mounted on an oil tank baseplate.

The turbine shown in Figure 2 is of the type described above, rated at 12,000 kW and installed in the British Sugar Corporation factory at Bury St. Edmunds in England.

Governing systems and controls

It is the governing and control systems of steam turbines which have been the most greatly affected by the changes which have taken place in the beet sugar industry. The early turbines installed were generally of large diameter with high inertia, running relatively slowly on low steam conditions. As powers have increased and also steam conditions, then the specification of an adequate governing system has become more arduous.

In a typical beet sugar factory turbine installation, there is a steam by-pass system around the turbine. This by-pass system is arranged to pass steam directly from the boiler through a pressure-reducing desuperheating station to the process pressure. The by-pass steam and the exhaust steam mains from the turbine join before going to the factory. The by-pass flow is generally of the order of 10% of the steam generated. The by-pass pressure-reducing valve is pressure-controlled to maintain the factory process pressure at the selected value. The turbo-generator is generally output-controlled and supplies power to the factory independently of any external supply. The turbine speed governor controls the opening of the inlet steam valves, so that sufficient steam is passed to meet the electrical power demand at

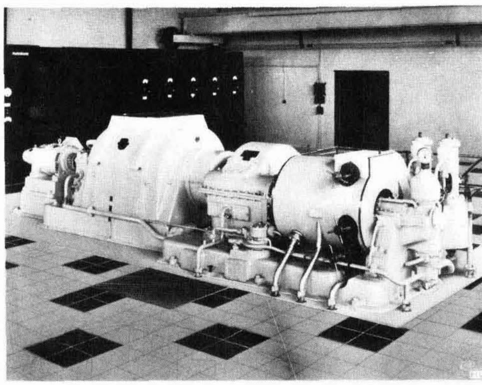


Fig. 3. A 2000 kW Allen turbo-alternator installed in 1945. The turbine has one throttle valve and 3 hand valves. Inlet steam conditions are 12 bar, 270 °C

all times. The full requirement for process steam is met by passing the additional flow through the by-pass line.

The very earliest turbines supplied to the beet sugar industry had a single throttle valve, lever actuated by the turbine speed governor together with a number of hand valves controlling additional groups of nozzles which were opened as the loads on the machine

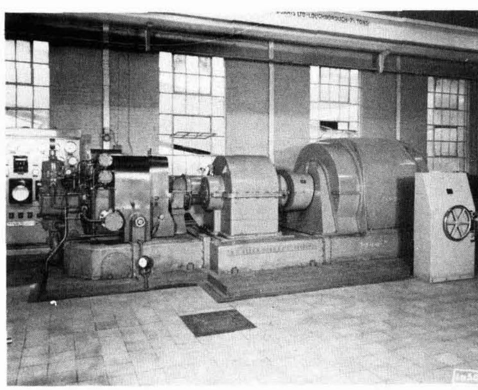


Fig. 4. A 3000 kW Allen burbo-alternator installed in 1959. The leverless oil relay governor operates six sequential automatic nozzle control valves. There are no hand valves. Inlet steam conditions are 20 bar, 320 °C

increased.

Later, turbines supplied made use of the relayless governing system (Fig. 3), where the single throttle valve was controlled by means of a hydraulic output from the speed governor. These turbines still retained hand valves to control other groups of nozzles which were opened when machine loads increased. Eventually, as the outputs of the turbines increased, some of the hand control valves were replaced with four automatic nozzle control valves although a single hand valve was often retained for overload. These four automatic valves were mounted vertically above the steam inlet chest.

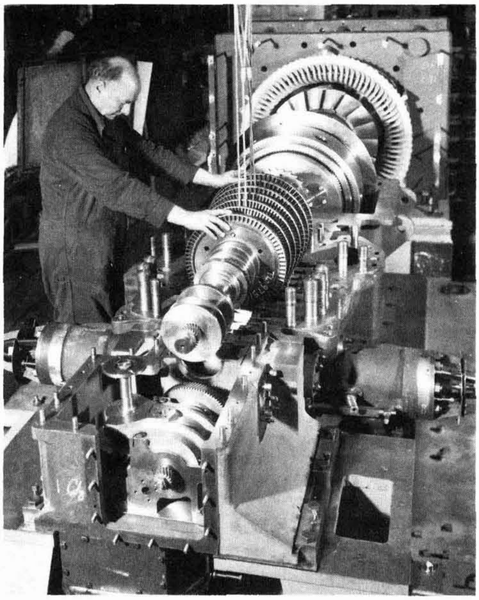


Fig. 5. A 4500 kW Allen HES Series I back-pressure turbo-alternator supplied to the European beet sugar industry

As steam inlet temperatures rose, further changes took place in the control system arrangement. The use of an always-open group of nozzles and the hand nozzle valve was discontinued. The leverless oil relay governor was retained and it was arranged to supply oil to six sequential automatic nozzle control valves (Fig. 4). These six valves were arranged horizontally, three each side of the turbine. This change in arrangement meant that in the event of an oil leak, the oil would not fall on to hot lagging. The use of these six sequential nozzle control valves meant that the most economical steam consumption was obtained at partial loads on the turbine. In the later stages of application of this type of governing system, large quantities of oil were necessary to ensure that the response of the control system met the specifications laid down.

In the past 10 years or so, steam pressures and temperatures have risen and throughput of steam has increased to meet the higher steam and power demands of the factories. Turbines have tended to become slightly smaller and to run at much higher speeds than previously (Fig. 5). To meet the governing requirements for such a turbine, with a relatively low inertia shaft system and high stored steam, then excessive quantities of oil would have been necessary if the older type of governing system had been retained.

Instead a whole new governing system has been developed, operating on relatively small quantities of oil with pressures of 100 bar. This system is shown in Figure 6. Small actuators are used to position the control valves. These have feedback, precise position control and high stiffness with very fast response. A packaged speed governor is employed, the output from which is used to move a modulating valve which directs modulated pressure oil to each of the valve actuators. The modulated oil pressure signal causes the valve actuators to operate sequentially. The package governor is designed to accept an external standard air pressure signal in the range 0.2 – 1.0 bar which can be used for additional control functions, such as exhaust pressure control, inlet pressure control, import or export load control. The hydraulic system includes accumulators which deal with transient demands for control oil.

The basic governing system is used in large and small turbines and provides the very rapid response necessary to achieve the good governing characteristics demanded in a modern beet sugar factory.

The hydraulic control system is interlocked with the turbine lubricating oil system, so that the control valves cannot be opened until the lubricating oil pressure is

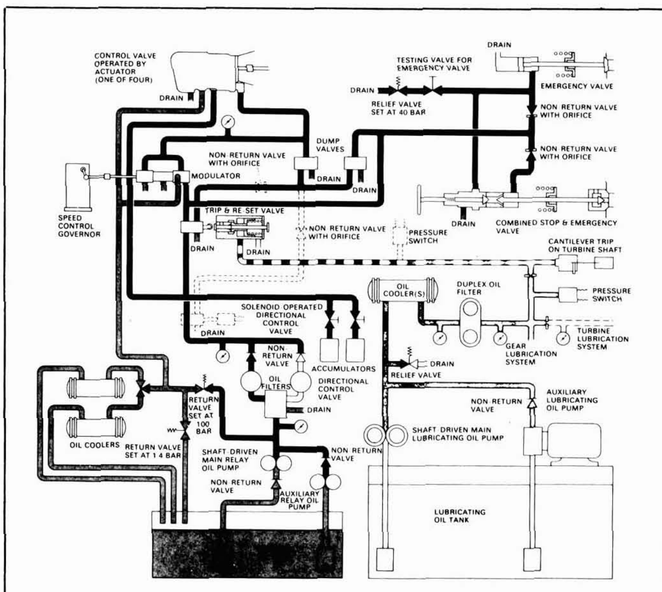


Fig. 6. Speed-governing 100 bar control oil system and lubrication system diagram

at the pre-set level. In the event of a loss of lubricating oil pressure during operation, therefore, the control system will close down and stop the turbine safely.

Maintenance and reliability

During the short but intense beet sugar campaign, the requirement for high reliability with minimum or zero maintenance is obviously very high. In the early applications of steam turbines for the sugar industry, it was considered desirable to use several small steam turbines for the factory power requirements; an unscheduled stoppage of one unit would not have a major effect on production rates. However, several small turbines cost considerably more than single turbine of the same total power output. This, together with the proven reliability of the turbines installed in the beet sugar industry, led to the installation of single units to meet the electric power requirements of a sugar factory. In addition to the saving in cost which results, there is a further benefit in terms of the higher efficiency of the higher power steam turbine. The power of turbines installed has, in fact, risen from 450 kW in the early part of the century to 12,000 kW some 60 years later.

Auxiliary equipment

All recently installed turbines are fitted with duplicate 100% duty interconnected oil coolers with interlocked oil changeover valves. This enables an oil cooler to be cleaned without interfering with the continuous operation of the turbine and it also means that a tube failure in one of the coolers will not necessitate a shutdown. Where, because of legislation on the discharge of effluent, a factory uses cooling water from a total recirculation system with a cooling tower, then the cooler is fitted with stainless steel tubing because the cooling water contains ammonia from the beet process. Where cooling water is taken from a river, the coolers have cupronickel tubes to provide protection against chlorine used to dose the water to prevent fouling of the tubes.

Duplex-type pressure oil filters are used to permit changing of a filter element whilst the machine is on load. As boiler pressures have increased over the years, greater attention has been paid to the purity of the boiler make-up and full demineralization plants are used. However, despite tight controls of make-up water quality, the steam supplied to the turbines may contain small quantities of ammonia and carbon dioxide. These impurities will not harm the turbine whilst it is hot but, as most beet sugar turbines spend a great part of the year shut-down in the off-crop season, these impurities can then cause serious corrosion of turbine internal parts. Whilst these internal components can be plated to resist corrosion, this is not really justifiable when corrosion can only occur when the turbine is shut-down for any length of time. The turbines are therefore arranged so that hot air can be passed through them. Motor-driven blowers with electrical heating elements are connected to the turbine by a flexible pipe on the turbine side of the exhaust isolating valve and hot air is blown through. During this operation the automatic steam inlet control valves are opened.

It is also possible that sugar and other solids will be carried over into the turbine in the steam from the boiler. Although the possibility of this happening is much reduced, because of the attention paid to make-up water quality, provision is still made for washing of the turbine internals by clean condensate, prior to the turbine being closed down at the end of the processing season. Condensate at a temperature of approximately 83°C and a pressure of 2-3 bar, is passed through the turbine whilst it is running at a very much reduced speed, until the drain water in the exhaust is clear and uncontaminated. The condensate feed is then closed down and the turbine slowly brought up to full speed for a short period to dry it out.

Early turbines in the beet sugar industry were fitted with turbine-driven auxiliary oil pumps, used to supply oil for starting purposes. As the size of the turbines increased and boiler pressures and temperatures were raised, it was considered that the boilers were unable to provide sufficient steam on shutdown to allow the turbine auxiliary oil pump to run long enough to cool the turbine bearings adequately. The steam driven pump was therefore replaced with a 100% duty rated electrically driven auxiliary oil pump which, as well as being started manually, is arranged to start automatically on loss of oil pressure due to failure of the main turbine shaft driven oil pump. With a 100% duty auxiliary oil pump, it is possible to continue to operate the turbine should the main pump suffer a failure, providing of course that the reason for the failure is investigated and the faulty component isolated.

The availability of an electrically driven oil pump confers a further benefit on the operation of the steam turbine in the sugar industry. Using the auxiliary oil pump, the governing and control hydraulic systems and the lubricating oil systems can be checked before the processing season starts, without the necessity of raising steam on the boilers.

Many turbines are also provided with a small d.c. motor-driven auxiliary oil pump, taking power from batteries, for use in the event of an emergency shutdown in the situation where public utility supply of power is

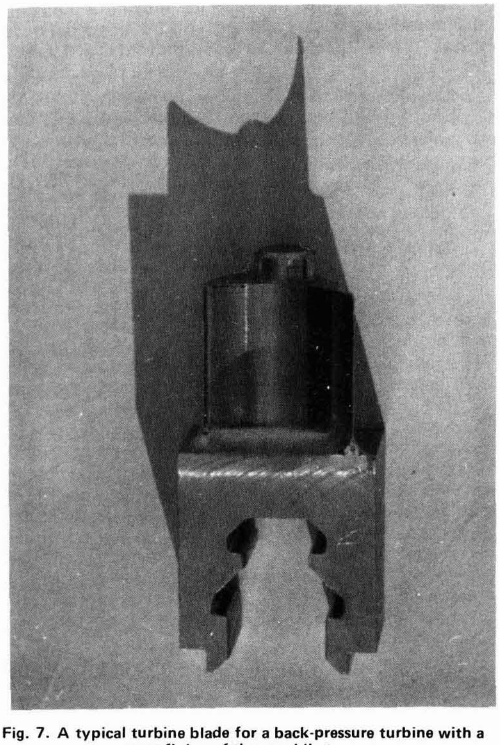


Fig. 7. A typical turbine blade for a back-pressure turbine with a root fixing of the straddle type

not available. Keeping oil circulating through the bearings prevents damage to the whitemetal surfaces from heat conduction along the shaft from a hot turbine.

As the atmosphere in sugar factories may contain particles of sugar dust or lime dust, generators are normally totally enclosed and water-cooled. Exciters are often fitted with air inlet filters and electric heaters prevent condensation in the alternator stator when the machine is shut-down during the off-season.

Bearings

The turbine bearings have also been subjected to change over the years, to keep pace with the developments of the steam turbines. Originally plain bearings were used on the relatively low speed turbines. As speeds increased and bearing duties became more arduous, damgroove type bearings were used to improve oil distribution and to ensure that the shaft system was stable. In later turbines when high powers were being obtained from small light turbines, offset half bearings began to be used.

Blading

To meet requirements for high efficiency, whilst retaining high strength, changes have taken place in the blades used in the steam turbines. High-speed cascade wind tunnels and experimental turbines have been used to develop new blade shapes to provide the high levels of efficiency required. Together with this development have come changes in the blade root fixing, to enable the high loads imposed by tall blades running at high speeds to be carried safely. Figure 7 shows a straddle root type of blade fixing, which has been the subject of considerable laboratory testing and analytical design studies, to ensure it was adequate to meet the duty and safety requirements of a back pressure turbine blade. Blading of this type has seen considerable service in a wide variety of turbines and very many process industries.

The future

It is difficult to identify precise dates for changes in the beet sugar industry. The process of development is a continuous one. Historically the requirements for steam turbines for the beet sugar industry have required more and more powerful turbines to meet the increased product throughput in the factories. As steam conditions have increased to meet the changing power to steam balance, caused by improvements in the process efficiency and product changes, then steam conditions can be expected to continue to increase in the future to meet even greater improvements in efficiency in the process.

Greater fuel economy is continuing to be achieved by the application of counter-current heat exchanges. Evaporation balance will only be achieved by vapour recompression. The compressors for vapour recompression will either require electrical power or single-stage turbine drives and this again means a change in the power to steam balance. The turbines to meet the requirements are already available and have proved their suitability in other industries. The governing systems which will be used will be the 100 bar system already described and currently showing excellent service in the beet sugar industry.

Conclusions

The history of the beet sugar industry is one of continuous development and improvement. A part of this development has been the continuous improvement of the steam turbine and its associated equipment to provide the efficiency and reliability so necessary to a continuous process industry.

C.H.P. (Combined Heat and Power) is a relatively modern piece of phraseology used to describe a system of factory operation which has been so much a part of sugar beet processing for several decades – i.e. the production of the factory electrical power requirements from the same steam eventually used in the process and achieved by first raising that steam to a high pressure and temperature and then expanding it in a steam turbine to produce the power. The economies to be derived are well appreciated by the beet sugar and other industries where approximately 80% of the heat supplied in the fuel can be converted to useful power and heat. Many beet sugar factories originally had coal-fired boilers. In later expansions and equipment replacement programs, the factories installed oil and natural gas-fired boilers. With the recent rises in costs of these two fuels it is certain that there will be a return to coal firing in the future.

Whatever the fuel, steam will always be required for the process and the steam turbine will be required to supply the electrical power reliably and economically.

Acknowledgements

The author thanks Mr. W. M. Lanyon of the British Sugar Corporation for his valuable comments during the preparation of this article and also the Directors of APE-Allen Limited for the permission to publish it.

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Summary

A survey is presented of steam turbine development and use in the beet sugar industry.

Le développement de turbines à vapeur dans l'industrie du sucre de betterave

On passe en revue le développement et emploi de turbines à vapeur dans l'industrie du sucre de betterave.

Die Entwicklung von Dampfturbinen in der Rübenzuckerindustrie

Es wird eine Übersicht über Dampfturbinen-Entwicklung und -Anwendung in der Rübenzuckerindustrie gegeben.

Desarrollo de turbinas a vapor en la industria azucarera de remolacha

Se presenta un examen del desarrollo de la turbina a vapor y su empleo en la industria azucarera de remolacha.

Czechoslovakian sugar expansion plans[1]. – Between the present and the year 2000, Czechoslovakia intends to increase sugar beet and beet sugar production substantially although it is not intended to expand the area devoted to beets. The area to be sown to beets is to reach 220,000 hectares, only slightly above the 218,000 ha which is the average established over the period 1977/80. Beet production by 2000 is to reach 10 million tonnes, against an average of 7.3 million tonnes for 1975/79, but the former figure apparently includes sugar beets for animal feeding purposes. Sugar production by the year 2000 should be of the order of 1,200,000 tonnes based on an average sugar content of 17%.

[1] F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 446.

Energy conservation studies in the beet sugar industry

By PETER VALENTIN (Süddeutsche Zucker-AG, Mannheim, Germany)

The price of heat in the thermal power plant of a sugar factory is determined by the fuel used for electrical energy generation. Purchased electrical energy is the most expensive form of primary energy at our disposal. It is well above light oil in cost and, moreover, variable tariffs complicate cost supervision with this type of energy. With use of light oil or gas, measures for reducing noxious emissions must also be considered but it is to be expected that gas, including synthesis gas, will increasingly be substituted for oil since its price is currently about 60% of that of heavy oil.

The future use of alternative fuels will increase in importance. A cost-balancing conversion of biomass, e.g. beet pulp, by pyrolysis to gaseous or liquid energy carriers, production of ethanol or methane, or even direct firing seem questionable on examination of the energy balances but cannot be ruled out for the future. Use of different kinds of fuel should by all means be pursued but it should be borne in mind that all fuels, including coal, are so valuable that the obligation to use them efficiently and sparingly should be self-evident.

Our investigations have been restricted to the feasibility of techniques whereby, based on possible supra-regional conditions, we can quickly ensure processing of the beet crop. Such programs cannot be evaluated with economic parameters.

