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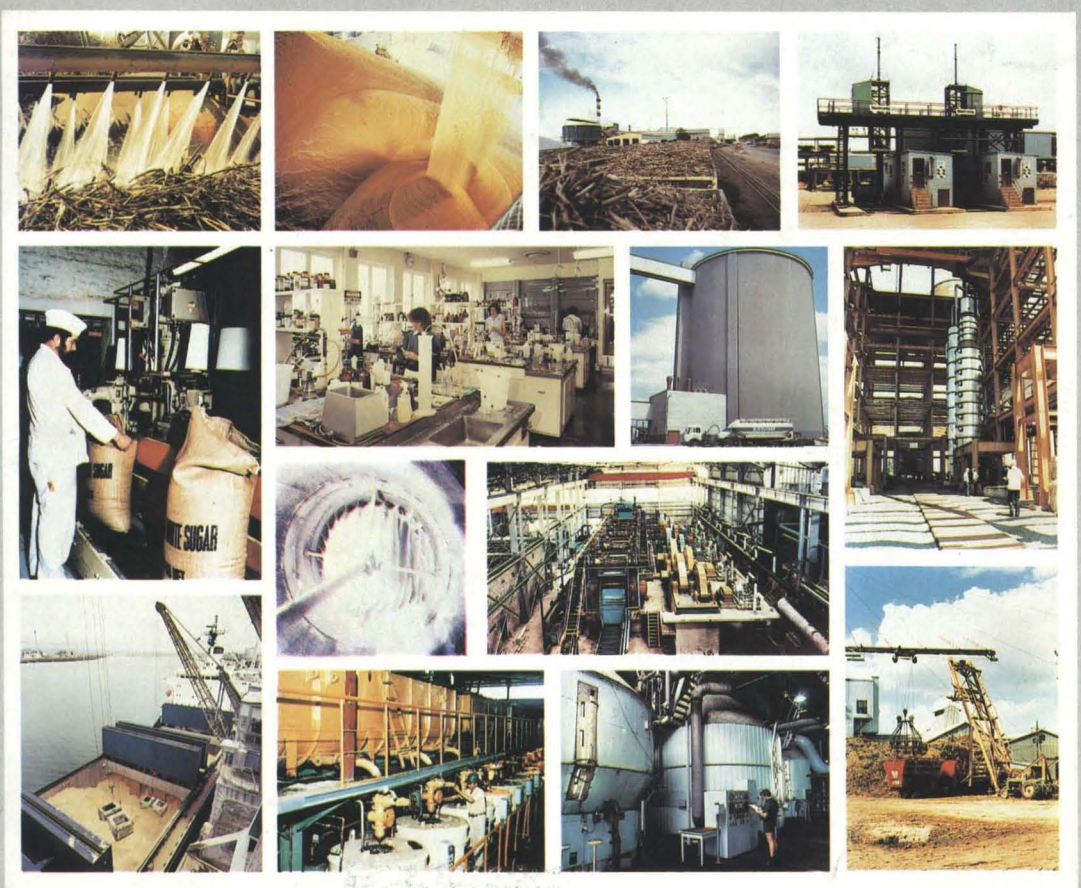

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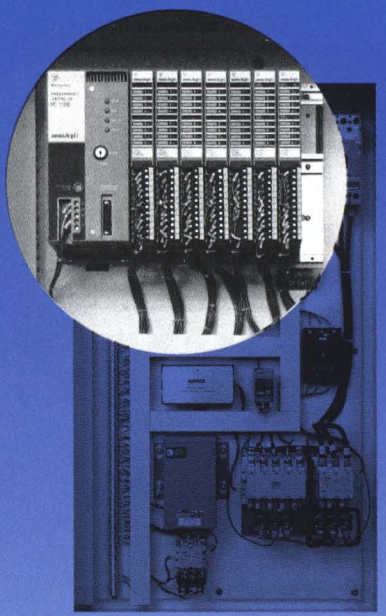

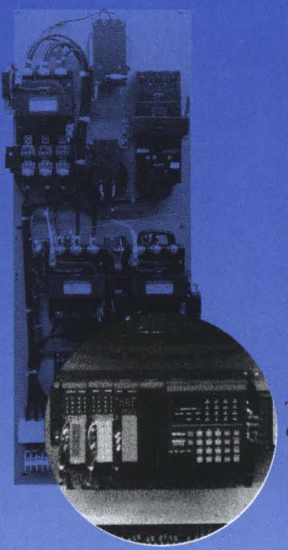

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News and views

World sugar prices

After the recovery in January, the world sugar market went through a quiet period in February with the London Daily Price for raw sugar moving within a range of $16.20. From $357 per tonne on February 1, the price rose to $365 on February 12 and then drifted downward to end the month at $348.20. White sugar prices showed even greater stability, starting the month at $432, rising to $437 on February 12 and then sliding to end the month at $426. Only a limited number of market events affected price movements: confirmation of a 2-million tonnes Sucden/Cuba sale and swap in order to fulfil the Cuban-Soviet clearing agreement; and permanent pressure created by buying interest from a long list of importers but for only small quantities, however. The continued absence of the key end-users — China, India and the USSR — promoted the weakness of the market in the second half of the month.

World sugar production estimates, 1989/90

The second estimate of sugar production in the current crop year, published by F. O. Licht GmbH at the end of January[1], shows an output which is over a million tonnes less than had been expected at the time of the first estimate in September. With a total of 106.5 million tonnes, raw value, this implies a further draw-down of stocks during 1989/90 from the level which was already critically low at the start of the season. There is also further cause for concern; considerable uncertainty exists over the crops in China, Cuba and India. Further, the possibility of considerable changes in sugar movements resulting from the political developments in East Europe points to a highly volatile market with an unpredictable outcome.

By comparison with the first estimate[2], world beet sugar estimates have risen to a total of 39,112,000 tonnes from 38,929,000 tonnes, reductions in the US, Chile, China and Japan being more than outweighed by increases in Europe, both East and West. The 1988/89 beet sugar total was 37,805,000 tonnes. It is among cane sugar producers that the more important reductions are seen. South's Africa's expected production is now set 274,000 tonnes lower and this accounts for almost all of the overall reduction in the African continent. North and Central America's production is set 850,000 tonnes lower, the major contributions being estimates smaller by 100,000 tonnes in Cuba, 330,000 tonnes in Mexico and 233,000 tonnes in the continental USA. Little change is expected overall in South America and Asia, but in Oceania the Australian figure is set 200,000 tonnes lower and that for Fiji by 25,000 tonnes. The world cane sugar estimate is thereby reduced to 67,342,000 tonnes against 68,768,000 tonnes expected earlier and 67,931,000 tonnes in 1988/89.

European sugar beet area, 1990[3]

One of the factors thought to limit extreme price rises is the growing share of production from the beet sugar industry. This is because, as an annual crop, it is relatively easy for the beet area to be expanded quickly, thereby providing a basis for a rapid response to short supplies. With wide recognition of the reduction in sugar stocks which has taken place over the past few years, it had seemed reasonable that beet farmers would be increasing their sowings quite markedly. As Europe is the major source of beet sugar, F. O. Licht's estimates for the 1990 sowings have been awaited with interest.

Surprisingly, there seems to have been a muted response to the stock position. The overall area sown to beet in Europe is forecast to rise by not more than 1.4% to 7.1 million hectares. The area sown to beet in the EEC is projected to grow by more than 2.5% while in Western Europe as a whole the expansion is forecast to reach 5%.

Excellent yields were achieved throughout Europe last year so that, on the basis of average yields, production might be expected to decline in spite of the greater area sown to beet in Western Europe. This could be misleading, however, as the trend of average yields has been upwards so that a past average yield might understate likely production. Nevertheless, a fall in sugar production seems a distinct possibility and the sugar market reacted to Licht's estimates with an increase in sugar prices. The initial area forecasts are tabulated below; based on average yields the 7,141,000 ha of 1990 would produce 31,151,000 tonnes of sugar against 32,903,000 tonnes from the 7,042,000 ha of the 1989 crop.

	1990	1989
	hectares	
Belgium	115,000	112,000
Denmark	67,000	67,000
France	450,000	417,000
Germany, West	411,000	392,000
Greece	44,000	48,000
Holland	124,000	125,000
Ireland	33,000	32,000
Italy	260,000	280,000
Portugal	1,000	1,000
Spain 180,000	170,000	
UK	200,000	194,000
EEC	1,885,000	1,838,000
Austria	49,000	48,000
Finland	30,000	31,000
Sweden	51,000	50,000
Switzerland	15,000	15,000
Turkey	400,000	354,000
Yugoslavia	170,000	141,000
W. Europe	2,600,000	2,477,000
Albania	12,000	10,000
Bulgaria	48,000	40,000
Czechoslovakia	176,000	181,000
Germany, East	220,000	217,000
Hungary	110,000	109,000
Poland	420,000	425,000
Rumania	265,000	260,000
USSR	3,290,000	3,323,000
E. Europe	4,541,000	4,565,000
Total Europe	7,141,000	7,042,000

Comecon trade reform proposals

A meeting was held in January between the members of Comecon, which include the countries of the East European bloc and Cuba. The USSR proposed that trade within the group should begin to

1 *Int. Sugar Rpt.*, 1990, **122**, 73 - 82.
2 *I.S.J.*, 1989, **91**, 244.
3 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 137 - 140.

take place in convertible currency from 1991. C. Czarnikow Ltd. point out[4] that the bulk of sugar trade within Comecon is between Cuba and the USSR with a smaller but still significant amount moving from Cuba to other East European partners. "Should Soviet proposals be adopted there will be gains and losses for Cuba. It will be a definite gain if all Cuba's sugar exports are to be paid for in free currency as this will give her a greater freedom of choice in obtaining her own requirements. On the other hand it is unlikely that the price, if world market levels are to be the guide, would approach the nominal value of the present return in roubles."

World sugar balance, 1989/90

F. O. Licht recently published[5] their second estimate of the world sugar balance for the crop year September 1989/August 1990 and the figures are reproduced below, together with corresponding figures for the previous year:

	1989/90	1988/89
	tonnes, raw value	
Initial stocks	29,521,000	33,066,000
Production	107,912,000	104,713,000
Imports	28,624,000	29,152,000
Total	166,057,000	166,931,000
Consumption	108,069,000	107,547,000
Exports	29,010,000	29,863,000
Final stocks	28,978,000	29,521,000
" " % consumption	26.81%	27.45%

Licht notes that production has nearly caught up with consumption and, on the assumption of normal weather, this trend could continue in 1990/91, so that next year could see a balance or even a slight rise in stocks. However, the figures show that the world as a whole has no surplus stocks left, and has begun to eat into working stocks. This is a highly precarious position and any production shortfall could result in higher prices.

Indonesian sugar situation[6]

Indonesia, aiming for self-sufficiency in sugar, is expanding plantations and factories but rising demand means that the country will continue to be an importer for the next few years. According to the head of the government-supervised Indonesian Sugar Council, imports seem to be inevitable because output growth cannot catch up with increasing consumption. Sugar production in calendar 1990 is expected to rise 5% from that of 1989 to 2.2 million tonnes, whilst consumption will rise 8.3% to 2.6 million tonnes. Imports are expected to be 400,000 tonnes, the same as in 1989. Production last year was 2.1 million tonnes or 13% below target, owing to lower than expected plantings. Farmers are less interested in growing cane because the return from a single cane crop over 15 months is only 60% of that from two rice crops grown in a year. The government hopes that more cane will be grown in the islands of Sulawesi, East Timor and Irian Jaya, and is considering increasing the price it pays for cane. However, farmers are reluctant to relocate to the outer islands from Java. Many of Indonesia's sugar factories are old and inefficient, and production costs are high. The government is currently seeking bids to renovate at least four factories outside Java, but only one in Sulawesi is likely to restart operations soon.