Energy conversion and fuel utilization efficiency

Primary energy is converted in sugar factories into two different energy forms, electrical energy and heat for heating purposes. Proper evaluation of fuel utilization for the two forms of energy is difficult by comparison with a power station used exclusively for energy conversion to electricity. There are various and, to a certain extent, contradictory views, based on exergy, reversibility of energy form and, last but not least, current market price.

Conversion to heat for heating purposes entails no problems and is carried out at about the same high efficiency for all techniques. Process heat, although one of the lowest value forms of energy, is nevertheless an important component in joint power/heat economy, providing economical utilization of energy right up to discharge of waste heat. Only utilization of heat for heating purposes in sugar manufacture permits the economical conversion of fuel to electricity. These facts highlight the importance of using factory power plants. Analyses from the off-season, when the factory power plants are not working and energy is taken from the grid, demonstrate this.

During plant shutdown processes such as liquid sugar manufacture, levulose and cube sugar production, biological water treatment, heating, etc., which have a high energy requirement, are carried out. During the campaign, the following are required: (1) use of high-grade thermal power plant, (2) reduction of operational energy consumption, (3) programming of heat consumers with the aim of economical thermal power coupling and optimization of conversion processes, and (4) avoidance of the need to buy electricity.

P. Valentin

Increase in the proportion of energy conversion to electricity, combined with successful measures for heat engineering rationalization, in the sugar factory process leads to an imbalance between electrical and heat energy. It is beyond dispute that the back-pressure steam turbo-generators used in sugar factories where heat in exhaust steam is utilized attain a fuel utilization efficiency which is achieved in scarcely any other process. This high efficiency in such relatively small thermal power plants with high specific capital costs is comparable to that of the many times larger power stations in the public sector. Pre-requisite is the complete utilization of exhaust steam.

Studies on the use of new thermal power plant systems with a higher electrical energy component start with the assumption that the fuel utilization efficiency must be maintained at approximately the same existing high level. The emphasis lies on raising the ratio of generated electricity to heat while maintaining high fuel efficiency; the surplus electricity generated is generally small and will disappear in time since further heat savings are planned. To adapt to this enforced development we are looking for ways of increasing the power yield from the plants.

Development of thermal power plants for the sugar industry

The use of back-pressure steam turbines with condensing sets located after them provides a good increase in electrical output at relatively high entropy expansion efficiencies of 82% and a condenser vacuum of 0.1 bar. However, the fuel utilization efficiency falls off rapidly. Consequently, this development route is not to be recommended, even with use of part-condensing turbines (bleeder-type turbines).

Increasing the thermal gradient must therefore be achieved by raising the boiler pressures. For the Südzucker factories these pressures are 64 and 80 bar at approx. 500°C, values which still permit use of ferritic steels. Higher pressures demand intermediate superheating because of the back-pressure. We have to weigh the advantages of an increased proportion of electrical power against a greater pressure fall in the intermediate superheater, a fall in the mechanical efficiency and a rise in the demand for "home-produced" power. The use of higher pressures cannot be ruled out in the future but they have not been adopted up to now because of the short service life of the plant and the relatively small size of the boilers (less than 100 tonnes.hr^{-1}).

Current investigations are being conducted on a new generation of combined gas-steam thermal power plants which produce three times the electrical energy of back-pressure turbines for the same supply of process heat. These are gas- or oil-fired diesel generators or gas turbines, the combustion gases from which, at 500°C and 11-16% oxygen content, are mixed with fresh air and used for combustion in a waste heat boiler.

Existing low-pressure boilers may be adapted for this purpose but require rearrangement of the convection heating surfaces in the form of tube bundles in the gas stream to radiation heating surfaces in the form of cooled combustion chamber walls. The nitrogen oxides in the waste gas can be maintained within desired limits at reduced temperature and the waste heat recovered thoroughly.

The process permits energy to be used for heating right down to low temperatures. The gas-steam thermal power plant with stepwise heat extraction for heating purposes under different conditions (Fig. 1) is suitable for the power heat coupling required in the sugar factory, while the fuel utilization efficiency is much higher than that of the pure energy power plant. Coupling it to components of the existing thermal power plant (waste heat boiler, back-pressure turbine, etc.) makes the gas-steam plant valuable because of the wide range over which it can be used for extensive load variations (covering of load peaks and troughs) while it also serves as a reserve unit.

The use of coal dust firing is another development to be seriously considered. Development of fluidized bed firing is already in its second generation and non-pressurized processes are being replaced by pressurized processes to give a higher combustion chamber efficiency and

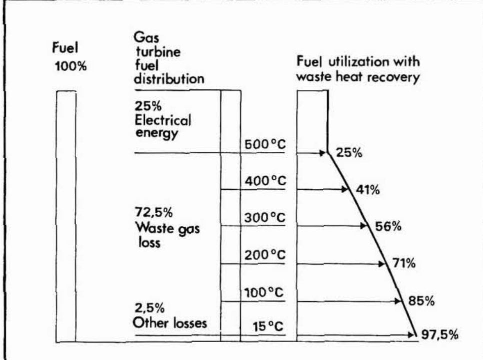


Fig. 1

allow the use of gas turbines. Fluidized bed processes permit burning of low-grade coal, as is well known.

The investment costs for coal-fired steam generators, particularly those using fluidized beds, are much higher than for steam generators designed for the burning of higher-grade fuels. This is also true for conversions to coal firing, since combustion chamber and duct dimensions, etc., must be altered. The following additional factors must also be considered when making a choice: (a) fuel transport, storage and treatment costs, (2) specific performances (i.e. investment costs of the steam generator), (3) maintenance costs resulting from wear caused by the fuel, (4) noxious emissions, and (5) efficiencies.

The high proportion of electrical energy to be produced in the face of thermal rationalization measures is likely to force us in the future to use high-grade thermal power plants and fuels. The values of potential energy savings attainable with the new generation of thermal power plants described, through power/heat coupling and conversion processes, including the use of heat pumps, are greater than the biggest cost difference which has occurred hitherto between coal and gas or light oil; this explains the road we have chosen.

The thermal power plant concept assumes, first of all, use throughout the year to an extent which corresponds to the energy and heat requirements (the latter for heating purposes) during the plant maintenance period. The plant is operated in conjunction with the existing thermal power plant. During the campaign the new generation power plant will contribute to an increase in the heat saving potential within the factory.

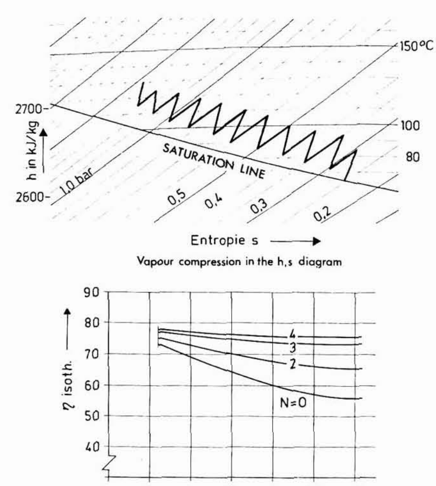
Heat pumps

Heat pumps expand the range of application of conversion processes in the sugar factory. The vapour fed to the condenser from the vacuum pans and the vapour from the pulp drying plant provide a noteworthy potential for heating purposes and can be partially converted into a useful heat flow. The use of heat pumps is necessary for optimum realization of this potential.

Since 1945 such a system has been used on a factory scale for compression of some 25 tonnes.hr^{-1} of pan vapour at Aarberg sugar factory in Switzerland. Multistage isothermal compression is indicated in the h,s diagram in Figure 2. The fluid medium is subjected to intense intermediate cooling during the compression process in order to approach ideal isothermal compression and thus provide an optimum performance (an example is given in Figure 2). The performance coefficient is $\geqslant 4.00$. Heat pumps may also be used to provide process heating.

Figure 3 depicts a system of heat pump connexion to sugar factory process equipment.

Investigations are also being carried out on heat transformers with a new kind of coupling to absorption heat pumps, the drive energy of which consists of low-



Vapour compression in the h,s diagram

Isothermal efficiency η vs. pressure ratio P_2/P_1 and intercooling stages

Fig. 2

temperature waste heat. However, because of the low effective temperature differences, their use has not proved economical up to now.

The range of application of electrically-driven heat pumps is limited as regards electricity consumption. Electric heat pumps, operating at a performance coefficient of 1:3, i.e. producing three parts of heat energy potential for one part of electrical input, convert only

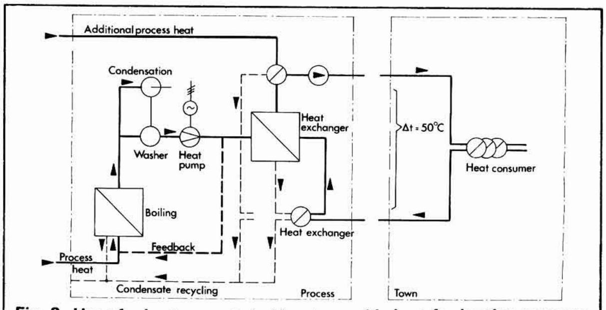


Fig. 3. Use of a heat pump in boiling to provide heat for heating purposes

90% of the primary energy into heat. The use of heat pumps is therefore only promising if energy is available for conversion in the sugar factory. Applications for heat

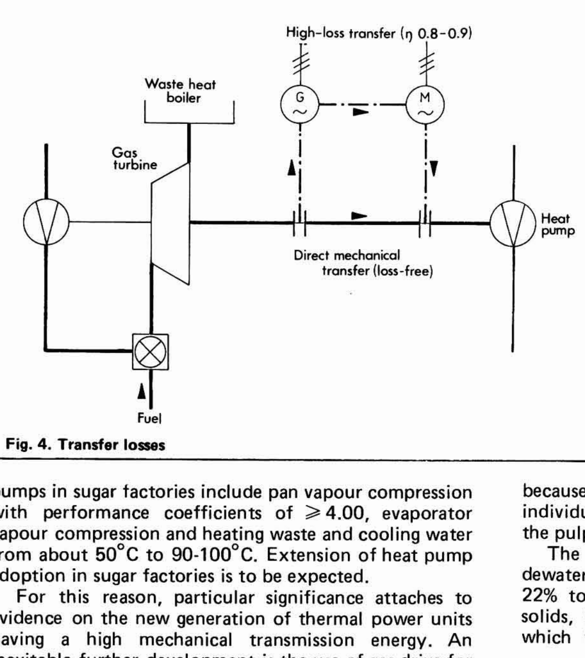


Fig. 4. Transfer losses

pumps in sugar factories include pan vapour compression with performance coefficients of ⩾4.00, evaporator vapour compression and heating waste and cooling water from about 50°C to 90-100°C. Extension of heat pump adoption in sugar factories is to be expected.

For this reason, particular significance attaches to evidence on the new generation of thermal power units having a high mechanical transmission energy. An inevitable further development is the use of gas drive for direct-connected heat pumps in the new generation of thermal power plants (Fig. 4). Transmission losses which occur in the generator and electric drive are avoided. The much-discussed advantage of a gas-driven heat pump using turbine exhaust heat as well as exhaust gas is effected in this case through connexion to the thermal power plant; a higher fuel utilization efficiency results.

Pulp drying

The decisive factor for operation and total costs, as well as evaluation and further development of suitable dry pulp production processes, is the moisture content, and efforts are being made to improve the mechanical separation efficiency of pulp presses. The nature of the raw material is an important factor, however, and the variation in power requirement for pulp presses at the same processing capacity, which may range from 1.0 to 1.7 kWh per tonne of processed beet, is evidence of this.

Important process factors affecting the dry solids content are known to include pulp quality, pH, temperature (which e.g. affects the viscosity of the press water) and the use of additives such as calcium ions. Constraints are imposed by the process, since additives can reduce sugar yield, while excessive temperatures allow nonsugars to pass into solution. There are suggestions for subjecting the pulp to a second pressing after addition of molasses[1]; the molasses addition raises the liquid volume and improves pressability through osmotic reaction of the concentrated liquid phase with the hydrated cell growth substances.

Mechanical dewatering in a dry solids range up to 24% requires high-grade electrical energy of 40 – 80 kJ per kg of water removed while the equivalent thermal drying process requires nearly 3000 kJ per kg. Combustion, i.e. direct conversion of primary energy in the drying gas, is associated with high exergy losses. The greatest losses arise in the combustion chamber and in the drying space as a result of the large temperature differences between the gas and the pulp. Assuming that unsaturated drying air is used, it would be possible to dry even without heat energy input. From the heat engineering point of view, however, the conventional direct-heated drum dryer is not likely to be replaced in the future.

In 1980, Cronewitz examined the total costs of water extraction by pressing and drying[2]. He found that the minimum overall cost is at present achieved at a pressed pulp dry solids content of 25%. However, this value will continue to rise because of increasing energy costs. Coordination of the individual process stages, based on the water content of the pulp, is shown in Figure 5.

The significance for the heat economy of mechanical dewatering of pulp to raise its dry solids content from 22% to e.g. 30%, followed by thermal drying to 90% solids, is seen from the estimated energy requirement which falls from 961 to 649 kJ/kg water removed.

The relation of energy to sugar factory equipment

The drying, treatment and pelleting of pulp loads the thermal power plant of a sugar factory with an electrical energy demand of some 0.6 kWh per 100 kg of beet. The consumption figures in Table I were found by Jakobiak[3] in investigations on a classical drum dryer.

The heat requirement for the drying plant rises when gas turbines are used but the surplus high-grade electrical energy produced (6.16 or 2.66 kWh/100 kg beet) is associated with the same important advantages as already mentioned for power plants.

The potential for gas turbine use in this interesting and (as regards energy economy) positive way should not be over-estimated. It is to be expected that drying

[1] Schneider & Kammerer: DT-AS 2731 285 of January 11, 1979.

[2] *Zuckerind.*, 1980, **105**, 129-139.

[3] "Energieeinsparung in der Schnitzeltrocknung" (Bartens, Berlin).

gas production from fuel through development in the field of pulp drying will be very limited. An extended involvement of the drying plant in the conversion heater circuit of the sugar factory is possible, however. The following list is not claimed to be complete: (1) use of the heat from dryer vapours in sugar factory heat equipment, (2) evaporation at low temperature, (3) flume water heating with jet pumps, (4) raising the temperature of air for heating purposes, and (5) use of boiler flue gas for drying.

Table I. Approximate heat and power relations in classical drum dryers

	Heat energy fraction	Electrical energy fraction	Electrical energy supply	Nett energy consumption
	MJ/kg beet			
1. Drying with direct firing	54.50	0.58	-	55.08 (100%)
2. Drying with direct firing and boiler flue gases	49.81	0.58	-	50.39 (91.4%)
3. Drying with direct firing and waste gas recirculation	51.28	0.29	-	51.57 (93.6%)
4. Drying with preceding gas turbine for the total waste gas stream and energy supply of 6.16 kWh/100 kg beet	84.68	0.88	22.27	63.29 (114.9%)
5. Drying with preceding gas turbine for a partial waste gas stream, direct firing and energy supply of 2.66 kWh/100 kg beet	65.64	0.58	9.67	56.55 (102.7%)

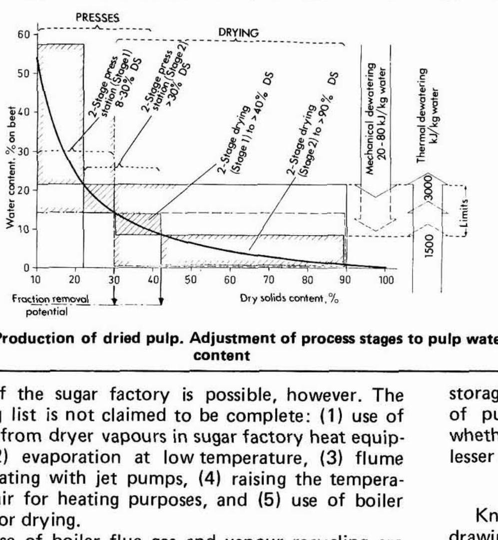


Fig. 5. Production of dried pulp. Adjustment of process stages to pulp water content

The use of boiler flue gas and vapour recycling are similar in their effects on dryer operation. They presuppose greater drum capacities for a given reduction of the hot gas discharge temperature. Their use permits establishment of an optimum excess of air. Cronewitz[2] and Huber[4] have examined the effects of boiler flue gas recycling on the heat requirement for drying and found potential savings of 4.7 – 9.4%. Hutchinson *et al.*[5] found savings of 5 – 6% in a practical experiment on vapour recirculation. This raises the cooling temperature limits during the drying process and the volume of waste gas falls with higher moisture content. One interesting variant is the admixing of dryer vapours with the combustion air, i.e. in the combustion chamber of the dryer; the dust in the waste gases is burnt, reducing emissions, and, according to Stadler[6], the heat saving is 4.8%.

Investigations by Cronewitz[2] on classical drum dryers having diameters of 3.25 and 4.6 m have revealed, with inclusion of boiler flue gases, an optimum heat requirement at cross-sectional loads of 3000 $kg.m^{-2}.hr^{-1}$ or a volumetric load of about 170 $kg.m^{-3}.hr^{-1}$. At higher throughputs the exhaust gas temperature losses increase while at lower throughputs the losses increase through the greater specific volume of gas. Pulp residence time, between 65 and 115 minutes, varied with load and controls and with regard to drying gas heat utilization.

Set against this optimum heat requirement is, however, the use of waste heat from the factory or dryer. The thermal efficiency or specific heat requirement in drying is in practice meaningless at a high input or with exclusive use of waste heat. Experiments are being conducted in this field with aeration dryers in an overall and a partial range with temperatures up to 80°C.

Water removal from pulp has also been tested in 1978 in an experimental unit based on the Carver-Greenfield technique. Pulp to be dried is treated with a liquid carrier, e.g. vegetable oil, and sent to a multi-stage evaporator where the carrier acts as a heat transfer medium. It has to be separated after discharge from the unit and energy savings of approximately 50% are possible[7].

A rotary tube contact dryer is also being investigated in which heat transfer takes place through heating tubes; live steam from the thermal power plant of the sugar factory is used as heating medium and the vapour produced in drying is supplied to the factory heat consumers. In such a dryer, noxious emissions and heat requirements are low but the proportion of electrical energy available to the factory is reduced.

Investigations are being made into the storage, transport, packaging properties and marketing of pulp at intermediate dry solids contents to see whether there is scope for drying some of the pulp to a lesser degree, so permitting a fuel saving.

Heat utilization efficiency

Knowledge of its utilization efficiency simplifies the drawing-up of a heat rationalization program in the sugar factory process. It varies for specific equipment and processes in each factory and an impressive example of high efficiency is the heat consumption for moisture removal in the evaporator which is about 150 kJ/kg against about 2680 kJ/kg extracted moisture required in pulp drying.

Heat requirements can be reduced by optimizing the heat circuitry as well as the type and surface area of the heating equipment while leaving the heat flow unchanged. For example, heat requirements are reduced by the use of a counter-current cossette scalder at the diffuser discharge point. The raw juice temperature is reduced, e.g. from 42° to 32°C, and permits recovery of waste heat from pan vapour before the juice purification station. For a juice draft of 110% the heat saving is 4235 kJ/100 kg beet, equivalent to 0.14 kg standard coal units

[4] *Zucker*, 1977, **30**, 485-489.
[5] *Zeitsch. Zuckerind.*, 1977, **102**, 16-21.
[6] *Zucker*, 1976, **29**, 502-505.
[7] Laumann: *VDI-Bericht*, 1979, (345), 121.

per 100 kg of beet. The total heat flow remains the same, while the heat required from the power plant is reduced.

The shift of a finishing process to the period outside the beet campaign was carried out by Südzucker in 1976 by introduction of thick juice storage at Plattling. The plant was designed on the basis of an increase in heat demand of about 8.5%, offset by reduced capital costs. The results confirmed the prior calculations. In both beet and thick juice campaigns it was aimed to create an equilibrium between heat and electricity consumers, although surplus electricity produced by the factory power plant during both campaigns can be disposed of.

Thin juice is concentrated to 68°Bx in a falling-film evaporator without condenser losses. The heat requirement for the entire plant is only 26 kg of nominal steam per 100 kg beet (2680 kJ/kg) as a result of the 50% reduction in pan boiling because of thick juice storage. This low heat demand is currently the attainable limit for process changes although further reduction in primary energy may be achieved by use of heat pump systems.

A high heat utilization efficiency assumes the use and further development of high-grade thermal processes and equipment including the following items which are not claimed to be a complete list: (1) surface condensers for heating and evaporation processes at low temperature, (2) jet condensers for heating of water and process media at low temperature, (3) low-temperature heat exchangers which make use of the temperature difference in material flows, (4) multiple use of energy through conversion processes, (5) heat pump processes based on drive by electricity, gas and waste heat on the absorption principle, (6) thin- or falling-film evaporators, (7) plate and spiral heat exchangers, etc.

Potential energy savings in juice end processes

The critical factor for heat requirements for juice heating is the raw juice temperature. A high heat utilization efficiency requires optimum dimensioning of equipment, when the effect of raw juice draft becomes secondary to that of temperature. With unsuitable equipment dimensions, changes in draft can cause a rapid rise in heat requirements[8].

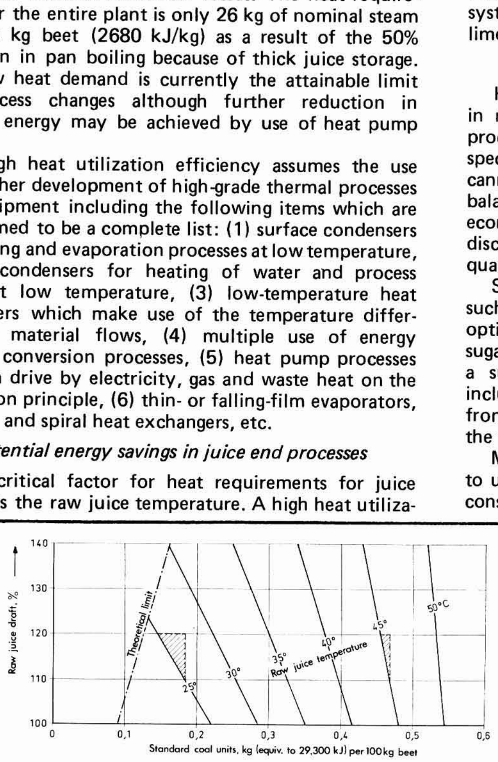


Fig. 6. Heating heat requirement of a diffuser at different raw juice drafts and temperatures. Basis: Cossette temperature 12°C; temperature of water introduced in the balance circuit 50°C

Raw juice temperature is dependent on the equipment and on cossette temperatures, as is well known. Optimum values can be achieved, however, as a result of the temperature pattern in the diffuser, the loading of the counter-current cossette scalder, and the cossette structure, etc. A 10% change in draft has no essential effect on the heat requirement of the diffuser for a raw juice temperature of 45°C. By contrast, for 25°C, such a change in draft causes a three-fold increase in heat requirement (the hatched section in Figure 6). Apart from the effect of raw juice temperature, Fig. 6 shows that a high juice draft at high juice temperatures reduces the heat requirements in diffusion.

In the juice purification station, a systematic logging of heat losses is essential. The excess waste gases in the individual carbonatation stages can be used to heat process media, as shown by Schiweck[9]. Further savings may be obtained by reducing the heat losses in CO_2-containing gas between the lime kiln and carbonatation, gas scrubber and water-ring pumps and in an increased utilization of the heat of reaction liberated during milk of lime preparation. Consideration should be given to resumption of tests, started earlier, on re-calcination of carbonatation mud. A reason for this is the increased solids content of carbonatation mud with new filter systems. Heat balances by comparison with conventional lime kilns indicate that further development is justified.

The sugar house

Heat consumption in the sugar house is dependent, as in no other process station in sugar manufacture, on process parameters. Without further development of the specific process equipment, heat rationalization measures cannot be adopted. As in the other stations, water balances have a fundamental significance for the heat economy of the sugar house, owing to the use of discontinuous boiling and product upgrading to high-quality crystal sugar, both of which need water additions.

Sugar cost can only be competitive against sweeteners such as HFCS in the future if considerable process optimization is applied to the production of crystal sugar. Two-thirds of the primary energy consumption in a sugar factory is represented by the sugar house, including ancillary operations. Non-sugar separation from sugar with the aim of optimum yield is assumed in the following considerations.

Multi-stage crystallization serves – subject to yield – to upgrade the product. Important factors affecting heat consumptions are the additions of dissolving, injection and wash water. This is clear from a comparison between raw sugar and white sugar boiling schemes. Factors affecting heat requirements include:

(1) reduction of conglomerates in order to achieve uniform grain size distribution, giving an improvement in centrifugal performance and a lower sugar moisture content which reduces the heat requirement in drying,

(2) poor crystal quality and grain size, whereby sugar has to be remelted, leading to increase in water usage and thus heat requirement,

(3) a high solids content in the feed charge, necessary for engineering reasons, which creates difficulties in crystallization; water evaporation and crystal growth take place in time phases which are difficult to control and necessitate water drinks,

(4) too low a solids content in the feed, so that the pan must be used as an evaporator, adversely affecting the heat utilization efficiency,

(5) requirements for given grain sizes which, to achieve the necessary control of supersaturation, require water addition,

(6) poor thick juice quality which requires heat concessions in the sugar house process, e.g. supplementary large water drinks in an otherwise rational standard liquor scheme, and

8 Valentin: *Zucker*, 1979, **32**, 695-701.
9 Patent application of June 22, 1979.

(7) the discontinuous nature of pan boiling, which has an adverse effect on operation of the station and the heat consumption.

Included among process parameters having an adverse effect are:

(1) change in the feed density as a result of fluctuations in the heating steam circuit,

(2) change in feed temperature and purity, and

(3) heat transfer in the calandria during discontinuous boiling.

Baloh[10] found the following maximum difference in steam consumption during a strike:

for low-grade product	1:8
for refined sugar	1:7.3
for 2nd product raw sugar	1:3.25

Mosich[11] found a value of 1:2.25 while Schiweck found 1:3. The following must be adjusted correspondingly:

(i) the feed mass flow,
(ii) the heating steam pressure,
(iii) the pan vapour pressure, and
(iv) the resulting temperature difference between heating steam and pan vapour, relative to a given atmospheric pressure.

A higher partial vacuum can be extremely disadvantageous in this respect. The crystallization rate decreases with falling temperature at constant supersaturation. The equilibrium between pressure head and boiling pressure in the pan is displaced and turbulence becomes worse[13]. These facts acquire particular significance in the processing of low-purity run-offs.

A higher heating steam pressure improves crystal movement in the pan. Limiting factors, however, are colour formation, sugar degradation, and failure to achieve a high heat utilization efficiency in the overall plant. From an almost limitless number of recommended methods, processes and equipment for improving sugar house operation, the following are of significance in respect of heat rationalization;

(1) Massecuite stirrers improve material transfer, crystal properties and heat transfer in the calandria, especially in the final phase of the boiling process from 90°Bx. The 10 – 15°C smaller temperature difference between calandria and juice space[13] than in natural circulation pans improves the heat utilization efficiency. The uniform temperature profile in the circulating massecuite which, according to Schiweck[12], is up to 10°C lower than in natural circulation pans, confirms the advantages of pans with stirrers. Investigations of an exploratory nature were carried out by Austmeyer[14].

(2) The secondary effect of stirrers in the initial phase of a strike and the high energy demand in the final phase indicate that the pan technique is still not optimum. Investigations on protraction of the final phase in crystallizers, in which the effect of the stirrer on material transfer is increased, with omission of evaporation/crystallization, are to be recommended from the heat engineering viewpoint.

(3) The production of crystal footing in separate pans, in which a small crystal surface is deliberately aimed for, is the state of the art. The load on the subsequent pans in a main line is thereby reduced. The potential energy saving is mainly as a result of the use of a feed charge of high Brix.

(4) A suggestion by Hoks[15] concerns a reduction of the water injected into thick juice or standard liquor. The feed charge is continuously concentrated to 82 – 85°Bx under vacuum at 100°C with use of conversion heat, and then transferred to the pans. This process can displace the threshold region of the continuous processes in the juice end of the factory right through to the sugar house. It has considerable heat engineering advantages, but up to now has foundered for technological reasons. Schiweck indicates[12] that in the system no attention is paid to the fundamental significance of steam bubble formation in the subsequent pan boiling.

(5) It is recognized, however, that the process is a victim of the state of the art, i.e. of the use of batch vacuum pans. It would be well to pursue the development of continuous boiling with its high potential energy savings.

(6) With existing measures for reduction of water addition, the suggested heat conversion stream and hence heat consumption can also be reduced.

(7) A further saving in heat is also possible through extended use of the conversion process, i.e. in increasing heat utilization efficiency, e.g. with a rise in the Brix to 82 – 85° as recommended by Hoks.

(8) Evaporation and heating with low-temperature pan vapours are already part of the art; if necessary, the number of stages of a multiple-effect can be increased.

In some Südzucker factories approximately 30% of sugar house heat is already being used for such low-temperature processes, including raw juice heating, raw sugar run-off concentration, boiler feed water treatment, etc. An extension of the processes to the low temperature range with the aid of heat pumps could, in an extreme case, lead to the complete crystallization process being carried out with conversion heat. In such a case, the effects of increased water addition (for product up-grading) on the heat economy would be of only secondary importance.

Summary

Areas of beet sugar factory operation which offer opportunities for improvement in energy saving are discussed. The use of gas turbines with waste heat boilers will permit a high electrical:heat energy ratio to meet modern requirements, while the application of heat pumps increases the recovery of energy from low-temperature streams. It is demonstrated that heat requirements for pulp drying may be greatly reduced by more effective mechanical water separation in presses and progress in this field is mentioned. The importance of assessing heat utilization efficiency and reducing losses is emphasized and the wide scope available for improving factory heat economy by better sugar house performance is described.

Etudes de conservation de l'énergie dans l'industrie du sucre de betterave

Les domaines d'opération de la sucrerie de betteraves dans lesquels se présentent des occasions de faire des économies d'énergie sont discutés. L'emploi de turbines à gaz avec des chaudières à récupération permettra un rapport plus haut entre l'énergie électrique et l'énergie calorifique afin de satisfaire aux besoins modernes, pendant que l'emploi de pompes à chaleur augmente la récupération d'énergie à partir de courants à basse température. On démontre que les besoins en chaleur pour le séchage des pulpes peuvent être fort réduits par

[10] Private communication.
[11] *Zeitsch. Zuckerind.*, 1976, **101**, 312-317.
[12] *Zucker*, 1977, **30**, 525-533.
[13] Ziegler: *Sugar J.*, 1978, **40**, (8), 8-15.
[14] *Paper presented to the Verein deutscher Zuckertechniker* 1979.
[15] *Zeitsch. Zuckerind.*, 1975, **100**, 23-29.

SIMUNYE 'WE ARE ONE'

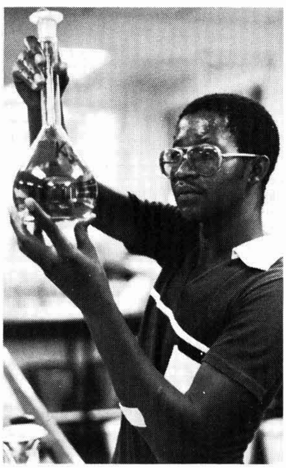
SIMUNYE, the name given to Swaziland's third sugar mill and estate by his Majesty, King Sobhuza II, means "we are one."

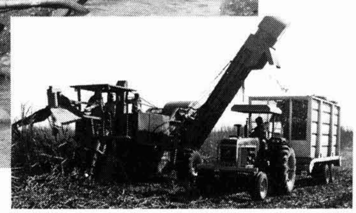
Tate and Lyle is honoured to have been asked by His Majesty and by the Swaziland Government and Nation to implement this ambitious project which will help Swaziland to become Africa's second largest exporter of sugar.

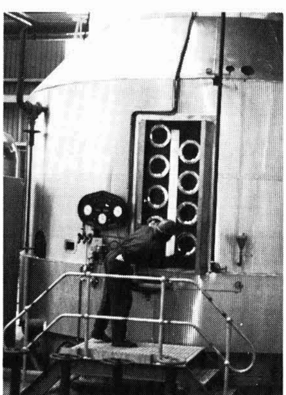
The co-operation between T & L and Swaziland has been in five main areas: conducting the initial feasibility study; equity investment in the project; advice on financing and selling arrangements (for sugar *and* molasses); supply of specialist machinery and equipment; and provision of management and technical know-how for the construction and the continuing operation of the mill and its estate.

Tate & Lyle is also proud to have participated in financing the project with other international corporations and institutions—from Nigeria, Britain, the EEC, Japan, the USA, South Africa, West Germany and many other quarters.

"We are one" has been the theme for all who have been associated with the establishment of Simunye. Unity and co-operation will continue to ensure its successful and prosperous future.







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une séparation mécanique plus effective dans les presses, et on mentionne des progrès dans ce domaine. L'importance de l'évaluation du degré d'utilisation de chaleur et de la réduction des pertes est soulignée, et on décrit la très bonne possibilitè d'effectuer une amélioration de l'économie calorifique de l'usine par une meilleure performance de la station de cristallisation.

Untersuchungen über Energieeinsparungen in der Rübenzuckerindustrie

Der Verfasser diskutiert jene Bereiche des Rübenzuckerfabrikbetriebes, die Potentiale zur Energieeinsparung bieten. Der Einsatz von Gasturbinen mit Abwärmekesseln gibt ein höheres Verhältnis von elektrischer zu thermischer Energie, um den neuen Anforderungen zu genügen. Die Energierückgewinnung aus Niedrigtemperaturströmen durch Anwendung von Wärmepumpen wird verstärkt eingesetzt. Es wird gezeigt, daß der Wärmebedarf der Schnitzeltrocknung durch eine wirksamere mechanische Entwässerung in den Pressen beträchtlich vermindert werden kann. Der Fortschritt in diesem Bereich wird diskutiert. Die Bedeutung des Wärmeausnutzungsgrades und der Verlustverminderung wird hervorgehoben, und die Möglichkeiten zur

Verbesserung der Wärmewirtschaft der Fabrik durch erhöhte Zuckerhausleistung werden beschrieben.

Estudios de conservacíón de energía en la industria azucarera de remolacha

Areas de la operación de la fábrica de azúcar de remolacha que ofrecen oportunidades para mejorar ahorros de energía se discuten. El uso de turbinas de gas con calderas a calor sobrante permitira una relación más alta de energía eléctrica a energía calorífica para satisfacer necesidades modernas, mientras aplicación de bombas de calor creçe·la recuperación de energía de flujos de baja temperatura. Se demuestra que las necesidades de calor para el secado de pulpa pueden reducirse por separación mecánica más efectiva de agua en prensas, y se describen avances en este campo. La importancia del asesamiento de eficiencia de la utilización de calor y de la reducción de pérdidas se subraya y la amplia alcance disponible para mejorar la economía calorífica de la fábrica por un cumplimiento mejor de la casa de cocción se describe.

Developments in boiler design and installation

By R. W. HORTON (NEI International Combustion Ltd., Derby, England)

Introduction

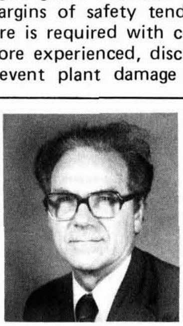
The use of the two-drum boiler becoming widespread within the cane sugar industry in the early 1950's overcame the previous limitations of output imposed by earlier designs, thus making it possible to install fewer large boilers to give the desired total steam output. This trend is continuing and currently plant is operating with individual boiler capacities up to 275 tonnes.hr^{-1}.

The use of the two-drum boiler has also enabled higher steam pressures and temperatures to be used than was hitherto possible and modern construction techniques make available the most modern practices in thermal cycles for power production.

It is therefore unlikely that boilers will impose any technical limitation in a sugar factory steam system. They will certainly not do so if a case can be made for maximum energy conversion by raising the steam conditions to allow maximum electric power to be produced and the surplus exported from the factory.

Steam cycles

Theoretically steam pressures of up to 100 bar or even higher can be justified. Under these conditions higher-grade materials are used for pressure parts and margins of safety tend to be reduced such that more care is required with control of feedwater quality and more experienced, disciplined operators are required to prevent plant damage by maintaining good operating practices, safety procedures and cleanliness.



R. W. Horton

A reasonable practical limit in most sugar factories is for the steam pressure not to exceed 45 bar although pressures above this have been in use for some time, notably in Hawaii.

There has been a gradual change from the widespread use of hearth or cell-type furnaces to suspension firing using various forms of static and moving grate, the dumping grate appearing to be currently the most popular. This trend permits other fibrous fuels, such as hogged wood, which may be available in the locality, to be readily fired as supplementary fuels.

Firing systems

A number of alternative methods of firing have been used with varying degrees of success, for example, static pin-hole grates using steam jets for ash removal and inclined water-cooled grates.

The use of suspension firing with dumping grates has enabled the steam output available from a single boiler to be increased significantly.

NEI John Thompson (Australia) have commissioned a boiler having an output of 275 tonnes of steam per hour at the C.S.R. Victoria Sugar Mill (Fig. 1). This boiler has a width of 12.8 metres and, subject to the method of firing used, there is no reason to believe that the boilers will limit further increase in unit output should the necessity arise.

The lack of a significant fuel bed within suspension fired boilers results in a rapid response to changes in steam demand but, more important, they rapidly lose pressure in the event of an interruption in the supply of fuel to the firing system. More attention must be paid to ensuring that there is always sufficient bagasse available at the boilers and being fed into the furnace.