US sweetener users seek a sugar quota increase[7]

The unexpected large increases in the US import quota this year are making it difficult for some exporters to meet their quota obligations. The case of Brazil is the most obvious, but other countries are in similar though less extreme difficulties. The reasons vary widely, according to Abel, Daft & Earley; some cut back production or stimulated domestic consumption when the US quota began to fall in the late 1980's. Now they are hard pressed either to produce more sugar or import white sugar for consumption so that raws can be shipped to the United States. Other countries are just having bad crops at an unfortunate time. There is also the case of Panama, where access to the US market was withheld so long that it is now too late to produce enough sugar to export, even with help from white sugar imports. Countries with troubles severe enough to place them with Brazil in a list of problem suppliers this year includes Argentina, Bolivia, Ecuador, Guyana, Panama, Paraguay, St. Kitts and Uruguay.

In view of this, the US Sweetener Users Association has asked the Department of Agriculture to make another increase of 150,000 to 250,000 short tons in the 1989/90 US sugar import quota to meet strong domestic demand, coupled with an expected shortfall in shipments from quota-holding nations.

Mozambique sugar crop, 1989[8]

The Mozambique government has reported that it produced 260,400 tonnes of cane in 1989, an increase of 28% on the 1988 figure of 220,600 tonnes. Sugar output was 25,000 tonnes; in 1973/74 output was 280,000 tonnes and the fall is attributed by the government to sabotage by MNR rebels and technical problems, particularly a shortage of spare parts.

Uganda sugar factory rehabilitation finance[9]

Loans to the value of $41.5 million have been agreed by donors including the Islamic Development Bank, the Kuwait Fund, the OPEC Fund, the Saudi Fund, the East African Development Bank, the Arab Bank for Economic Development in Africa and the PTA Bank, to be applied against the $73 million cost of rehabilitating the state-owned Kinyala sugar factory in Uganda. The Uganda Commercial Bank and the Bank of Baroda have agreed to to participate in the provision of working capital for the project. Work will start in July 1990, consultants and project managers being F. C. Schaffer of the US and Booker Tate Ltd. of the UK.

4 *Czarnikow Sugar Review*, 1990, (1792), 3-4.
5 *Int. Sugar Rpt.*, 1990, **122**, 105 - 112.
6 *Public Ledger's Commodity Week*, February 3, 1990.
7 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 146 - 147.
8 *AIM news agency reports* (Mozambique), January 10, February 19, 1990.
9 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 13 - 14.

Malawi experience in fuel ethanol production and utilization

By P. J. Watson
(Lonrho Sugar Corporation, 138 Cheapside, London EC2V 6BL)

Introduction

Interest in fuel ethanol was motivated by the rapid rise in crude oil prices in the late 1970's and the success of the Brazilian Proálcool scheme. Malawi is a small landlocked country with high population density and an economy based on agriculture. Its primary foreign exchange earners are tobacco, tea and sugar.

The sugar industry has grown from a modest beginning in 1966 when land in the Lower Shire was developed to form what is today the Sugar Corporation of Malawi, to an industry with annual production of nearly 190,000 tonnes from some 14,500 ha of irrigated land. It is an estate-based industry; however, the estate located in the Dwangwa delta on Lake Malawi has a smallholder operation adjacent to the company estate.

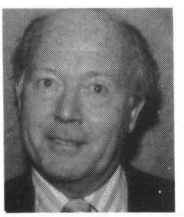
In 1979, the government invited a number of organizations, including the sugar industry, to make submissions for the establishment of an alternative fuel program based on fermentation ethanol. The government decided to support a proposal based on the construction of a 40,000 litres/day distillery at the smaller Dwangwa factory to utilize the 20,000 tonnes of final molasses available, sufficient for a 10% ethanol blend, additional production being based on the use of sugar.

This decision was contrary to the sugar industry's proposals which recommended a distillery at the large Sucoma estate, where some 32,000 tonnes of molasses were available. It has created problems both technical and economic for the ethanol industry.

The ethanol industry

The Dwangwa distillery is owned by a parastatal organization and is operated independently from the adjacent sugar factory. It obtains its process steam from the factory during the crop, while a diesel-fired boiler is used during the inter-crop.

During the construction phase, the distillation plant capacity was



P. J. Watson

increased to 60,000 litres/day. In the mid 1980's, additional batch fermenters were installed to permit production at the same level, increasing production capacity to 12 million litres/day. Conventional ethanol production technology was used: batch fermentation using closed circuit cooling, plate heat exchangers, and low pressure distillation using benzene on the extrainer.

The total cost of the plant, completed in 1982, was approximately US$8 million, which included the necessary facilities for ethanol blending and storage at the oil company depots.

The company negotiated an ethanol price-fixing formula based on the landed price of premium gasoline, together with supplement on octane leverage reflecting the saving gained by the oil companies in importing lower octane fuel for blending (for example, a 15% blend permitted a reduction in the base stock gasoline of 6 octane points).

Initially, the plant operated very profitably utilizing the Dwangwa molasses which had been stockpiled prior to distillery start-up to supplement the current season's molasses. With an ex-mill price of $9/tonne (yielding 270 litres/tonne) in 1983 resulting in a total variable cost of production, including process chemicals and utilities, of 6 U.S. cents/litre anhydrous ethanol compared with ex-distillery fuel ethanol price of 48 cents/litre, this was to be expected. However, by the end of 1983, production from Dwangwa final molasses was limited to six million litres compared with the market requirement of ten million litres. Meanwhile, the civil war in Mozambique had cut off Malawi's normal supply route, resulting in a dramatic increase in the landed price of petroleum products owing to the tortuous supply routes available. Under these conditions, the ethanol company, which had seen the ethanol price under the pricing formula increase dramatically, was able to consider a higher cost feedstock, namely sugar. The sugar industry itself, owing to the Mozambique situation, had also incurred a major increase in its freight rates at a time of low world market sugar prices with a resulting fall in ex-factory prices for exports.