Very short-term fuel interruptions or shortages can be catered for by the use of long fuel chutes between the bagasse conveyors and the fuel feeders, but this increases the height of the conveyors and hence plant capital cost.

More satisfactory alternatives are either continuous recirculation of fuel from storage to supplement the

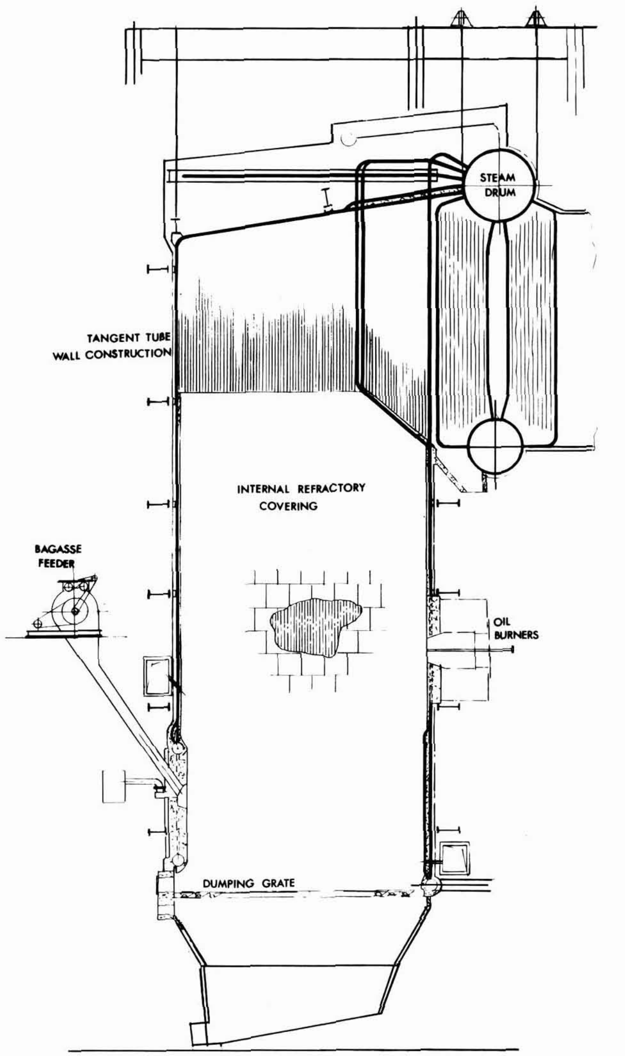


Fig. 1. Bagasse-fired boiler of 275 tonnes per output

flow from the mill, or preferably with fuel storage situated between the mill house and boiler house with mechanical reclaiming such that the fuel supply to the boilers is completely independent of the mills (Fig. 2).

Such equipment may well have a substantial initial cost but there are significant savings to be made in terms of more assured availability of the steam generating system, and fewer interruptions to mill and process plant.

It is normal practice with coal, liquid and gaseous fuel systems and modern wood-fired (chipped or hogged) systems to have fuel storage and transportation systems that will ensure a continuous fuel supply. There is no logical reason why such practices have not been fully recognised as a necessary part of fibrous fuel systems nor why such plant should not be engineered and supplied as an essential integral part of the boiler installation scope of supply.

Another significant saving that can be associated with the provision of a continuous primary fuel supply is the reduced use, or perhaps even the elimination of the need for, auxiliary fuels which should be accompanied by a reduction in the design capacity and cost of the auxiliary fuel storage, transportation and combustion equipment.

Such developments should result in easier boiler operation and provide the opportunity to maintain a situation where power generation and process operation can continue uninterrupted no matter what short-term situation occurs in the mill house.

Long-term situations regarding interruption of the primary fuel supply can be overcome through drying and storage of bagasse and/or the use of auxiliary fuels, but the higher integrity fuel supply system permits ample warning for the operators to prepare the backup fuel supply to the boiler system, thereby maintaining availability and preventing unnecessary loss of output.

Boiler design trends

Current developments in the detailed design of boilers for the sugar industry are mainly concerned with reducing the amount of site work necessary during construction and simplifying operation and maintenance to accommodate the use of lesser experienced labour that is more usually available locally, particularly in developing countries.

Other areas are increased boiler efficiency, because of the demand for bagasse for other economic purposes such as paper and board manufacture and the high cost of auxiliary fuels. Also, the reduction of the emission of grit and chemicals from chimneys is necessary to comply with pollution regulations being introduced in various parts of the world, while a further area is the development of mechanical ashing systems to improve boiler house environmental conditions and reduce labour costs.

Most of the developments usually need to have been well-proven in other industries before being applied to boilers for installation in cane sugar factories, which are usually in geographically-remote locations where spare parts and the necessary engineering expertise for fault analysis and repair are not readily available. Reliability

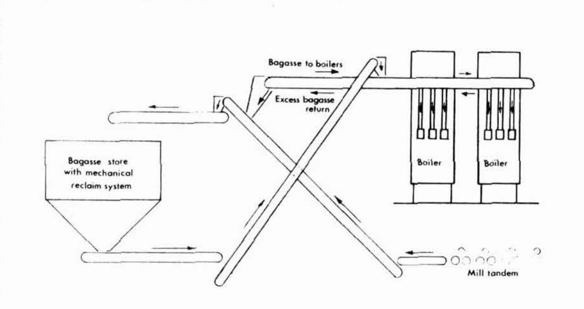


Fig. 2. Bagasse conveying system for continuous feed to boilers

Refractories in preformed shapes are fragile and susceptible to damage during transit from manufacture to site, necessitating supply of erection spares sufficient for requirements to be guaranteed for the timely completion of the construction programme. Castable refractories require careful mixing to ensure that the design properties are obtained, while mouldable refractories have a limited shelf life before they begin to deteriorate. Both require adequate storage, and a stringent curing procedure has to be carried out after construction to obtain the desired properties and maximum service life.

is absolutely essential, the installation of stand-by plant being kept to an absolute minimum in view of the extended periods available for maintenance resulting from the seasonal operation.

In this respect a major development is the introduction of fully water-cooled walls using either tangent tubes or fully welded walls with interconnecting fins between each tube (Fig. 3). This type of construction eliminates the need for a considerable quantity of the refractory applied to the boiler structure.

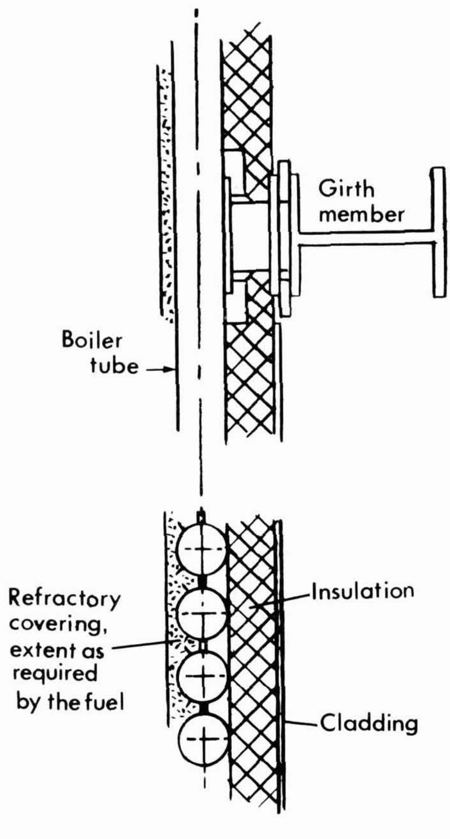


Fig. 3. Typical welded wall construction

The economical use of fully water-cooled wall panels requires maximum fabrication in the manufacturer's works, which, as a result, can be carried out under more suitable conditions than can usually be realized on site. Also, the necessary established quality control and testing facilities are readily available in the manufacturer's works. Panel dimensions have to be selected carefully to permit the most economical transport. In the final evaluation it is not unusual for the ex-works costs to be higher than for a piece small site-erected construction; however, the final commissioned cost of the plant and the capitalized cost, taking account of reduced maintenance and improved availability, should be considered as significant factors in plant selection.

Depending upon the range of moisture content in the bagasse, it may be necessary to include partial refractory covering of the furnace wall interior surface in the combustion zone. This is to maintain sufficient radiant heat in the system to give satisfactory combustion and to achieve re-ignition after any unforeseen short-term interruptions in the bagasse flow. This refractory is usually attached to the tubes by studs welded to the tubes or fins during manufacture. Any local breakdown of the refractory is thus of little consequence over a short period since the heat-absorbing enclosure of the boiler remains intact and safe in operation. Repair can readily be carried out during a short-term shutdown.

To maintain consistent quality and design and generally to improve the service available to the industry, standard boiler designs have been developed where the major variable is the boiler width, the incremental changes being associated with convenient steps in the dimensions or number of units of the firing equipment. Variations in design are usually limited to improvements resulting from continuous feedback of operating experience.

Installation

The control of the final quality of the product is particularly difficult where equipment is installed in remote locations with a considerable amount of site assembly necessary, as with large water-tube boilers. Components have to be handled many times during transport to site and may be stored without adequate protection against the weather until required for assembly and hence can be subject to damage and deterioration.

In such cases there is scope for improvement through designs based upon a modular concept requiring the minimum of site work, and the design to be arranged such that site work involves simple and proven processes. Whichever solution is selected it will only usually be as good as can be achieved by adequate control of site labour and construction staff.

Operating considerations

It is recognized that cane sugar factories impose highly fluctuating loads upon their steam generating systems. As the process steam requirements tend to be steady, these upsets are usually created by putting into or taking out of operation the various items of equipment that involve the use of steam unnecessarily quickly or introducing several steam users concurrently, the inexperienced operator perhaps not immediately realizing the effect this has upon the boiler plant.

Providing that the process steam requirements are constant, reduction of load on turbo-alternators or mill turbines should have little effect upon the boilers if the high pressure to process pressure reducing station and its control system are correctly designed.

As boiler designs have developed, become more compact and more highly rated in terms of steam output per unit of heating surface, the water level in the boiler steam drum has become more sensitive to rapid changes of load which are usually presented to the boiler as changes of pressure. These load changes can occur at such a rate that conventional boiler systems with commercially available, established and field-proven forms of controls, are unable to create changes in water and fuel flow in a manner that will ensure a timely stabilizing effect.

Accepting that, in this context, overall plant operation practices can leave much to be desired, the effects of fluctuating water level can be reduced by the use of larger diameter steam drums and internal steam separation systems which are not influenced by the water level variations.

This, of course, will tend to lead to an increased capital cost for the ex-works equipment supply, but is to be weighed against the gains of fewer interruptions to process operation caused by excessively high or low water levels in situations where operator problems cannot be easily resolved.

Drum water level control of multiple boiler installations, particularly where the feedwater pumps have a steep characteristic, is improved by maintaining a constant feedwater pressure upstream of the individual boiler level controllers, thus making the level controllers of each boiler independent of variations in other boilers. There are various means of achieving this, one of the simplest being constant-speed pumps with a leak-off type regulator, excess water returning to some convenient point in the system on the suction side of the pumps.

Automatic control systems of varying degrees of sophistication are applied to boilers in an attempt to reduce operator involvement. However, the need for a qualified instrument engineer to be able to analyse control system faults and maintain equipment in operation must be fully appreciated and weighed against availability of such personnel in contrast with operators.

Thus, whilst the introduction of more automatic controls may reduce the need in terms of the number of boiler operating staff they will tend to increase the demand for a lesser number of more experienced, and better qualified control systems engineers. Improved availability of control systems can be obtained by enclosing panels in a separate room to prevent the equipment becoming contaminated by fine bagasse particles that inevitably fall from the conveyors.

Heat recovery systems

Traditionally, the problem with bagasse has been one of how to dispose of it as produced from the milling plant, owing to difficulties associated with storage and transport. Consequently, there has not been a widespread tendency to obtain the maximum heat recovery from the fuel.

The realization of benefits associated with preheating of the combustion air supply gave rise to conditions where most boilers are fitted with air preheaters as the only means of heat recovery. These are favoured, as hot air, although not essential, does assist combustion and usually permits higher combustion ratings than can be achieved with cold air. Air preheaters are also "non pressure parts" in boiler terminology and failure of the heating surface, which may occur owing to erosion or corrosion, does not have the same consequences on boiler operation as would the failure of an economizer tube or other pressure part.

The heat recovery that can be achieved by an air preheater is limited by the maximum hot air temperature that the combustion equipment can tolerate. For stokers, the maximum air temperature is approximately 250°C, the actual value varying between manufacturers. Where fuel economy is justified by the ability to burn bagasse in boilers out of crop, as with refineries and distilleries, or the use of the bagasse for other purposes, the boiler thermal efficiency can be increased by the use of an economizer in addition to an air preheater.

Final gas temperatures of 150°C can be achieved quite economically by this method.

Auxiliary fuels containing sulphur, for example oil and to a certain extent coal, impose their own restrictions upon the heat recovery equipment. If the temperature of any surface in contact with the products of combustion falls to the acid dew point, which for oil containing a significant amount of sulphur may reach up to 170°C, sulphuric acid will form on the cooled surfaces and, unless of a resistant material, they will be subject to corrosion. This applies to heat recovery equipment, ducting, fans and chimneys.

Proven methods are available for the prevention of this type of corrosion and begin with correct design of the equipment to maintain temperatures of the critical parts above the acid dew point and the correct material selection.

Methods for maintaining the heat recovery equipment heating surfaces above the minimum dew point temperatures are applied to air preheaters through the use of steam or hot water, air by-passing or air recirculation. With economizers the various forms of feed-water heating such as high pressure deaerators and boiler water recirculation are used. These systems are satisfactory for a boiler plant when firing oil as the only fuel. Where oil is the auxiliary fuel and such measures are not necessary when firing the primary fuel, bagasse, then very good operator discipline is required to ensure that the necessary operational procedures are introduced during periods of oil firing. Conversely, for maximum economy when burning bagasse alone, the bagasse firing conditions must be reverted to completely when the oil is shut off.

Operating experience with bagasse and other solid fuels indicates that, under mixed firing conditions, i.e. bagasse and oil at the same time, a significant percentage of oil can be fired along with bagasse without corrosion being experienced. The carryover of ash and partially burnt solid fuel particles have an absorbing and cleansing effect, but little is known at this time of the limiting values that can be used in design owing to the difficulty of obtaining reliable long-term operational data.

Under conditions of mixed firing the operating procedure tends to be as required by oil firing, hence reducing the potential for heat recovery from bagasse. As a result mixed firing is undesirable.

To achieve further economy, bagasse drying can be applied. This system usually employs the heat in the flue gases leaving the boiler heat recovery equipment to remove moisture from the fuel in dryers. The overall effect is to reduce the flue gas temperature leaving the chimney and hence reduce the heat lost in the flue gases.

Final gas temperatures of 100°C and below may be achieved, giving a 3-4% improvement in the overall plant efficiency.

The reduced moisture content of the fuel enables some boiler economies to be obtained. As the fuel is drier, say 30% moisture against the normal 50%, it is easier to burn and this, coupled with the higher boiler thermal efficiency, enables smaller combustion equipment to be installed for a given steam production. Economies at the boiler may not be as high as first anticipated, because the requirement to maintain the gas temperature entering any convection heating surfaces below ash softening temperature, to avoid heating surface slagging, prevents the effective radiant heat absorbing surface of the combustion chamber being reduced.

Bagasse pulps are used in the manufacture of most grades of paper from corrugated to white bond. In the process the pith is separated from the bagasse and can be used as a fuel or a roughage for animal feeds. Because of its sizing and low density, suspension firing is preferred.

Combustion is very easy but, because of the very fine grading of the material, it is similar to firing of pulverized coal with no combustion taking place on a fuel bed. In these circumstances an interruption in the fuel supply to the boiler resulting in a flame-out could create a dangerous situation on reintroduction of the fuel into a hot boiler, unless either permanent pilot flames are available, or interlocks preventing reintroduction of the fuel without a sequenced start-up procedure are included. There are no other signifiant changes in the boiler design necessary for pith firing.

Environmental considerations

The introduction of restrictions upon chimney emissions into areas hitherto unaffected is necessitating the use of high-efficiency dust collection systems in flue gas streams.

Removal of grits from the flue gases is readily carried out by conventional grit collecting equipment but, to ensure compliance with a specific particulate emission regulation, it is essential that the dust concentration and grading entering the dust collector is accurately predicted. There is a lack of information on this subject and such data that are available are difficult to apply owing to the number of variables involved that influence both the grit quantity, size and density discharged from a boiler. Among the factors influencing grit emission are the type of combustion equipment, fuel grading, moisture content and sand content, gas velocities through the boiler and, not least, the operation of the boiler.

Most of these factors can vary considerably from day to day in a particular boiler and it may therefore be necessary to build significant margins into the grit collecting equipment if the emissions are to be controlled under all modes of operation.

Regulations can specify either the concentration of suspended particulate matter in the chimney discharge or the resultant concentration in the air at a habitable elevation at some point in relation to the chimney. This latter value is dependent upon so many variables that it is almost impossible to determine the grit collector efficiency necessary to achieve the requirements.

A typical requirement for dust concentration at the chimney discharge is 400 mg/Nm^3 referred to dry flue gas at 12% CO_2. Concentrations from a boiler can vary from 1500 to 12,500 mg/Nm^3. Mechanical collectors can only achieve collection efficiences of about 92% depending upon the particle sizing and density, while electrostatic precipitators are not particularly suitable for low sulphur fuels, so that compliance with stringent requirements can only be achieved by the use of bag filters or gas scrubbers. These require a considerable space to be accommodated in the plant layout compared with mechanical cyclone collectors and hence the possible future introduction of high efficiency grit collection equipment should be seriously considered in any new plant layout.

Gas scrubbers are still being developed to select materials of construction that will resist the erosion as well as the corrosive action resulting from the use of sulphur-bearing auxiliary fuels such as oil.

Having installed gas scrubbing, an effluent disposal problem is introduced; the water and grits have to be separated for ultimate disposal, which may be achieved either in conjunction with or independent of the overall factory waste disposal scheme.

In addition to restrictions upon dust emission, limits may be imposed upon other pollutants such as oxides of sulphur and nitrogen which, if applied to sugar factories firing oil, can present high cost remedies.

Ash removal and disposal

A most important area when considering the firing of bagasse in suspension is the design of the system to handle the large volume of high and low density material discharged from the grit collector. The complete plant must be able to handle the worst possible conditions at each refuse collecting point in order to operate successfully.

During the 1970's mechanical ash handling equipment for bagasse fired boilers developed and became an integral part of the boiler plant. A number of satisfactory methods are available divided basically into wet or dry systems. The "wet systems" are usually of the water sluice type (Fig. 4), necessitating a high percentage of make-up water, the quantity depending upon the method selected for solids disposal from the factory.

These are particularly suitable for boilers fitted with dumping grates where the ash is deposited beneath the grate and contains a significant amount of burning or unburnt fuel. The water-filled or sluicing chambers beneath the grates quench any burning material, thereby preventing undergrate fires and grate damage.

The grits from boiler hoppers and dust collectors are deposited in the sluices via water seals and washed away along with the ash to the separation equipment or disposal point outside the boiler house. This method is dust- and smoke-free, contributing to a clean environment. Where gas scrubbers are used for grit removal the effluent can also be readily discharged into the sluicing system to the common disposal point.

Various methods of separation of grits are available giving some measure of water recirculation to reduce the make-up requirement. Make-up cannot be completely

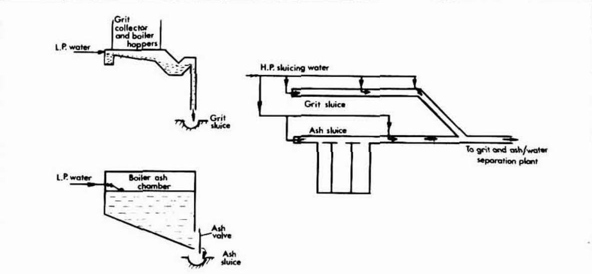


Fig. 4. Typical high-pressure ash and grit sluicing system for dumping grate

eliminated because water is absorbed by the refuse and carried away with it and also ash system blowdown may be necessary to maintain the quantity of fine suspended material at an acceptable level. It must be appreciated that this make-up water does not require to be treated to a potable quantity; however, for effective long-term performance of the system, the concentration of solids held in suspension must be limited.

The dry methods may utilize pneumatic, vacuum or screw conveyors or a combination of these. Some of the simple, mechanically robust, successful systems utilize submerged conveyors beneath the grates and launders beneath the boiler and grit collector hoppers (Fig. 5). As the solid material is separated from the water in the system itself and deposited in a form suitable for removal from site by trucks, they are considered in this context as dry.

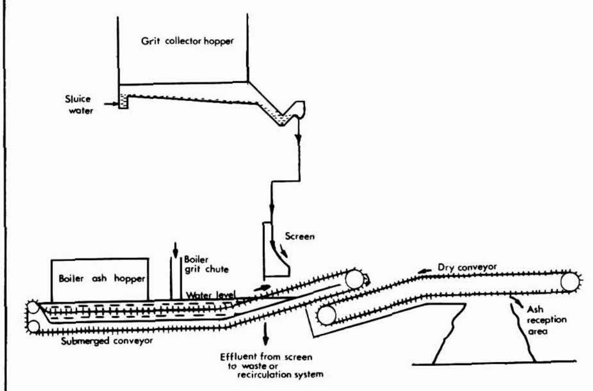


Fig. 5. Typical "dry" ash and grit handling system

As with the sluicing plants, make-up water is required to replace that which is evaporated or absorbed and carried away in the refuse or to replace ash system blowdown that may be necessary to control suspended solids.

Various combinations of these systems can be applied to travelling and dumping grates.

Both wet and dry methods adequately seal the various ash and grit exits from the boiler against air leakage or infiltration.

Boilers for beet sugar factories

There has been little recent major development of the boilers for beet sugar factories. Generally these use either oil, gas or coal as the primary and perhaps only fuel supply and are generally more readily accessible geographically to the major European boiler suppliers. As a result the trend for works prefabrication of boiler parts and the use of welded walls has been accepted for some time.

In the case of oil and natural gas-fired boilers, shop assembled compact units have been used to reduce site activities to the absolute minimum.

The use of coal and fuel oil fed from bunkers and storage tanks respectively, means that a continuous fuel supply to the boilers is much more reliable and therefore the boilers are not subject to the same disadvantages in terms of fuel interruptions as in the cane sugar industry.

Also, largely because of the geographical location of the beet sugar factories, and because of the use of more industrially universal types of boiler plant, spares are easier to obtain and trained operators and maintenance staff are relatively easier to employ. For the same reasons more automatic controls can be incorporated into the plant; this, together with the nature of the fuels used, permits a more integrated smooth control of the complete factory system to be achieved.

Summary

This review indicates the current trends in the design of boilers for the cane and beet sugar industries which are being developed in an integrated manner by the leaders in boiler technology in order to offer the industry conditions that can permit:-

(a) improved cycle efficiency for the factory process, (b) improved economy through the capacity for generation and sale of electrical energy, (c) integrity of fuel supply and rapid response to process demands for steam, (d) furnace designs minimizing risks in relation to refractory and insulation construction that can permit operation in a fail-safe manner, (e) improvements in performance and fuel economy through the provision of improved heat recovery equipment and systems, (f) improved methods for minimizing environmental pollution, (g) realistic instrumentation and control systems appropriately matched to the skill of the operating staff, and (h) improved boiler integrity and availability through the achievement of a controlled quality in manufacture and construction, the minimization of site work, ease of operation and planned preventive maintenance.

L'évolution dans la conception et l'installation de chaudières à vapeur

Cette revue rélève les tendances actuelles dans la conception des chaudières à vapeur pour les industries du sucre de canne et de betterave, et qui sont élaborées de façon intégrée par les grands de la technologie des chaudières afin d'offrir à l'industrie des conditions qui permettent: (a) une plus grande efficacité du système de fabrication, (b) une amélioration économique par la possibilité de produire et de vendre de l'énergie électrique, (c) la fiabilité de l'alimentation en combustible et une réponse rapide aux appels de vapeur par la fabrication, (d) des conceptions de foyer qui minimalisent les risques courus par les maçonneries réfractaires et isolantes, permettant un travail sans défaillance, (e) l'amélioration des performances et l'économie de combustible par l'installation d'un équipement et de systèmes améliorés de récupération de chaleur, (f) des méthodes améliorées pour la minimalisation de la pollution de l'environnement, (g) une instrumentation réaliste et des systèmes de régulation bien adaptés à la formation des préposés et (h) une meilleure fiabilité et disponibilité par la réalisation d'une qualité contrôlée en cours de construction et de montage, la minimalisation du travail sur le chantier, la facilité d'exploitation et l'entretien préventif plannifié.

Entwicklungen bei der Konstrucktion und Installation von Dampfkesseln

Dieser Übersichtsartikel beschreibt die augenblickliche Entwicklung bei der Konstruktion von Dampfkesseln für die Rohr- und Rübenzuckerindustrie, wie sie von der führenden Herstellern in integrierter Weise entwickelt werden, um der Industrie Bedingungen zu offerieren, die folgendes ermöglichen: (a) einen verbesserten Kreislaufwirkungsgrad für den Fabrikationsprozeß, (b) verbesserte Wirtschaftlichkeit durch die Möglichkeit zu Herstellung und Verkauf von elektrischer Energie, (c) Elastizität und Anpassung an Änderungen des Dampfbedarfs der Fabrik, (d) Ofenkonstruktionen, die das Risiko in Bezug auf Feuerbeständigkeit und Isolierung minimieren und dadurch einen störfreien Betrieb erlauben, (d) Verbesserungen in Leistung und Brennstoffwirtschaftlichkeit durch den Einbau von verbesserten Wärmerückgewinnungsanlagen und —Systemen, (f) verbesserte Methoden, um die Umweltbelastung zu minimieren, (g) zuverlässige Mess— und Uberwachungssysteme, die dem Ausbildungsgrad der Bedienung in geeigneter Weise entsprechen und (h) verbesserte Kesselzuverlässigkeit und Verfügbarkeit durch Ausführung von Qualitätskontrollen bei der Herstellung und Konstruktion, durch Minimierung der Montagearbeiten, einfache Bedienung und geplante präventive Instandhaltung.

Desarrollo en el diseño y instalación de calderas

Este informe examina las tendencias actuales en el diseño de calderas para las industrias azucareras de caña y remolacha que se desarrollan en una manera integrada por los lideres en la tecnología de calderas para ofrecer a la industria condiciones que permiten: (a) eficiencia cíclica mejorada para el proceso fabril, (b) economía mejorada por la capacidad para generación y venta de energía eléctrica, (c) integridad de provisión de combustible y respuesta rápida a demandas del proceso para vapor, (d) diseños de hornos que minimizan peligros respecto de la construcción de refractorios y isolación que permiten operación de modo falta-seguro, (e) mejoramientos en cumplimiento y economía en combustible por la provisión de equipos y sistemas mejorados para recuperación de calor, (f) métodos mejorados para minimizar contaminación del ambiente, (g) instrumentación realista y sistemas de control emparejado aptemente al habilidad del personal operativo, y (h) integridad y disponibilidad mejorada de la caldera por la realización de una calidad controlada en fabricación y construcción, minimización de obra en-sitio, facilidad de operación y programado entretenimiento preventivo.

Amorphous sugar

By H.E.C. POWERS

The name sugar immediately brings to mind the familiar crystals of our tea tables but the word amorphous means "without shape" and so-called amorphous sugar, produced in Brazil at the rate of a million tonnes a year, is really a micro-crystalline or fondant sugar. However, Palmer *et al.*[1], in 1956, reported the production of a truly non-crystalline form of sugar with a description of its preparation and of its unusual properties. A fine spray of sucrose solution was blown into a hot, very dry atmosphere which afforded evaporation so rapid that, if the operation were carried out correctly, there was insufficient time for the sucrose to form nuclei and for crystals to grow. Under the microscope the product appears as minute spheres having a diameter of 1-2 microns, each virtually a supercooled liquid which will not crystallize in years if suitably sealed in an atmosphere below 10 R.H. Makower & Dye[2] reported the proportion of water to be of the order of 1% at 5 R.H. and 2% at 11 R.H. At higher humidities the absorbed water ultimately permits nucleation and crystallization. The freshly dried material was a powder resembling pepper in handling. That produced from low purity syrups was slightly better to handle but the hygroscopicity of both high and low purity products was such as to render them hopeless as commercial products.

H. E. C. Powers

A similar amorphous condition is produced in the making of toffee and other confectionery, but this is achieved by delaying nucleation by addition of invert sugar, glucose, etc.

In my own studies I came to realise that a thin layer of sucrose solution might also be dried to an amorphous form, and was in fact able to prove this. Essentially it is necessary to create a large syrup surface area per unit weight, in order to facilitate sufficiently rapid evaporation. In addition, movement and shock, both most efficient producers of nucleation, must be eliminated. But, using thin films exposed to atmospheres of very low R.H., and by paying great attention to the elimination of foreign nucleation catalysts, I was able eventually to produce an amorphous "glass", one centimetre thick, with but one nucleus forming and that unable to grow because of the almost immovable state of the component molecules of sucrose. Production of a near glaze occurred when crystals from the centrifugal passed through the hot dry air of the granulator countercurrent so that it was dried fiercely to probably well below the E.R.H. of 10. Owing to the extremely high viscosity of this outer molecular film, the inner film *cannot* be dried out in the granulator and attainment of later near-equilibrium is extremely slow, taking many weeks under practical conditions.

1 *J. Agric. Food Chem.*, 1956, **4**, (1), 77-81.
2 *ibid.*, 72.

SUGAR CANE AGRONOMY

The use of distillery waste as a fertilizer for sugar cane in Trinidad. B. R. Cooper and M. Prasad. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 53-59, 68. — Vinasse, neutralized with lime, was applied at four levels (0, 56, 112 and 168 tonnes.ha^{-1}) to a sandy loam soil using a split plot design, and sub-plot treatments were made with 0, 190 and 380 kg.ha^{-1} of KCl, application being at planting together with N and P fertilizer. The vinasse produced significant cane and sugar yield increases in 1st ratoons which were highest with 112 tonnes.ha^{-1} while the increases in plant cane were not significant at 5% level. Soil and leaf K levels were increased, maximum effect again being with 112 tonnes.ha^{-1}. There were no significant effects of the KCl treatment on yield or quality of either crop.

The effect of conversion of cambered beds to a ridge and furrow layout on sugar cane yields in Guyana. V. M. Young-Kong and N. E. Jackson. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 87-90. — Trials over a 4-year period are reported for comparison of cane growing on cambered bed fields and fields which had been converted to a layout of ridges at 5½ ft spacings and furrows. The latter gave increased yields of both cane and sugar in wet and dry years, in ratoon crops but not in plant cane. The nutritional status of the cane in both systems was similar, but that of plant cane in the ridge and furrow fields was better over old drains than over old bed tops.

Chemical ripening in Trinidad of variety B 41227 with glyphosine. G. F. Mason. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 130-138, 159. — Applications of Polaris to cane in Nov./Dec. 1974 and 1975 were made at three different levels. Good responses were obtained in all cases when the cane was grown on heavy soils, although there were differences in time and degree of maximum response. In only one case was there a response in cane grown on light sandy soil and the difference is thought to be due to different water-retention properties of the soil which affected the rate of natural ripening. The treated fields showed a more rapid growth rate than untreated ones. Ratoon growth was not adversely affected by the treatment.

Commercial application of Polaris chemical ripener in Guyana. N. E. Jackson. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 139-142, 159. — Experience with 1000 acres of cane treated with Polaris during 1973-76 showed that the best response was obtained at the beginning of the second season, while it is inferred from limited trials that a good response would be obtained in the first season provided heavy rains fell in December/ January. A delay in harvesting of 18 weeks after Polaris application owing to heavy rain was found in one instance to have given, nevertheless, a 10.1% increase in the TC:TS ratio. The yield of cane per acre was lower in 11 out of 14 trials by comparison with untreated fields, but yields of ratoon cane appear to have been increased because of better regrowth after harvesting Polaris-treated cane.

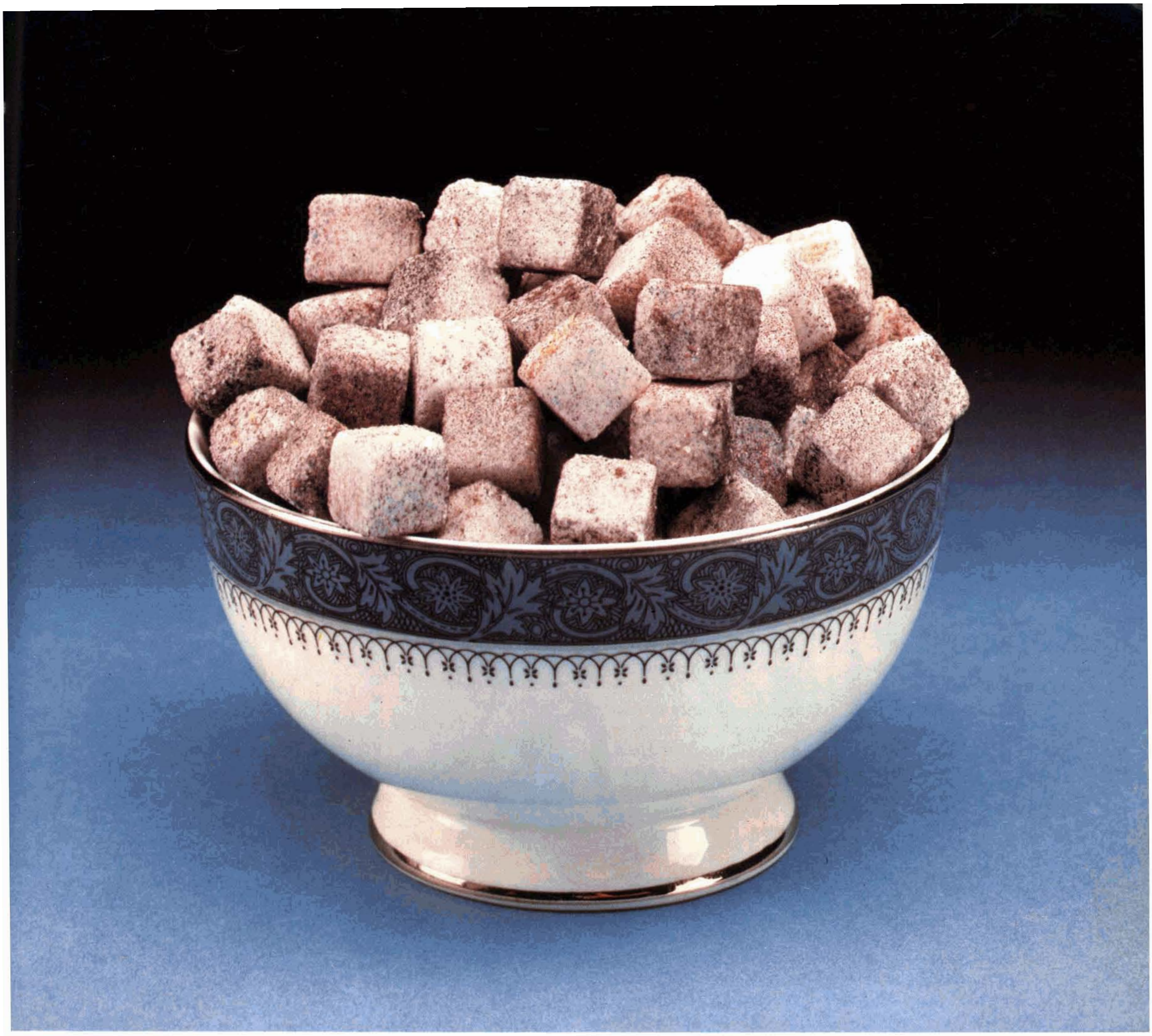
Chemical ripening in Jamaica — progress and prospects. D. Eastwood. *Proc. 1976 Meeting W. Indies Sugar Tech.*, 143-155, 159. — Studies with chemical ripeners in various cane areas of Jamaica are reviewed. Glyphosine produced economical responses in the wet eastern part of the island with four varieties and with a fifth in the west. Its effect is greatest in the early and later periods of the crop; ripening was diminished in the mid-crop when juice quality was at its best. Cane under moisture stress did not respond to glyphosine. Limited trials with LFA 2129 from May & Baker Ltd. showed a similar ripening pattern. It is concluded that benefit can be obtained with chemical ripeners provided due attention is paid to variety and date of application.

Technology of the application of urea to sugar cane. J. Pinna C. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.* (Peru), 1977, **6**, (1/2), 15-29 *(Spanish)*. — A review is made of the literature on this form of N fertilizer and losses which may arise through leaching, lixiviation and volatilization. The advantages and disadvantages of different methods and times of application of urea to cane soils in Peru are discussed, and it is concluded that, for normal soils, the best method is to apply it as early as possible, in a single dose, and covering with soil.

Typical drainage problems of the agrarian sugar production cooperatives of Peru. I. A. Risseeuw. *Bol. Técn. Divn. Técn. Inst. Central Invest. Azuc.* (Peru), 1977, **6**, (1/2), 30-48 *(Spanish)*. — The geo-morphology and hydrology of Peruvian coastal soils are discussed and drainage problems identified. Soil heterogeneity hinders the application of theory, and knowledge of the hydraulic characteristics and depth of subsoil strata become very important. The importance of drainage ditches is indicated as well as other means of coping with a high water table.