It was therefore agreed to supplement the factory's final molasses by converting the Dwangwa factory to a two-boiling system, releasing about 7000 tons of *C*-sugar for fermentation; approximately 760 kg of *C*-molasses and 190 kg of sugar are obtained from one tonne of *B*-molasses. The conversion to a two-boiling system led, as a bonus, to a marked improvement in the operation of the Dwangwa factory which is designed to produce a maximum proportion of white sugar for both export and the local market. In recent years, 80% of production has met EEC No. 2 quality requirements.

Operationally, the distillery has performed well, the installation of an HPLC instrument in 1985 enabling much closer control of fermentation, thereby ensuring that batches were fully fermented prior to distillation. Results obtained by HPLC in particular resulted in a major reduction in the level of nutrient addition, and a similar benefit was reported by Triangle Ltd. in Zimbabwe[1].

Surprisingly corrosion has not proved a problem in the mild steel fermenters. After about six years Triangle have had to replace mild steel with 3CR12. However, the safe disposal of the distillery effluent, which had not been seriously considered in the study, proved to be a problem. Initially it was discharged into the Dwangwa surface irrigation system. However, the potash content of Dwangwa molasses is relatively high – 50 - 52% of total ash – compared with 30%, for example, in

Paper presented to British Society of Sugar Cane Technologists, 1989.

1 Tannock: *Proc. 58th Ann. Congr. S. African Sugar Tech. Assoc.*, 1984, 74 - 77.

South Africa.

During the 1982/83 season it was found that the ERC % cane in those fields on which vinasse had been applied was significantly lower compared with the previous season – by an average reduction of 0.6%. Foliar analysis also showed an average of 1.49% potassium compared with 1.32% in those fields without vinasse. There were other factors which could have affected the recoverable crystal sugar level including water balance, nitrogen shortage and nutritional imbalance. However, it was decided to discontinue vinasse application within the estate as high potassium levels are known to result in lower boiling house recoveries.

Dwangwa estate soils potassium content varies widely and the irrigation system design would not permit selective vinasse application without a complex reticulation system.

Since 1983 considerable experience has been gained at Triangle on the effect of potash on both cane yield and ERC and application rates of 480 kg K_2O/ha using a 200:1 dilution have been shown to be beneficial. At Triangle K_2O uptake by cane is about 374 kg/ha of which 165 kg/ha is removed from the field in the cane.

The ethanol company, as a temporary measure, constructed some large evaporation ponds. Initially these were too deep, creating anaerobic conditions which resulted in the creation of a thick scum leading to low solar evaporation rates. Even with shallower ponds this has not proved a satisfactory system and it was decided in 1987 to construct an anaerobic digestion system to reduce the BOD of the effluent to a more acceptable level, permitting controlled discharge into the Dwangwa river at periods of high flow and into the estate irrigation system at other times, subject to close control of the potash content. The first digester should be commissioned later in 1989 and the installed cost is expected to be $1.5m. The methane recovered should permit the production of hydrated ethanol out-of-crop or, with supplementary boiler fuel, anhydrous alcohol.

Commercial digesters such as at the Bacardi plant in Puerto Rico achieve a reduction of about 60% from a COD of 70 - 80,000 mg/l; this suggests that the treated effluent will still have a COD of 30,000 mg/l compared with a normal upper limit of 120 mg/l for river discharges. The impact of the discharge of partially treated effluent into the Dwangwa river about 2 km above its mouth should be a cause for concern with its impact on marine life in Lake Malawi.

The average flow in the Dwangwa River is below 50 cusecs in the autumn, which will result in a dilution factor of less than 1:150. In practice, extraction for irrigation will reduce the dilution factor substantially. Research in America has shown that a dilution of 1:10,000 is necessary for total safety. Concentrations of over 1:400 can result in significant environmental damage.

Sucoma, with direct access to the Shire River with a minimum flow of 15,000 cusecs, could safely dispose of its effluent without treatment if necessary. In practice incorporation in the irrigation water shall be acceptable.

Common management of the distillery and estate could probably have designed a satisfactory reticulation system at a lower cost. Distillery economics have, however, deteriorated significantly recently for a number of reasons, namely, the probability of an improved fuel transport system using the "Northern Corridor" route, leading to much lower landed fuel costs, reduction in the "real" petroleum product price, and increase in world sugar prices resulting in a higher price being paid for the recoverable sugar in *B*-molasses.

At present, the distillery is obtaining additional molasses from the southern factory at a cost in excess of $65/tonne compared with $3.5/tonne ex-factory, owing to the high cost of Dwangwa sugar and the need for the sugar industry to maximize sugar production to meet rapid growth in the local market and take advantage of the high hard currency prices obtainable for regional exports.

The decision to create an independent company located at the smaller of the two estates has proved, in the author's opinion, to be a mistake for the reasons given below (a conclusion reached independently earlier this year by a USAID funded study on the expansion of the ethanol industry):

Lower available tonnage of cheap fermentable sugar;

High overheads incurred with independent operation;

The effluent disposal problems are greater at Dwangwa than at Sucoma;

Conflicts of interest between sugar estate and distiller lead to operational difficulties; and

Higher fuel transport costs – 60% of the fuel market is in Southern Malawi (a short distance from Sucoma).