"In situ" study of the effect of herbicides on the nitrogen status of a cane soil of coastal Peru. T. Yengle P., A. González V. and J. Pinna C. *Saccharum* (Inst. Central Invest. Azuc., Peru), 1977, **5**, (2), 89-108 *(Spanish)*. Atrazine, alone and in combination with Ametryne and Ametryne + 2,4-D, Terbutilazine, and Asulam were applied to soil and the total N, ammonium N, nitrite and nitrate measured after 1, 4, 8, 16, 32, 48, 64 and 96 days, the changes relative to the same soil before treatment being studied statistically. The results showed that Ametryne and Terbutilazine increased total N up to 4 days, but that Atrazine and Asulam did not do so. The NH_4^+ content was reduced on the first day by Ametryne, Asulam and Atrazine, the last stimulating the production of NO_2^- and NO_3^-.

Influence of 2-chloroethyl phosphonic acid in the induction of tillering in sugar cane (*Saccharum* spp.) — variety NA 56-79. A. A. Lucchesi, A. C. Florencio, O. P. Godoy and J. P. Stupiello. *Brasil Açuc.*, 1979, **94**, 209-217 *(Portuguese)*. — The title acid, as a commercial product (Ethrel), was applied at 0, 1, 2, 3 and 4 litres. ha^{-1} to plant cane 5½ months old and to a 3rd ratoon crop 40 days after harvesting. The numbers of tillers were counted monthly between application and harvesting. The results showed that there was no influence on the plant cane, but tillering was increased significantly in the ratoon crop at 3 litres.ha^{-1}. The best time for application to ratoon cane was immediately after initiation of tillering.



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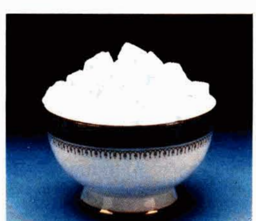

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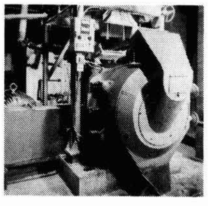


CANE PESTS AND DISEASES

Calculation of the dispersion of the sugar cane borer *Diatraea saccharalis* **(Fabr. 1794).** P. S. M. Botelho, A. C. Mendes, N. Macedo and S. S. Neto. *Brasil Açuc.*, 1978, **92**, 337-342 *(Portuguese)*. – A total of 21 pheromone traps were placed in a block, one at the point where previously marked males of the borer moth were liberated and the others at intervals of 5, 10, 20, 40 and 80 metres from the central trap in the form of a cross. Counts were made of the males trapped, and it is calculated that the average distance covered by half the male population of *D. saccharalis* was 42.5 m per day.

Rotting of roots by *Pythium* **spp. in sugar cane.** R. M. Valdebenito S. and H. Tokeshi. *Brasil Açuc.*, 1978, **92**, 351-359 *(Portuguese)*. – A review is presented of the literature on the disease, including its history, symptoms, taxonomic and pathogenic aspects, isolation techniques, interactions, control, etc.

Tests of insecticides for control of the sugar cane borer *Diatraea saccharalis.* P. S. M. Botelho, N. Macedo, A. C. Mendes and O. Nakano. *Brasil Açuc.*, 1979, **94**, 6-16 *(Portuguese)*. – Comparison of a number of insecticides for control of the borer *D. saccharalis* in the fields of Usina São João, Araras, SP, showed that Endosulfan 3G at 50 $kg.ha^{-1}$ gave slightly better results than Thiofanox at 10 and 20 $kg.ha^{-1}$, Carbofuran 5G at 20 $kg.ha^{-1}$, Aldicarb 10G at 10 $kg.ha^{-1}$ and Triazophos 1.75G at 45 $kg.ha^{-1}$.

Eldana saccharina **– a cane stalk borer in Africa.** Anon. *IRAT Informations*, 1978, (10), 4 *(French)*. – Characteristics of the title borer, which has become the major cane pest in tropical Africa, are described. It is essentially damaging to maize as well as sugar cane, but is also found on plants of other crops as well as numerous weeds. An average of 460 eggs is laid per female, one generation lasting about 45 days at an average temperature of 25°C. The extent of damage is highly variable, even within a narrow range of geographical and climatic zones. In some cases, it can cause more than 20% loss of sugar per ha. There are several predators, particularly ants, which destroy a large proportion of the eggs and larvae and thus play an important role which must be considered in any chemical control plans. Apart from possible chemical and biological control, there are agronomic measures which should contribute to considerable reduction in infestation, particularly irrigation, elimination of contamination sources (by cleaning the fields after harvesting and planting healthy material, etc.) and use of tolerant varieties.

A new nematicide for use in sugar cane. E. J. Robbertse. *S. African Sugar J.*, 1979, **63**, 63. – Results of 11 trials are reported in which Curater 10% G nematicide (containing Carbofuran as active ingredient) at 30 $kg.ha^{-1}$ increased cane yield and expected recoverable sugar by comparison with the control and was as effective as the standard (unnamed) treatment in both plant and ratoon cane.

Losses in sugar cane juice quality due to internodal borers in Maharashtra state. A. S. Patil and D. G. Hapase. *Maharashtra Sugar*, 1979, **4**, (6), 49-52. – The effect of infestation by *Chilo infuscatellus* and *Sesamia inferens* on cane Brix, sucrose content and juice purity was determined in four varieties, of which Co 775 was the worst infested. In general, substantial falls occurred in all three parameters when at least five internodes were affected.

Studies on the biology of *Sticholotis madagassa* **Weise (Coccinellidae:Coleoptera), an exotic predator on the scale insect** *Melanaspis glomerata* **Green of sugar cane.** C. S. Rao, S. V. Rao and B. H. K. Rao. *Indian Sugar*, 1978, **28**, 453-454. – The various stages in the life of *S.madagassa* are briefly described. The predator has been imported into India from Mauritius.

Response of sugar cane to the application of some systemic insecticides at the time of planting. G. C. Sachan, R. C. Chhibber and J. K. Verma. *Indian Sugar*, 1978, **28**, 557-560. – Two-year trials in which granular systemic insecticides were applied at 1 $kg.ha^{-1}$ a.i. to setts at planting showed that treatment increased germination and yield by comparison with the untreated control. Of the five insecticides tested, Phorate proved best, increasing yield by 21.80% by comparison with only 12.07% given by the next best treatment. Gamma-BHC gave very good results in early growth, but proved the least effective of all five treatments in terms of final yield.

Population fluctuation and average density of *Diatraea saccharalis* **(Fabr., 1794) in Araras, SP.** P. S. M. Botelho, N. Macedo and A. de C. Mendes. *Brasil Açuc.*, 1979, **94**, 83-91 *(Portuguese)*. – Light traps were used to determine the average population density and fluctuations in population of the title borer during the period January 1973-December 1977. The traps were located in the paths between blocks of cane of different varieties and counts were made twice a week. The borer was present all year round but with a main peak in August and secondary peaks in March, May and December. The average number trapped per month in 7 traps was 63, but there were variations between 3 and 272, and numbers varied from year to year.

Causes of the propagation and development in Cuba of the disease bacterial red stripe of sugar cane. G. E. Vesminsh, A. Chinea and A. Cañada. *Cienc. Agric.* (Acad. Cienc. Cuba), 1978, (2), 53-64 *(Spanish)*. – The occurrence and development of red stripe disease caused by the bacterium *Pseudomonas rubrilineans* is discussed from its initial observation in Cuba in 1972. The disease occurs in all provinces and its spread appears to be a function of variety and soil-climate conditions. The disease is most prevalent in the eastern provinces, Cienfuegos, Villa Clara, Matanzas and certain parts of Camagüey and La Habana, and is largely associated with cultivation of the highly susceptible variety B 4362 and the susceptible varieties My 5464 and My 5514. The disease is transferred to plant and ratoon crops from old plantings, and the late harvesting of susceptible varieties contributes to its increase. High rainfall favours the spread of red stripe and it is consequently less widespread in regions of low rainfall.

BEET SUGAR MANUFACTURE

Aspects of stirrer design for vacuum pans. K. Austmeyer and K. Kipke. *Zuckerind.*, 1979, **104**, 395-401 *(German)*. The advantages of massecuite stirrers are listed and considered to outweigh the disadvantages of investment cost and energy consumption. A typical pan arrangement with a five-bladed propeller is briefly described and illustrated. The role of the stirrer is that of a mixer as well as aid to circulation, and during crystal growth it serves to homogenize as well as regularize temperature distribution. The range of Reynolds' numbers in which the stirrer is to operate is of prime importance in the design of a system, but determination of the viscosity of a solids-liquid system such as massecuite is very difficult. A method of determining the requisite stirrer capacity and hence rating of the drive motor is explained and its application to low-grade massecuite boiling demonstrated. The effect of stirrer diameter and rotary speed on delivery rate, power consumption and torque is discussed.

Operational and process optimization of large-capacity centrifugals. S. Matusch. *Zuckerind.*, 1979, **104**, 401-404 *(German)*. — Means by which the operation reliability of the Selwig & Lange batch centrifugal of 1500 kg capacity is ensured are listed, and factors having a positive effect on performance indicated. Details are given of the automatic control system developed for the machine, and typical performance figures are presented. The advantages of D.C. drive for the centrifugal are listed and demonstrated by comparison between the performances of A.C.- and D.C.-drive machines. The purity and colour of the sugar from the massecuite were higher and lower, respectively, in the D.C. machine, the water wash period being the same in both cases.

Treatment and disposal of sugar factory wastes and muds to the benefit of the environment. L. Haraszti. *Cukoripar*, 1979, **32**, 70-74 *(Hungarian)*. — The sources of waste water and waste materials in a sugar factory are indicated and COD and BOD_5 levels encountered in the Hungarian sugar industry are discussed. A typical system of waste water treatment and recycling is described with the aid of a diagram; it is pointed out that, despite recycling and more economical use of fresh water, there is still need to reduce the quantities of solid waste, which has continued to increase, and to utilize it in such a way that the environment, particularly rivers, is protected.

Effect of alteration in the raw juice purification scheme at Yares'k sugar factory. Yu. P. Kalenyuk, N. A. Savchenko and A. E. Golovatyi. *Sakhar. Prom.*, 1979, (5), 29-32 *(Russian)*. — By recycling half of the 1st carbonatation mud (15-20% on beet) from the clarifiers to preliming with 10% defecation juice instead of 1st carbonatation juice (150-160% on beet), followed by fractional liming and conventional 1st and 2nd carbonatation, the total quantity of material subjected to preliming was reduced from 310 to 175% on beet, so that lime consumption (at the same dosage rate on beet) fell and hence the fuel consumption for limestone calcination. In the scheme used, no milk-of-lime is added in preliming, which takes 6.5 min (compared with 3.4 min when carbonatation juice was recycled); main liming and 1st carbonatation retention times are 18.7 and 15.0 min, respectively, compared with 9.7 and 9.4 min. Juice alkalinity was unchanged, but sugar yield and daily throughput rose, while molasses sugar and filter cake losses were lower.

Experience in utilization of a KDA-30-66 diffuser at Zhashkov sugar factory. O. P. Marchenko and N. A. Kavun. *Sakhar. Prom.*, 1979, (5), 32-35 *(Russian)*. An account is given of design faults in the Soviet KDA-30-66 tower diffuser, and descriptions are given of the various modifications carried out at Zhashkov as remedial measures.

Results of trials on surface-active agents in massecuite boiling at Spitak sugar factory. E. S. Shakhyan and G. Kh. Egoryan. *Sakhar. Prom.*, 1979, (5), 35-36 *(Russian)*. — Results of tests with AMGS-100 (an acetylated monoglyceride of stearic acid) surfactant carried out in 1975/76 and 1976/77 are summarized. When added to massecuite at 20-50 ppm it normalized sugar house operations, particularly at the end of the campaign when beet quality was considerably reduced. At 50 g/15-20 tonnes it prevented foaming of the massecuite within 1-2 min, while white sugar yield from 50 tonnes of *A*-massecuite was raised from 16 to 18 tonnes by adding 20 ppm of the agent at various boiling stages. Massecuite purity at dropping was 1.5 units higher, and boiling time was cut by 20-60 min. However, the material is not at present produced in sufficiently large quantities and the costs are high.

Conditions for efficient operation of a RZ-POS-1,5 carbonatation juice clarifier. I. G. Chugunov. *Sakhar. Prom.*, 1979, (5), 36-40 *(Russian)*. — The title clarifier is a second-generation, multi-tray type which operates well, with 70-80 minutes' retention, provided it is correctly installed and properly operated. However, in many cases this has not been so, and guidance is given on the correct procedures to follow.

Adsorption treatment of beet sugar factory products with granular active carbon. Ya. O. Kravets, G. P. Pustokhod, R. D. Gorbunova, M. V. Dvornichenko, L. G. Kuts and S. A. Gurova. *Sakhar. Prom.*, 1979, (5), 40-43 *(Russian)*. — Laboratory experiments were conducted in which syrup of approx. 60°Bx was passed through a column of regenerated AG-3 granular carbon at 60 $cm^3.hr^{-1}$. In all cases purity was raised slightly and colour was markedly reduced. pH fell during the initial period (up to 5 days), after which it tended to rise toward the original level, especially where the carbon had been regenerated after saturation as opposed to regenerated commercial-grade carbon; this was attributed to K and Ca adsorption, while the later pH stabilization was attributed to leaching of Mg into the syrup. Sulphates and Na were also adequately adsorbed. The crystallization rate of syrup rose as a result of carbon treatment, but thermal stability was somewhat lower than for untreated syrup, so that 80-82°C is recommended for treatment in contrast to 90°C. Regeneration with steam at 800°C for 30 min gave a decolorizing efficiency of 86.5-91.0% compared with 91.5% for fresh carbon.

BY-PRODUCTS

Prospects of developing a power alcohol industry in Thailand. K. Bejraputra. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 24 pp. – The possibility of producing fuel alcohol from cane molasses in Thailand is discussed. Both technical and economic aspects are examined, and a development program based on 1 million tonnes of molasses per year and a 85:15 gasoline:alcohol blend is outlined.

Trends in the production of ethyl alcohol by fermentation. R. G. B. Carracedo. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 19 pp. Ethanol production in various countries of the world is discussed, and data are given on alcohol production from cane molasses at each of the 12 Cuban distilleries.

Potential availability of fermentation alcohol from sugars and starches in developing countries. L. Hepner. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 14 pp. – An assessment is made of the quantity of ethanol that could be produced from excess raw sugar and molasses in developing countries. Alcoholic fermentation of starch-containing crops is also examined.

Fermentation alcohol in the Commonwealth Caribbean. D. A. Ali. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 14 pp. – The possibilities of and constraints on manufacture of fuel alcohol from sugar cane and other crops in British Commonwealth countries of the Caribbean are discussed.

Can fermentation alcohol be substituted for wood as a cooking fuel? J. Moundlic. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 12 pp. – While ethanol cannot be used instead of wood for traditional cooking in developing countries, it can be used by adapting butane pot-heaters, and would bring the benefit of reduced deforestation. The possible yield of alcohol from cane molasses at a factory producing 30,000 tonnes of sugar per year is calculated to replace 80,000 tonnes of wood.

Fuel and chemical feedstock from sugar cane in Central America. L. Ingram. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 8 pp. – The annual gasoline consumption in Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica totals some 359 million gal; if 15% of the gasoline were replaced with alcohol, some 120 million gal of molasses would be needed for alcohol fermentation, but only 75 million gal is produced, and half of this is used as animal feed and in industry, particularly for rum and baker's yeast manufacture. The quantity of cane needed for alcohol manufacture from juice would require an increase in area of 20-25%, although such an increase is not considered a problem except for El Salvador. Moreover, it would be possible to increase cane yield per ha. Cassava is also considered a suitable complementary material for alcohol production. Investment and operation costs depend on the distillery system used (centralized, integrated or autonomous distilleries), and the costs are calculated for an autonomous plant. Comparison is made between the prices of gasoline and a 85:15 blend, and a graph is presented of ethanol price *vs.* cane price. It is emphasized that the world price of sugar directly affects the price of cane (as shown for the period 1972-78), and that a high sugar price would probably significantly reduce the availability of sugar cane for a sucro-chemical industry.

Advantages and limitations of the use of alcohol produced by fermentation as fuel in developing countries. H. Maurel. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 4 pp. – The production of ethanol from cane, molasses or sugar is discussed, and use of a medium-sized distillery advocated. Caution is recommended in the approach to a major program – the amount produced should represent an appreciable proportion of the requirement (otherwise financial savings will be insignificant), although the program should not be too ambitious and release surplus alcohol onto a world market, thereby risking a fall in price and endangering export prospects.

Distillation, rectification, low-energy processes. K. Eder. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 8 pp. – The author briefly describes stages in ethanol manufacture from molasses (both beet and cane), viz. preparation of the molasses, fermentation, distillation, and treatment of vinasse. The energy consumption in each stage, including recovery of concentrated vinasse and mechanical vapour compression, is indicated in a table.

Brazil's energy alternatives. A. E. Inojosa de Andrade. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 12 pp. – The manufacture of ethanol from sugar cane in Brazil is discussed. While the major advantage is the financial saving by comparison with oil imports, vinasse disposal poses a serious problem. A number of possible solutions have been found, but all are expensive.

Fermentation – second way for utilization of vegetable sources. K. Schreier. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 20 pp. – Power alcohol production from sugar cane, molasses or maize by fermentation and distillation in autonomous and non-autonomous distilleries is discussed. Cost factors, energy balances and plant layout are indicated. Cost factor distribution is compared for distilleries of identical capacities but handling different raw materials.

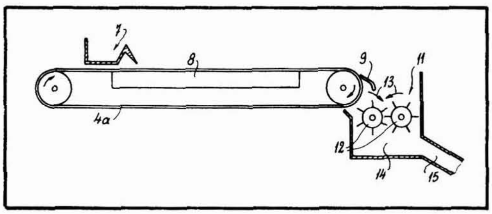
Vinasse concentration and vinasse utilization. T. P. Melman. *Paper presented at UNIDO Fermentation Alcohol Workshop*, 1979, 9 pp. – Concentration of vinasse from alcoholic fermentation of beet molasses is discussed on the basis of the experience of B. V. Zuid-Nederlandse Spiritusfabriek in the company's distillery at Bergen op Zoom, Holland. Because of its binding properties and high nutritive value, the concentrated vinasse is mainly used in pelleted animal fodder mixtures. Comparison is made with molasses in respect of binding and pelleting, while beet and cane vinasses are also compared in regard to chemical composition and digestibility. Feed trials with beef and dairy cattle are reported.

PATENTS

UNITED STATES

Manufacture of dry solid molasses. P. Jaconelli, of Venissieux, France, *assr.* AVD A Votre Disposition. **4,013, 482.** March 16, 1976; March 22, 1977.