However, with low oil prices and the likelihood of Malawi's links with the sea via Mozambique being re-opened, the economics of a second distillery which has recently been proposed by both the Government and the US Aid mission to process Sucoma molasses are marginal. A second plant would also have serious implications for the existing plant which would be limited to processing the available *C*-molasses. At present it is economical to transport molasses from Sucoma to Dwangwa. Without this the reduced level of operation would make it difficult for the company to recover the existing overheads and continue to service its debts.

What lessons have been learned

The location of the distillery should take into account long term cost and availability of fermentation feedstocks.

The true cost of disposal of effluents, particularly the long-term environmental and agricultural impact, has to be evaluated.

There is a need to integrate the plant fully into sugar factory operations, making lines of communication and planning easier and reducing overheads. An important added advantage is the ability to utilize low-grade sugar for

ethanol production, taking into account the overall mill and distillery production economics.

Particularly when the sugar prices are low, long term trends in fuel and raw material prices have to be evaluated as far as is practicable; however, the cyclical nature of the sugar industry and the uncertainties of the crude oil market make this difficult.

Under present conditions, with crude oil at $18 - 19/barrel, fuel ethanol production is only financially viable if ex-factory molasses prices are heavily discounted on international prices (New Orleans or Rotterdam) and the operation has a modest debt servicing burden; in addition, production probably has to be carried out on a reasonably large scale, at least to 40,000 litres/day to keep unit fixed costs at an acceptable level.

Ethanol utilization

Malawi has successfully implemented an ethanol blend program with the blend level varying from 15 to 20%, depending on supply. No major problems have been encountered with ethanol storage out-of-crop, blending, storage of both ethanol and blended fuel and distribution, vehicle driveability and long term engine life, or customer acceptance. Subject to availability, the blend is being increased to 22% at present.

An extensive trials program has been undertaken over the last six years in parallel with the national marketing of ethanol blends in Malawi to widen the utilization of ethanol. However, whilst this has been largely successful technically, its implementation must await an increase in the real price of oil to $25 - 30/barrel at current prices.

Fuel and engine trials, particularly on agricultural tractors, have been carried out, including modification of diesel engines to spark ignition for 100% ethanol use, addition of ignition improvers to ethanol, use of ethanol/diesel emulsions and of ethanol/diesel blends with a stabilizer.

These trials at Sucoma are described in detail in earlier papers[2-4]. Two ethanol-fuelled cars were imported from Brazil in 1983 and have proved to be reliable, with excellent drivability and low maintenance costs. A trials program with Series II and Series III Landrovers, modified for use with ethanol instead of gasoline, has shown that vehicle performance is unimpaired. However, owing to the lower volumetric energy value of ethanol, fuel consumption is about 40% higher, with resultant need to discount the ethanol price for this application.

Whilst the replacement or extension of diesel fuel and the conversion of gasoline fueled engines has been shown to be technically possible, at current oil prices, even in Malawi, the use of ethanol for these applications is uneconomical unless large-scale ethanol production is possible from very cheap feedstock. In Malawi today, for example, the direct cost in US cents/litre of production of ethanol and the ex-distillery fuel prices are given below based on current (October 1989) beneficial feedstock values ex-factory:

Direct production cost	US cents/ litre	Total cost, cents/litre
Nutrients, chemicals, steam and power	2	
Source of fermentable sugar:		
Dwangwa molasses, $3/tonne ex-mill	1	3
Sucoma molasses, $15/tonne ex-mill plus road transport to Dwangwa	25	27
Raw sugar $220/tonne ex-mill	40	42
Potential ex-distillery selling price	Current	Via Mozambique
Gasoline blending	41	34
Landrover fuel	25	20
Diesel substitution	11 - 15	

The low value of Dwangwa molasses reflects the extremely high transport costs with the Nacala railway line through Mozambique closed.

Ethanol in Malawi – success or failure?

Over the past eight years, the ethanol program has saved Malawi over $4 million per annum and has provided a secure source of fuel. However, the high profitability of the project has largely been due to the high transport cost of imported fuels and to low feedstock prices.

At the end of last year, the landed price of gasoline was 33 US cents/litre in Malawi compared with ex-Gulf refinery price of 12 US cents/litre. Dwangwa molasses is worth about US$3/tonne compared with a typical ex-factory price of US$25-30 which many producers obtain on the export market, while depressed world sugar prices have been below the direct cost of production.

At current world oil prices and molasses prices pertaining in most producer countries, the production of fuel ethanol is unlikely to be commercially viable without government fiscal incentives as currently proposed, for example, for the South African sugar industry's Richards Bay project. Recognition of its true economic value as an octane enhancer by the oil industry is important. However, if low-cost molasses is available in sufficient quantities, with the long-term probability that oil prices will rise to at least $25/barrel, then fuel ethanol production offers a good financial return. At lower oil prices, there are, however, substantial foreign exchange benefits to be obtained, making such projects attractive on a national basis.

The views expressed in this paper are those of the author.

continued on page 66

2 "Malawi ethanol expansion options" (Office of Energy, USAID), February 1989.

3 Noble & Watson: "Ethanol alternative diesel fuel in Malawi", *Paper presented to Alcohol Fuels Conference* (Paris), October 1986.

4 Watson: "Ethanol, its potential as substitute or extender for diesel fuel in tropical agriculture" *Paper presented to Conf. on small engines and their fuels in developing countries* (Reading University), September 1987.

Biomass-fired steam-injected gas-turbine cogeneration for the cane sugar industry

By Eric D. Larson, Joan M. Ogden, Robert H. Williams and Michael G. Hylton

(Continued from page 54)

Case study: Utility perspectives

Jamaican context

While the GSTIG would provide much more attractive rates of return to a sugar producer than would a CEST plant, the capital involved (Table I) would be far in excess of investments to which sugar producers are accustomed. By contrast, the investments in a GSTIG unit would typically be less than what an electric utility might invest in building a comparable amount of new central station capacity (Figure 4). In addition, the capacity increment of a single GSTIG would be smaller than a typical new central station power plant, allowing a utility to better match the evolution of electricity supply and demand.

For a utility, cogenerated electricity would be of interest if it cost less than other utility sources. Fuelled by briquetted cane residues at a "steam-conserving" factory, the GSTIG would produce exportable electricity for about 4.1¢/kWh, and the CEST would produce about half as much electricity for about 4.8¢/kWh. In the scenarios involving oil as the off-season fuel the costs would be about 5.2¢/kWh for the GSTIG and 5.4¢/kWh for the CEST. These cogeneration costs are compared in Figure 6 with the cost of power from a new 61 MW coal-fired power plant, which is being considered by JPS as a least-cost expansion option. It would produce electricity for an estimated total cost of 5.0 - 5.8¢/kWh (see the section "Exported electricity price" above). In all cases shown in Figure 6, the GSTIG plant would provide comparable- or lower-cost electricity than the new coal-fired option, even with a low price for coal.

The cost of cogenerated electricity is also compared in Figure 6 with the *operating* cost of existing oil-fired power plants, which would range from 4.5 to 6.1¢/kWh (see the section "Exported electricity price" above). For all cases where biomass is the sole fuel, the GSTIG facility would produce electricity at a lower cost, even with oil at $2.9/GJ ($19/bbl). Under these conditions, it would be economically worthwhile to scrap existing oil-fired plants and replace them with new GSTIG facilities.

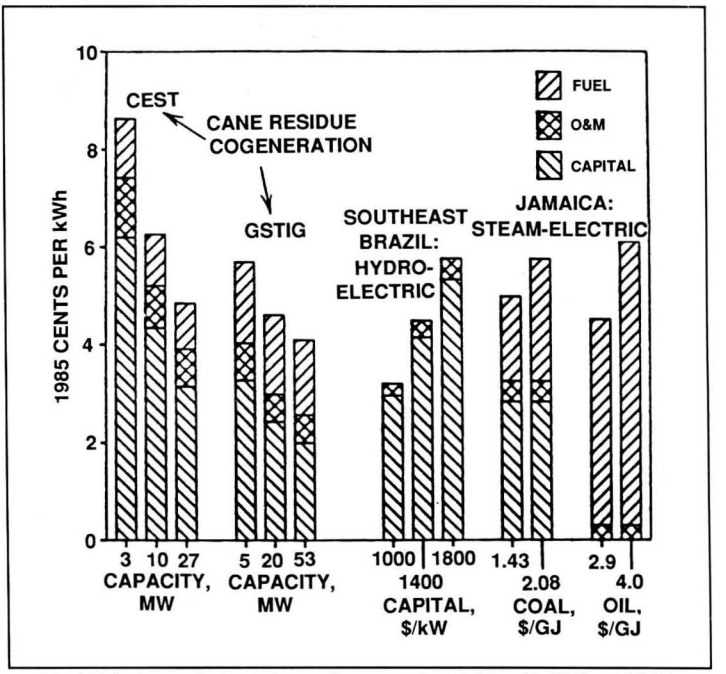


Fig. 6. Estimated levelized cost of generating exportable electricity with CEST and GSTIG cogeneration systems at a "steam-conserving" sugar factory and for three central-station alternatives[1]. Total costs are shown for a new 61 MW coal-steam plant in Jamaica and new hydro-electricity plants supplying power to Southeast Brazil. Also shown is the cost of operating existing oil-steam plants in Jamaica. Table I gives cost assumptions for the largest CEST and GSTIG plants. Assumptions for the smaller plants are in the Larson *et al.* report[1]

If Jamaica's total resources of cane residues were to be exploited for power, some existing oil-fired generating capacity could be retired, new central-station power plant construction could be deferred for many years or perhaps decades, and substantial foreign exchange would be saved. A typical 1980's cane harvest (2.2 million tonnes) would support nearly 80 MW of CEST units that could export about 500 million kWh of electricity annually, or over 150 MW of GSTIG units that could export about 1000 million kWh per year. For comparison, JPS generated 1437 million kWh in 1985. If GSTIG generated power were to displace new coal-fired capacity, up to $270 million dollars of foreign earnings might be saved over the 30-year life of the plants (Table IV). If cogenerated power displaced electricity from existing oil-fired units, up to $300 million might be saved (Table IV). Per kWh cogenerated, the savings with GSTIG would be 50 - 90% greater than with CEST.

Southeast Brazilian context

Southeast Brazil, where much of Brazil's sugar cane grows and which includes the heavily industrialized state of São Paulo, provides an interesting contrast to Jamaica, because it is a cane-producing region which relies heavily on hydro-electric power, which is a much less costly electricity source than most alternative sources. With electricity

Table IV. Potential foreign exchange savings to Jamaica with alternative cogeneration systems (at the 1985 level of cane production) by avoiding construction of new utility central station coal-fired capacity or by displacing existing oil-fired capacity*. For this analysis, all capital is assumed to be foreign exchange

Generating technology	Potential new capacity, MW	Required capital investment, $10^6$$	Life cycle foreign exchange requirements for fuel, $10^6$$**	Life cycle foreign exchange savings with cogeneration *vs.* coal or oil-fired central station $10^6$$**	$/MWh
CEST cogeneration†	79	132	0		
vs. New coal-steam†† with coal at:					
$1.43/GJ	88	116	70	54	3.54
$2.08/GJ	88	116	102	86	5.64
vs. Existing oil-steam†† with oil at:					
$2.9/GJ	0	0	172	does not apply‡	
$3.2/GJ	0	0	190	58	3.81
$4.0/GJ	0	0	237	92	6.89
GSTIG cogeneration†	153	160	0		
vs. new coal-steam†† with coal at:					
$1.43/GJ	172	226	138	204	6.84
$2.08/GJ	172	226	200	266	8.92
vs. Existing oil-steam†† with oil at:					
$2.9GJ	0	0	337	177	5.94
$3.2/GJ	0	0	372	212	7.11
$4.0/GJ	0	0	464	304	10.2