Molasses from a thin-layer evaporator is delivered to an overflow trough 7 which spreads it in a thin layer on the upper surface of a belt conveyor 4a (comprised of stainless steel strips) which is cooled by suitable means such as contact with a tank 8 of circulating cold water. In this way the temperature of the molasses is brought rapidly down from 130°C to ambient and spread in a layer 2-4 mm thick on the belt.



It is removed by a scraper blade 9 and delivered to a precrushing device 11 which may consist of drums 12 carrying paddles which mesh without contact. The precrushed molasses is delivered through spout 15 to a pulverizing device. This operates by impact without significant crushing or friction so as to avoid partial melting and cohesion of the powdered dried molasses.

Separation of levulose from a mixture of sugars. H. Odawara, Y. Noguchi and M. Ohno, of Kamakura, Japan, *assrs.* Toray Industries Inc. **4,014,711.** February 18, 1976; March 29, 1977. – Levulose is separated from a mixture with dextrose (an isomerization product, invert sugar) by placing a (10 – 18% w/w) aqueous solution of the mixture in contact (at 10° – 60°C) with crystalline alumino-silicate (a faujasite of type X, Y or L, mordenite) (having at lease one metal cation selected from the group comprising alkali metals, alkaline earth metals, Cu, Ag, Zn, Cd, Al, Pb, Fe and Co), having an average pore diameter > 5Å (5 – 15Å), desorbing the adsorbed sugars with water, and separating the levulose-rich fraction.

Obtaining sugar crystals from a sugar solution. D. Hoks, of Hengelo, Holland, *assr.* Stork Werkspoor Sugar B.V. and Suiker Unie Holding B.V. **4,016,001.** June 13, 1975; April 5, 1977. – A concentrated sugar solution from a multi-stage evaporator (at about 65°Bx) is passed continuously (by means of a positive-displacement pump) to a pre-concentrator where it is heated while at less than atmospheric pressure so that it is further concentrated (to about 85°Bx). (The level and pressure in the pre-concentrator are maintained at fixed values.) Syrup from the pre-concentrator is passed continuously (by means of a positive-displacement pump) to a (spherical) holding vessel where it is held, with stirring, at the same temperature but at a pressure higher than that in the pre-concentrator (atmospheric pressure). When sufficient has accumulated in the holding vessel, the syrup is discharged batchwise (with continuous stirring) into a vacuum pan while simultaneously adding seed crystals, applying heat and reduced pressure by steam withdrawal. The power required for stirring the syrup in the holding vessel is monitored and sugar solution from the evaporator introduced when this power reaches a predetermined value.

Animal feed block. S. A. DeSantis, of Rolling Hills, CA, USA, *assr.* M. D. Appleman. **4,016,296.** March 18, 1976; April 5, 1977. – The animal feed block comprises 25 – 75% (40 – 60%) by weight of molasses, 0.5 – 5% (1 – 2.5%) of water-absorbent clay, 0.2 – 3% (1 – 2%) of a water-binding agent (Ca or Na soap or a mixture of these) and 5 – 35% of a natural protein, 0.2 – 10% of a non-protein N source, 0.5 – 7% of a P source, 1 –10% of a fatty acid, 1 – 5% of a fat or a mixture of the last five ingredients.

Cane harvester base cutter. D. J. Quick, of Bundaberg, Queensland, Australia, *assr.* Massey-Ferguson Services B.V. **4,019,308.** October 10, 1975; April 26, 1977.

Separation of water-soluble carbohydrates. R. F. Sutthoff and W. J. Nelson, *assrs.* Standard Brands Inc., of New York, NY, USA. **4,022,637.** February 23, 1976; May 10, 1977. – A solution containing carbohydrates A (dextrose) and B (levulose) is applied to a column of a fractionation medium (porous particulate ion exchange resins) (at 40° – 80°C), followed by elution water, and the effluent separated into fractions (a) rich in carbohydrate A, (b) rich in carbohydrate A but highly contaminated with carbohydrate B, (c) rich in B but highly contaminated with A, (d) rich in B and (e) diluted but rich in B. To the column are admitted fraction (b) above, a volume of feed solution equal to fraction (d), fraction (c), fraction (e) and a volume of elution water equal to fraction (a). The steps are repeated in a cyclic manner with fractions (a) and (d) collected as products.

Separation of a ketose from an aldose by selective adsorption. R. W. Neuzil and J. W. Priegnitz, *assrs.* UOP Inc., of Des Plaines, IL, USA. **4,024,331.** May 27, 1976; May 17, 1977. – A (liquid phase) mixture of the sugars (dextrose and levulose) is brought into contact (at 20° – 200°C and atmospheric to 500 psig pressure) with an adsorbent comprising an X-zeolite having at its exchangeable cation sites Na^+, Ba^{++} or Sr^{++}, or $Ba^{++} + K^+$ or $Ba^{++} + Sr^{++}$, thereby selectively adsorbing the levulose, and thereafter recovering it (by desorption with water). The column of adsorbent includes three zones: an adsorption zone, a purification zone, and a desorption zone; the feed and elution water are added to the first and third, respectively. The addition points are periodically advanced down the column to shift the zones and maintain output of the product fractions.

Beet harvester. V. D. Haverdink, of Ankeny, Iowa, USA, *assr.* Deere & Co. **4,024,920.** October 24, 1975; May 24, 1977.

Fabricating boards from sugar cane rind fibres. S. E. Tilby, of Victoria, B.C., Canada. **4,025,278.** March 5, 1975; May 24, 1977. – A mass of cane rind fibres is accumulated in the collection zone of a board-forming apparatus and compressed by the sweep face of a horizontally-reciprocating first stage plunger so that the fibres are compacted and re-orientated substantially parallel to the sweep face. The fibres are then compressed by a vertically reciprocating plunger into an extruder passage below the collection zone and so are brought to a defined board segment having rind fibres with their axes largely parallel to the length of the board segment. The board segments are heated to melt the natural resinous binder substances present and then cooled, when the binders solidify and harden to give a unitary board structure.

Increasing the sucrose content of sugar cane plants. J. E. Franz, of Crestwood, MO, USA, *assr.* Monsanto Co. **4,025,332.** August 19, 1976; May 24, 1977. – The sucrose content of cane is increased by the application, 2-10 (3-7) weeks before harvest, of an effective amount (0.5 – 5 $lb.acre^{-1}$) of an N-phosphonomethylglycinamide of the formula $X\text{-}CO\text{-}CH_2\text{-}NH\text{-}CH_2\text{-}PO(OH)_2$ (or a salt thereof), where X is morpholino, piperidino, pyrrolidino or NHR and R is H, $C_1 - C_5$ alkyl (methyl, *n*-butyl), alkenyl (allyl), cyclo-hexyl, $C_1 - C_2$ hydroxyalkyl or $C_3 - C_4$ alkoxyalkyl, and the salt may be an alkali metal, ammonium or lower aliphatic hydrocarbon amine salt.

Dry isomerase activation. T. L. Hurst, of Decatur, IL, USA, *assr.* A. E. Staley Manufacturing Co. **4,026,764.** March 20, 1975; May 31, 1977. – The isomerase activity of a dry (dextrose) isomerase preparation is enhanced by pretreating it initially in an aqueous solution which contains an activating amount of a metal ion (Mg or an element of atomic number 24-27) and/or a thiol-generating reducing agent (sulphite ions) and/or a monosaccharide [1 – 4M (1 – 3M) dextrose] which the enzyme can isomerize. The enzyme dry solids:solution ratio is between 1:25 and 2:3, pH 5.5 – 8.5 and temperature lower than 40°C.

Continuous hydrolysis of pentose-containing material (bagasse). G. A. Nyman and G. Savö, *assrs.* Anstalt Gemass, of Vaduz, Liechtenstein. **4,025,356.** January 13, 1975; May 24, 1977. – See UK Patent 1,483,132[1].

Solid animal feed. J. J. Schroeder and M. D. Appleman. **4,027,043.** October 28, 1975; May 31, 1977. – The solid feed supplement comprises (45 – 93%) molasses to which is added 0.5 – 5% as P_2O_5 of a soluble phosphate or phosphoric acid, 0.5 – 5% of Al_2O_3, MgO or CaO or a mixture of these to give a molar ratio of 4 per mole of P_2O_5, sufficient to solidify the supplement; further ingredients include 2 – 30% (5 – 20%) of animal-edible fat, 0.05 – 1% of a fat emulsifying agent, 0.5 – 6% (2 – 4%) of (pre-gelatinized) starch, 5 – 40% protein equivalent of a non-protein N source [(2 – 15%) urea, biuret or ammonium phosphate].

Acid hydrolysis of polysaccharide-containing raw material. K. Kiminki, R. Kulmala and S. Sipilä, of Pori, Finland, *assrs.* Oy. W. Rosenlew AB. **4,029,515.** September 19, 1975; June 14, 1977. – The (organic solvent-treated) raw material (bagasse) is continuously decomposed by hydrolysis under pressure and at elevated temperature in a reactor in two stages, the first being carried out in the upper part of the reactor using a hydrolysis agent in the vapour phase and the second in the lower part of the reactor using a liquid hydrolysis agent. The raw material is impregnated with concentrated acid and fed into the reactor; water vapour is supplied to the bottom of the reactor and the acid and water vapour convert pentosans to furfural, acetic acid, methanol and acetone while hexosans are hydrolysed to di- and tri-saccharides. From the upper part of the reactor a condensate is removed, containing the pentosan decomposition products. Dilute acid (and water) is fed into the reactor (at several points) into the bottom part of the liquid phase and the di- and tri-saccharides decomposed to mono-saccharides and into saccharic and fatty acids which are removed from the liquid phase at several places.

Drip irrigation sytem flushing valve. B. A. McElhoe and J. G. Tabrah, *assrs.* Hawaiian Sugar Planters' Association, of Honolulu, HI, USA. **4,031,915.** June 12, 1975; June 28, 1977.

Sugar beet nematode hatching agent. J. D. Willett and L. M. Cheek, *assrs.* Research Corp., of New York, NY, USA. **4,032,551.** January 7, 1976; June 28, 1977. – A neutral lipid fraction which enhances nematode cyst hatching is obtained by extracting sugar beet with methanol and/or chloroform, and the extract fractionated chromatographically to isolate a terpenoid having a MW of about 255, about 410 or about 435.

Ripening of sugar cane by use of ammonium *iso*-butyrate. L. G. Nickell, of Ellicott City, MD, USA, *assr.* W. R. Grace & Co. **4,033,755.** March 30, 1976; July 5, 1977. The sugar yield from cane is increased by application 2 – 10 weeks (3 – 8 weeks) before harvest of an effective amount [1 – 80 (1 – 40) $lb.acre^{-1}$] of ammonium *iso*-butyrate.

Continuous centrifugal. P. Natt and H. Kurland, *assrs.* Braunschweigische Maschinenbauanstalt, of Braunschweig, Germany. **4,033,879.** July 15, 1975; July 5, 1977. See UK Patent 1,474,158[2].

Beet sugar production. S. Meguro, S. Imafuku, K. Kawamura, S. Hashimoto and S. Narita, *assrs.* Hokkaido Sugar Co. Ltd., of Tokyo, Japan. **4,036,694.** September 23, 1975; July 19, 1977. – Sugar is recovered from beet molasses in the form of a saccharate cake and returned to the juice purification stage. Prior to lime addition, however, the raffinose in the molasses (diluted to 20 – 50°Bx) is hydrolysed to sucrose and galactose by treatment with (10^6 – 16 x 10^9 units per gram of raffinose of) α-galactosidase (at pH 4.5 – 7 and 20 – 55°C). The raffinose hydrolysate is separated from the enzyme and added to the calcium saccharate-forming step, a corresponding quantity of saccharate-containing solution being removed and passed to the juice purification stage. Saccharate-containing solution, to the extent of 3-10 times the addition rate of hydrolysate, is withdrawn from the saccharate-forming reaction, passed through a cooler and returned to the reaction in order to maintain the temperature below 20°C.

Treatment of raw sugar (cane) juice. R. J. Hunwick, of Wollstonecroft, Australia, *assr.* Dorr-Oliver Inc. **4,039,348.** April 14, 1975; August 2, 1977. – Raw juice is treated in one or more cyclone separators and the grit-free juice sent to the clarifier. The mud from the clarifier is treated in a solid-bowl centrifuge and the separated juice returned to the clarifier feed. The raw juice and degritted juice may be held in two sections of a surge tank with an opening in the partition between them so as to maintain a constant level.

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1 *I.S.J.*, 1980, **82**, 162.
2 *ibid.* 98.

TRADE NOTICES

Automatic density control. Valmet Instrument Works, P. O. Box 237, SF-33101 Tampere 10, Finland.

The Valmet density transmitter is essentially a balance that measures the changing mass of fluid in a glass or stainless steel U-tube connected to the balance arm and to an electrical or pneumatic transmitter. A change in downward force on the U-tube resulting from density change in the fluid is thus transferred to the transmitter which converts it into an electrical signal in the range 0-20 mA or 4-20 mA (in the case of the DENS-EL instrument) or into a pneumatic signal in the range 0.2-1.0 bar or 3-15 psi (the DENS-AIR instrument). The transmitter, which can be provided with a built-in mechanical temperature compensation device, has a sensitivity of $<0.1\%$ and is applicable to fluids having densities in the range 0.5-3.0 $kg.dm^{-3}$ at flow rates up to 120 $litres.min^{-1}$ with the metal tube model or 80 $litres.min^{-1}$ with the glass tube model. Maximum working pressure and fluid temperature are, respectively, 10 bar and 110°C. Examples of typical applications mentioned include levulose solution, sugar syrup and molasses.

Cosmo hand refractometer. Milestone Corp., Shimizu Bldg., 34-16 Shinjuku 1-chome, Shinjuku-ku, Tokyo, Japan; Michael Smith Engineers Ltd., Oaks Rd., Woking, Surrey GU21 1PH, England.

The Cosmo hand refractometer, designed for use in the sugar and associated industries, has a temperature compensation system comprising a dial graduated in °C (covering the range 10-40°C) and a built-in thermometer, the dial being rotated by hand so that the value opposite the index line corresponds to the thermometer reading. The refractometer uses a blue field against which the vertical scale is calibrated in % dry solids in intervals of 0.2 units. Model K-0032 covers the range 0-32% and the K-0062 28-62%. Corresponding models are available without temperature compensation, while K-82 and K-92 models covering the ranges 45-82% and 58-92%, respectively, have metal instead of acrylic cover plates (but again no temperature compensation).

SIMASGA source book. Sugar Industry Manufacturers and Services Group of Australia, P.O. Box 128, Spring Hill, Queensland 4000, Australia.

The 56-page SIMASGA source book is a directory of manufacturers of factory equipment and agricultural machinery as well as suppliers of chemicals for the cane sugar industry. The information is given in the form of individual advertisements as well as a Buyers' Guide, with product headings and an address section. The book also contains a detailed survey of the Australian sugar industry.

Metcon cane agricultural equipment. Metcon (Australasia) Pty. Ltd., P.O. Box 104, Glen Waverley, Victoria 3150, Australia.

Details of the Don range of cane equipment are given in individual leaflets, including everything needed for complete mechanization. Apart from ploughs, toolbars, fertilizer applicators and cultivation equipment, the range includes the Don 800 cane harvester, the Don 820 cane loader, the Don 830 cane transporter and the Don 340 and 350 cane planters. Brochures are also available describing the Triklon drip irrigation system and Australis irrigation sprinklers.

Shimadzu equipment. Shimadzu Corp., 14-5 Uchikanda 1-chome, Chiyoda-ku, Tokyo 101, Japan.

The Shimadzu Corp. manufactures analytical and measuring instruments, process control instrumentation and control equipment, and industrial instruments and equipment as well as medical and aircraft equipment. The corporation's activities are outlined in a brochure, while details of the LC-3A high-performance liquid chromatograph and GC-7A/7AG Series gas chromatograph are given in brochures CA197-901 and CA186-901A, respectively.

Complete sugar factories and refineries. Marubeni Corp., 4-2 Ohtemachi 1-chome, Chiyoda-ku, Tokyo 100, Japan.

A 21-page brochure describes, in English, French and Spanish, the services offered by Marubeni in the design and construction of complete sugar plant; photographs and details are given of factories and refineries erected by the company in the Philippine.

"BMA Information". Braunschweigische Maschinenbauanstalt, Postf. 3225, D-3300 Braunschweig, Germany.

Issue No. 18, 1979, of "BMA Information" contains a number of features, including details of the expansion of Mhlume sugar factory in Swaziland, mention of Ormoz and Virovitica sugar factories in Yugoslavia, the BMA cane diffusion system, BMA filters for the cane sugar industry, BMA arcuate screens, the CSM anaerobic process of waste water treatment, and a number of brief news items. An article, written in collaboration with Professor K. Misselhorn of the Institute for Fermentation Industry and Biotechnology in Berlin, surveys both the conventional cane and beet juice extraction processes and processes suitable for alcoholic fermentation of juice and molasses. Fermentation of starch-containing materials is also described. Alcohol yields from fresh beet, cane and molasses are indicated, and comparison of yields is made between sugar- and starch-containing materials subjected to various processes. Activities of Starcosa GmbH in the field of alcohol production are mentioned.

The Paxman sugar filter. Paxman Process Plant Division, GEC Diesels Ltd., Paxman Works, Colchester, Essex CO1 2HW, England.

The Paxman rotary filter for use in handling clarifier muds is available in filter areas of up to 700 ft^2 (65 m^2). The stainless steel or copper screen filter medium is supported on easily removable snap-in polypropylene mats covering the drum surface. Paxman can supply all ancillary equipment such as bagacillo ducting, cyclones, feed mixer tanks and clarifiers if required. Details of the filter are given in brochure BPA/ETP/2M/9 78, which illustrates a filter destined for the Philippines sugar industry as well as a Kenyan sugar factory which operates two Paxman 37.2 m^2 filters.

Compact automatic batch centrifugals. Fives-Cail Babcock, 7 rue Montalivet, 75383 Paris Cedex 08, France.

A recent colour brochure from Fives-Cail Babcock describes, in English, French and Spanish, the salient features of their automatic batch centrifugals, which are available in three models: the C 221 of 700 kg maximum massecuite charge, the C 331 of 1000 kg maximum charge, and the C 411 of 1300 kg maximum charge. The brochure also illustrates the electrical features and outlines the principle on which centrifugals operate.

New Guinea sugar factory contract. — Kawasaki Heavy Industries Ltd. has received an order for the construction of a sugar factory in Papua-New Guinea to the value of 8000 million yen. The factory will produce 300 tonnes of white sugar per day and will start operations in August 1982.

Borehole pumps for Bangladesh. — Sigmund Pulsometer Pumps Ltd., a member of the SPP Group, has obtained a contract from the Bangladesh Food & Sugar Corporation for the supply of 23 four-stage vertical borehole pumps, each driven by a diesel engine through a right-angle gearhead and flexible shaft.