* For a cane production of 2.2 million tonnes per year, and CEST and GSTIG export electricity production of 231 and 452 kWh/tc, respectively. Thus, the CEST and GSTIG systems would produce 500 and 1000 GWh/year, respectively

** For a 12% discount rate and a 30-year life cycle

† Assuming all of the capacity is installed at a cost of $1671/kW for CEST and $1048/kW for GSTIG, which includes factory retrofits for a "steam-conserving" factory, and calculated capacity factors of 73% for CEST and 74% for GSTIG

†† Assumptions associated with the cost of electricity from the coal-steam plant and the oil-steam plant are given in the subsection entitled "Exported electricity price"

‡ CEST power would not displace oil-fired power unless the price of oil is at least $3.2/GJ, where the fuel plus operating cost for the oil-fired plants would equal the total generating cost for the CEST (4.9¢/kWh)

Table V. Estimated potential worldwide GSTIG generating capacity at sugar factories with the 1985 level of sugar cane production (assuming 10 tonnes cane per tonne of sugar[27])

Region	Potential electrical capacity, MW*
South America	17,800†
Asia	14,000
Central America	10,100
Africa	4,900
Oceania	2,700
United States	1,900
Europe	200
Total	51,600

* Assuming a 206 day season, 24 hour/day operation, 90% plant availability, and a GSTIG fuel requirement corresponding to 172 tonnes of cane per hour for a 53 MW unit

† Includes capacity that would be installed at alcohol production facilities in Brazil

demand in São Paulo growing at 8 - 10% per year[25], the installation of new hydro-electric capacity is under consideration. Since nearly all of the economical potential has already been exploited in the South, however, new hydro-electric plants would be built in the Amazon, with transmission lines connecting them to São Paulo[26]. Electricity from such facilities is estimated to cost from 3.2 to 5.8¢/kWh, depending primarily on the siting of the facility (Figure 6).

Based on the calculations for the Jamaican case study, large (53 MW) GSTIG cogeneration plants operating year-round on briquetted cane residues at sugar factories in São Paulo could supply electricity at a cost in the mid-range of those estimated for new hydro supplies, and small units would be competitive with the higher-cost hydro-electric plants. By contrast, only the larger CEST units would be competitive and then only with the higher-cost hydro-electric plants (Figure 6).

25 "Balanço energético do Estado de São Paulo 1984." (Conselho Estadual de Energía, São Paulo, Brazil), 1986.

26 Correa: *Personal communication*, 1987.

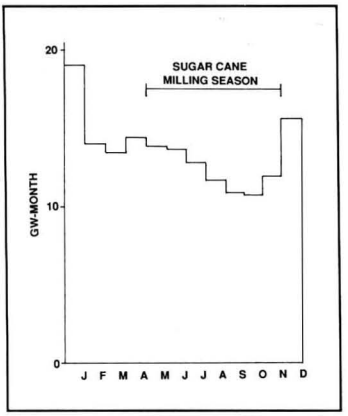


Fig. 7. The current hydro-electricity supply "trough" for a typical rain year, and the cane milling season in the state of São Paulo, Brazil[1]

Given the shortage of capital in Brazil (as in many other developing countries), the capital charges alone for electricity may be as important as the total cost of generation, in which case the GSTIGs would have a significant advantage at any scale. For example, the capital charges for GSTIG power would be 50 to 80% of those for hydro-electric capacity costing $1400/kW (Figure 6). For CEST, only a modest capital advantage would be gained, and only with larger units.

Even if GSTIG units were operated only during the milling season, the produced power may be attractive to the utilities if hydro-electric and GSTIG options were considered together. Since the cane milling season coincides with the dry season, cogeneration at sugar processing facilities could help fill the hydro-electric power "trough," (Fig. 7), thus making greater use of the installed hydro-electric capacity.