Filter cloth sales. — P & S Filtration Ltd., manufacturers of filter cloths, report increased sales within the sugar industries of the EEC and Greece. They hold a dominant position as suppliers to the UK sugar industry.

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

Bolivia sugar statistics[1]

	1979		1978		1977	
			tonnes, raw value			
Initial stocks*		108,151		96,612		86,940
Production		288,439		285,000		281,292
		396,590		381,612		368,232
Consumption		198,075		195,000		156,981
Exports						
Argentina	2,060		324		2,504	
Chile	46,681		27,414		22,800	
Haiti	0		0		6,481	
Syria	12,701		0		0	
USA	65,082		50,078		82,854	
		126,524		77,816		114,639
Final stocks		71,991		108,151		96,612

* Calculated

Tanzania sugar expansion[2]. — It is reported that Tanzania is to increase its sugar producing capacity to 400,000 tonnes annually by 1990. This sugar is to be for domestic consumption, however, and net exports are not planned. Sugar production during the 1979/80 season is estimated at 135,000 tonnes, against consumption estimated at some 160,000 tonnes.

Alcohol from sugar cane[3]. — A new company, Technoferm Developments Ltd. (TFD), has been established by Mitchell Cotts — Lenon for promoting the development of an improved process for alcohol production from industrial crops. TFD is patenting a novel process approach to the utilization of sugar cane as a fermentation feedstock whereby, unlike the conventional use of cane juice, molasses or sugar, the whole fibre of the cane stalk is subjected to microbiological and enzyme activity. The resistant fibrous portion of the stalk is used as fuel, while the fermentation is continuous and alcohol is separated as it is formed. TFD hopes that its new process will lead to a reduction in alcohol production cost by half, thus aiding tropical developing countries to produce motor fuel from their own resources.

Pakistan sugar crop, 1979/80[4]. — The 1979/80 cane crushing season came to an end in May with a total of 5,792,722 tonnes of cane processed to yield 543,968 tonnes of sugar, white value, against 576,928 tonnes produced in 1978/79. Production in the Punjab was 12% down on 1978/79 and that of Sind Province up by 16.3%, but in the North West Frontier Province, production was cut by 75.6%, all five sugar factories in the Province having to close down in the middle of the season for lack of cane[5]. Mills were also forced to close early in the Punjab. Beet sugar production to the end of May totalled 13,853 tonnes, white value, against 11,182 tonnes in 1978/79. According to reports from official sources, imports of 400-500,000 tonnes costing $250 million have been made, although sugar is said to be as scarce as ever in the market.

Guyana spring crop sugar production[6]. — The state-run Guyana Sugar Corporation has announced that the country's ten mills have finished crushing the spring cane crop with an outturn of about 104,000 tonnes of sugar against the target of 130,000 tonnes. The crop finished a month late because of rainy weather which caused harvesting conditions to deteriorate. The Government target for the two crops totals 356,000 tonnes, raw value, against 316,414 tonnes produced in 1979.

New Indian sugar factory[7]. — The seventh sugar factory in Madhya Pradesh was commissioned recently in Barlai village in Dewas district. It is a cooperative venture with a capacity of 1250 tonnes per day, and is named The Malwa Sahakari Sakhar Karkhana Maryadit. About two-thirds of the investment has been provided by the state government. White sugar is produced by the double-sulphitation process and capacity is to be raised soon to 2000 tonnes per day.

Flooding in Poland[8]. — Heavy rains have inflicted serious damage on the Polish sugar beet crop; according to Polish sources, fields are partly waterlogged in some areas which have received the heaviest rainfalls for 250 years. The official Polish news agency PAP has said that the rain in the first half of July flooded 220,000 hectares of arable land in addition to the 200,000 hectares submerged earlier in the month. It seems likely that Poland may have no sugar for export next season as a consequence.

Morocco beet sugar factory expansion. — ABR Engineering, who built the Beni Mellal sugar factory in 1969, have received a contract worth 350 million Begian francs for its expansion from 3600 to 4800 tonnes daily processing capacity.

Venezuela sugar statistics[9]

	1979		1978	
		tonnes, raw value		
Initial stocks		240,765		78,842
Production		347,007		402,641
		587,772		481,483
Imports				
Argentina	12,221		25,690	
Brazil	77,660		79,464	
Dominican Republic	203,210		270,411	
EEC	0		64,674	
USA	0		35	
		293,091		440,274
		880,863		881,757
Consumption		695,258		680,992
Final stocks		185,605		240,765

Illegal Mexican sugar exports[10]. — The Mexican authorities are investigating contraband movements of Mexican sugar to the United States, Guatemala, Belize and other Central American areas. According to the National Sugar Industry Commission, the exports are causing new internal sugar shortages in spite of recent imports of 600,000 tonnes of sugar. Illegal exports are attractive since the retail price in Mexico is a third less than retail prices in the United States. Industry sources said that internal prices should be raised to world market levels to stop the illegal exports.

Fuel alcohol project in Nicaragua[11]. — A public organization under the Nicaraguan Institute for Agricultural Reform, Agroinra, is considering the installation of a plant for the production of anhydrous alcohol to be mixed with gasoline for use as fuel. A distillery having a daily capacity of 150,000 litres will be installed and the necessary energy will be provided by the bagasse from a 7000 ha cane plantation. Nicaragua is interested in a process which needs only a small amount of automation.

Further Chile sugar factory sales[12]. — The Chilean state-owned sugar company IANSA is offering for sale two more of its beet sugar factories, at Rapaco and Llanquihue. The factories have processing capacities of 1200 and 1950 tonnes of beet per day, respectively, and national and international bids were called for by September 22, 1980. IANSA recently sold two other plants at Curico and Los Angeles to the privately owned Chilean sugar company Cía de Refinería de Viña del Mar. Originally, IANSA owned six plants.

Tongaat Sugar Ltd. 1980 report. — For the third successive season, Tongaat increased its share of total industrial production in South Africa, attaining 10.44% against 10.11% in 1978/79. This was largely due to the availability for a full year of cane previously crushed by Melville, and of 40,000 tonnes of cane from the Ndwedwe area of KwaZulu. South Africa produced 2,070,263 tonnes of sugar in 1979/80 of which Tongaat contributed 217,573 tonnes. With the generally dry conditions, the factory experienced difficulty in maintaining its previous level of recovery because of its limited crystallizer capacity and the overall recovery for the season was disappointingly low at 87.02% against 87.78% achieved in 1978/79. Total cane crushed was 1,911,460 tonnes of which 750,229 tonnes was harvested from company - owned and - managed land. Only 22,000 tonnes were harvested mechanically but significant changes were made to the chopper harvester which greatly improved its efficiency. The industry is now faced with a very severe drought which, in many cases, is considered to be one of the worst in the history of the industry. It is very difficult to predict either the company's or the country's crop but the situation is extremely serious and there is no doubt that there will be a fall-off in profitability for 1980/81. The drought is particularly unfortunate because it seems likely that the world price of sugar is likely to remain high and the advantage to the industry declines as the crop falls because over 400,000 tonnes of export sugar has already been priced forward at levels which at the time seemed attractive and prudent but which nonetheless are now below current levels.

1 *I.S.O. Stat. Bull.*, 1980, **39**, (6), 20.
2 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 345.
3 *World Sugar J.*, 1980, **3**, (1), 32.
4 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 396.
5 See *I.S.J.*, 1980, **82**, 132.
6 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 393.
7 *Indian Sugar*, 1980, **29**, 693.
8 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 428.
9 *I.S.O. Stat. Bull.*, 1980, **39**, (4), 94.
10 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 370.
11 *Westway Newsletter*, 1980, (80), 11.
12 F.O. Licht, *International Sugar Rpt.*, 1980, **112**, 371.

BREVITIES

Chile sugar imports[9]

	1979	1978	1977
		tonnes, raw value	
Argentina	70,070	22,038	194,538
Bolivia	46,681	27,414	22,800
Belgium	0	0	18,485
Brazil	22,067	40,219	10,826
Colombia	98,994	24,000	0
France	0	0	7,609
Peru	28,863	11,989	87,706
Other countries	0	0	9
	293,253	179,920	341,973

Uganda sugar production[1]. — Sugar production in Uganda fell to only 3226 tonnes in 1978/79, compared with 142,000 tonnes in 1970, the Finance Minister announced in his budget speech. The country's three major sugar schemes have a nominal capacity of 195,000 tonnes a year, and steps have been taken to revive production.

Thailand sugar industry reorganization[2]. — The Ministry of Agriculture and Cooperatives has established agro-economic zones for the production of sugar cane in 17 provinces. It is hoped, as a result, that the planters will be assured of getting a fair price for their cane and the sugar factories will be able to secure adequate supplies at a steady price. Plantations will be within 100 km of the sugar mills and planters will have to register with the local authorities. It is estimated that for a basic export quota of 1.2 million tonnes under the International Sugar Agreement, a production of 22.5 million tonnes of cane is required to fulfil exports and satisfy domestic demand. The domestic sugar trade has almost returned to normal and white sugar is now more readily available at the controlled retail price. Resumption of raw sugar exports was permitted from mid-July, when the millers completed the additional production of 50,000 tonnes of white sugar for domestic consumption required of them by the government[3]. To cover increased costs in producing this additional sugar, the millers have requested the government for a subsidy of Baht 82.25 million and exemption from the 7.7% business tax.

Irrigation project for Brazil[4]. — The President of the Rio de Janeiro Sugar and Alcohol Cooperative (Coperflu) has requested that the Brazilian Treasury Department extend a credit of $120 million for the installation of an irrigation system in the area of Campos, in the state of Rio de Janeiro. It is claimed that the installation of such a system in the Campos cane fields would increase the yield of cane from 45 to 130 tonnes per hectare which, in turn, would increase proportionally the production of sugar from 4 to 14 tonnes per hectare.

USSR sugar refining capacity increase[5]. — The USSR plans to build six sugar refineries under its 1981 - 85 Plan with capacities of about 6000 — 12,000 tonnes of raw material per day. Planned 1980 production should total 12 million tonnes.

Mali sugar study. — Technip S.A. of Paris has signed a contract with the government of Mali for a study on the establishment of an agro-industrial complex at Bankoumana in the upper Niger valley which will include a sugar factory having an initial capacity of 30,000 tonnes a year and crushing cane grown on 3000 hectares of irrigated cane fields.

Canadian HFCS plant expansion[6]. — The Canada Starch Co. Ltd. has said that it plans a $16.5 million expansion to its corn wet milling plant at Cardinal, Ontario, to increase HFCS production, among other things. High fructose corn syrup capacity is expected to increase by 25% but it was not said what the total capacity would be.

New cane varieties for Louisiana[7]. — Two new varieties, CP 72-356 and CP 72-370, have been released for commercial planting in Louisiana. They ratoon well and have a low fibre content, although CP 72-356 is susceptible to borer attack. The selection system in Louisiana takes about eleven years from crossing to release of a new variety.

Philippines alcohol program[8]. — The Philippine National Alcohol Commission (PNAC) has announced that 24 alcohol distilleries will be built within the next four years at a cost of 1600 million pesos to produce 400 million litres of pure alcohol a year; the alcohol produced will be mixed with gasoline to fuel motor vehicles and other gasoline-powered engines. Pilipinas Shell is putting up a 203 million pesos integrated distillery to produce its own alcohol for blending with gasoline. The proposed plant will require the development of a total of 12,000 hectares of sugar cane and cassava plantation for its raw materials.

Indian sugar factory re-opening[10]. — The West Bengal Government has decided to take over the Beldanga sugar factory in Nadia District which has been closed since 1947. About 3 million rupees has been allocated for its rehabilitation and the State Government is conferring with the National Sugar Institute on technological requirements for the mill's renovation. The capacity of the factory is 800 t.c.d.

Fiji sugar production, 1979. — The Annual Report of the Fiji Sugar Industry's Independent Chairman notes that the 1979 cane harvesting and crushing season was longer than usual because of the large amount of cane supplied to the country's four mills. Fortunately, the weather was reasonably favourable, particularly at the end when harvesting could have become difficult. A total of 4,058,251 tonnes of cane were crushed, against 2,849,378 tonnes in 1978, and sugar production reached 473,181 tonnes, against 346,690 tonnes. The cane:sugar ratio rose to 8.58 from 8.2 but it is still good by world standards, and arises from the low sugar content of cane crushed early and late. Cane yield reached 65.8 tonnes per hectare or 28.4 long tons per acre; this compares with 19.1 tons per acre in 1974. Mill expansion programmes under way should allow crushing of 4 million tonnes of cane in a shorter season. With a later start to the 1980 crop, sugar production is expected to reach the region of 500,000 tonnes this year.

Sugar beet cultivation resumption in Israel. — Cultivation of sugar beets in Israel will be renewed this autumn following an agreement reached between growers and the Sugat sugar factory. The plant will pay the farmers $56 per tonne of beet and about 120,000 tonnes of beet are expected to be grown on 2000 hectares of land, mainly in the south and north of the country.

Increased exports authorized for Argentina. — Legislation passed in late July will permit Argentine sugar producers to export sugar in excess of the 1980 production quota of 1,315,000 tonnes. Previously, exports had been set at 330,000 tonnes and surplus sugar was to be converted to alcohol for export. Argentina's 1980 raw sugar export potential is estimated at 600,000 tonnes.

Senegal sugar expansion[11]. — The Société Sucrière du Sénégal, with an investment of around $150 million, will invest $80 million during the next three years for expansion and modernization of its mill at Richard Toll. The capacity will be raised from 3000 to 5000 t.c.d. and production capacity will reach 120,000 tonnes per year. The cane area serving the factory is to be enlarged from 6000 to 8000 hectares.

Hawaii harvest postponement[12]. — Hawaiian sugar producers are postponing the harvest of a sizeable portion of the 1980 sugar crop until early next year owing to abnormal rain which is hampering field operations, according to trade sources in New York. The delay, which has resulted from unusually wet fields since February, may reduce 1980 output to under 1,000,000 tonnes from the expected 1,500,000 tonnes. It is still too early to tell whether the heavy moisture might have damaged sugar yields. The Hawaiian sugar crop grows in a two-year cycle and producers will allow some cane to stand another 5-6 months because of the inability to harvest on time.

1 *Reuter Sugar Newsletter,* June 16, 1980.
2 *Standard Chartered Review,* July 1980, 37.
3 F.O. Licht, *International Sugar Rpt.,* 1980, **112**, 435.
4 *Sugar y Azúcar,* 1980, **75**, (7), 19.
5 *Public Ledger's Commodity Week,* July 12, 1980.
6 *S. African Sugar J.,* 1980, **64**, 221.
7 *Sugar Bull.,* 1980, **58**, (18), 4.
8 *Standard Chartered Review,* August 1980, 26.
9 *I.S.O. Stat. Bull.,* 1980, **39**, (6), 25.
10 *Indian Sugar,* 1980, **29**, 4.
11 *Westway Newsletter,* 1980, (81), 20.
12 *Public Ledger,* July 11, 1980.

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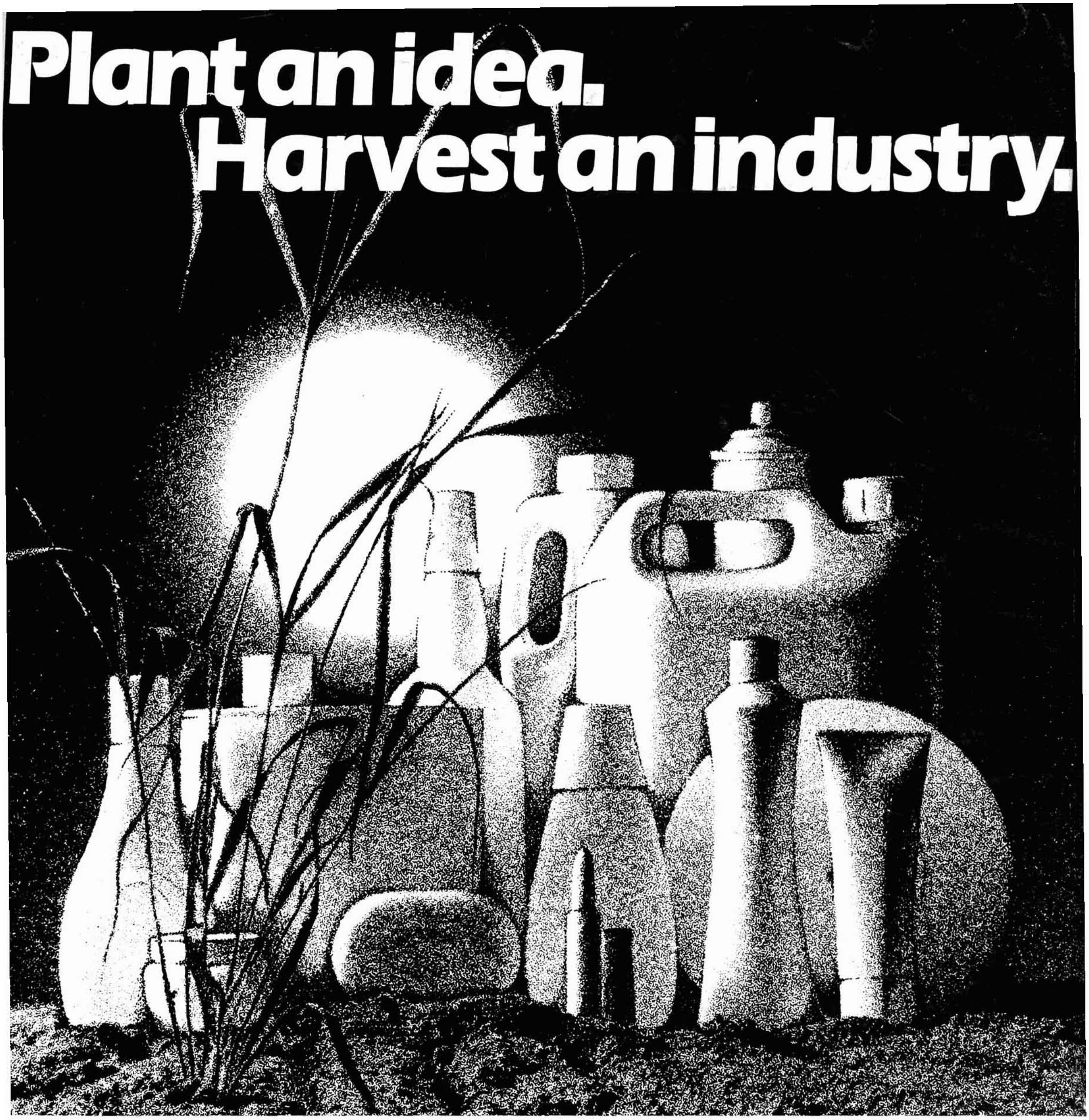

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