Implications

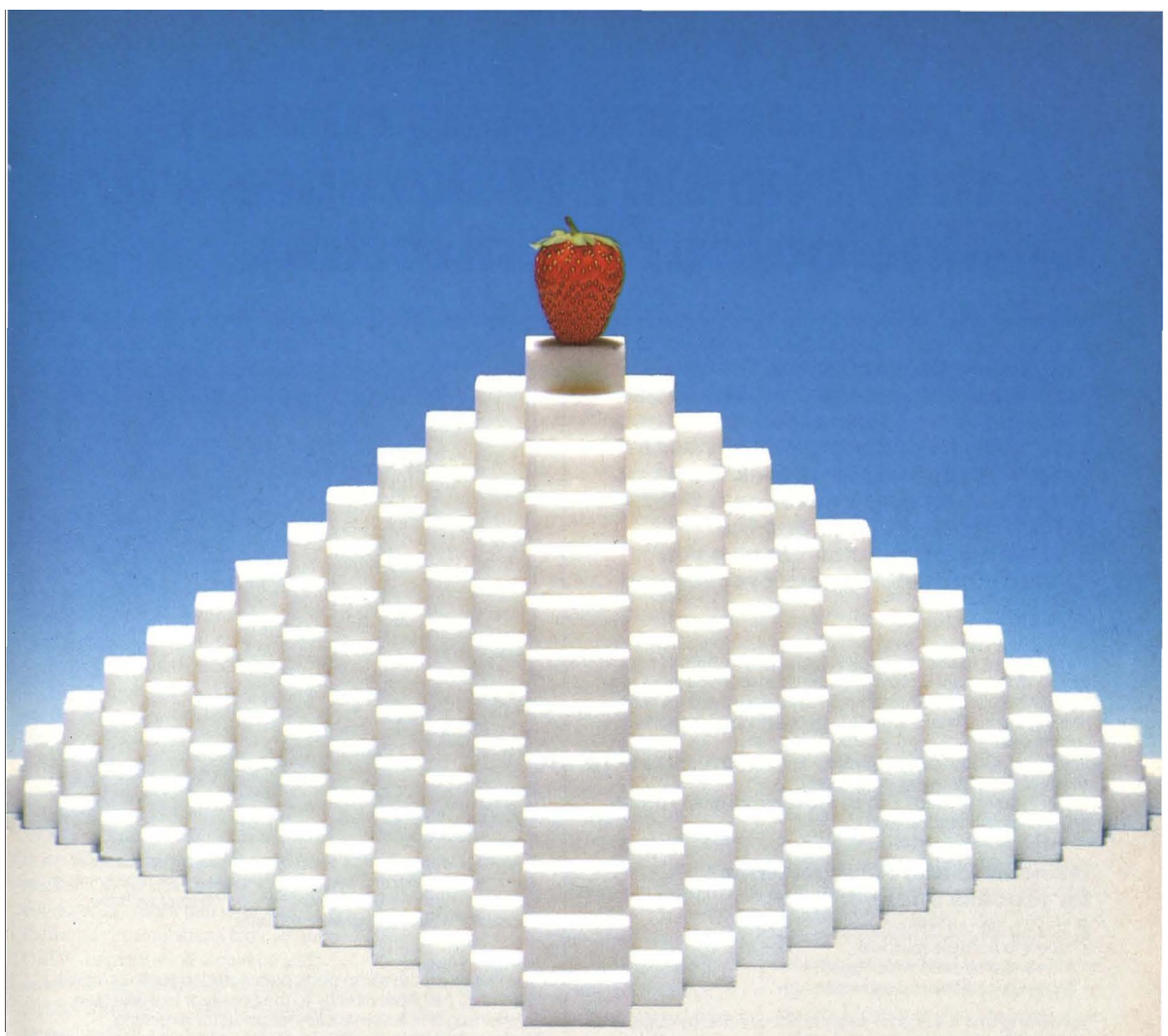
The introduction of GSTIG units world-wide could have a significant impact in over 70 countries that grow cane. The amount of cane residues produced globally in 1985 would support over 50,000 MW of GSTIG capacity, most of which would be in developing countries in Asia and Latin America (Table V). Based on an extrapolation of the results for Jamaica, some 300×10^9 kWh of electricity could be produced at the 1985 level of cane production (Table VI). This is more than a quarter of the electricity generated by utilities in these countries in 1982, and is comparable to the level of electricity generated with oil.

A global transition to GSTIG cogeneration offers challenges for both the sugar and electric utility industries.

Table VI. GSTIG electricity generating potential in 10^9 kWh per year using the 1985 level of cane production (A) and the actual total electric utility generation in 1982 (B) in developing countries[1]

	A	B
Asia		
India	31.6	129.5
China	19.0	327.7
Thailand	10.8	16.2
Indonesia	7.6	11.9
Philippines	7.4	17.4
Pakistan	6.4	14.9
Taiwan	3.4	45.0
Iran	0.90	17.5
Vietnam	0.81	1.69
Burma	0.45	1.52
Bangladesh	0.42	2.98
Malaysia	0.32	11.1
Nepal	0.12	0.284
Sri Lanka	0.07	2.07
Sub-total	89	600
Central America		
Cuba	35.5	10.8
Mexico	15.7	73.2
Dominican Republic	4.2	2.38
Guatemala	2.3	1.42
El Salvador	1.2	1.45
Nicaragua	1.1	0.945
Honduras	1.0	1.04
Costa Rica	1.0	2.42
Jamaica	0.94	1.30
Panama	0.72	2.71
Belize	0.49	0.065
Barbados	0.45	0.339
Trinidad	0.36	2.30
Haiti	0.23	0.352
St. Kitts	0.12	not available
Sub-total	65	101
South America		
Brazil	95.0	143.6
Colombia	6.1	21.3
Argentina	5.5	36.2
Peru	3.3	7.25
Venezuela	2.1	39.0
Ecuador	1.3	3.09
Guyana	1.1	0.255
Bolivia	0.78	1.40
Paraguay	0.36	0.569
Uruguay	0.23	3.47
Surinam	0.05	0.175
Sub-total	116	256
Africa		
South Africa	11.4	109.0
Egypt	3.7	17.2
Mauritius	3.1	0.320
Zimbabwe	2.1	4.16
Sudan	2.0	0.910
Swaziland	1.8	0.075
Kenya	1.6	1.73
Ethiopia	0.87	0.618
Malawi	0.69	0.410
Zambia	0.64	10.3
Ivory Coast	0.57	1.94
Tanzania	0.47	0.720
Madagascar	0.45	0.342
Cameroun	0.32	2.15
Zaire	0.30	1.48
Senegal	0.30	0.631
Mozambique	0.26	3.25
Somalia	0.24	0.075
Nigeria	0.23	7.45
Angola	0.23	1.46
Uganda	0.15	0.569
Congo	0.11	0.195
Mali	0.09	0.080
Gabon	0.05	0.530
Burkina Faso	0.05	0.123
Chad	0.04	0.065
Guinea	0.02	0.143
Sierra Leone	0.02	0.136
Benin	0.02	0.016
Liberia	0.01	0.389
Rwanda	0.01	0.066
Sub-total	32	166
Oceania		
Fiji	1.6	0.241
Papua New Guinea	0.13	0.441
Sub-total	2	1
All cane sugar-producing developing countries	304	1124

27 "Sugar Yearbook 1985", (International Sugar Organization, London), 1986.



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– if there is a massecuite leak,
– if the water nozzles are clogged,
– if there is insufficient washwater,

providing that the inferior sugar is not covered by sugar of the required quality.

■ You can optimize the performance of your centrifugals
The measurement results tell you whether to adjust the running time and amount of washwater of the individual centrifugal.

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Short pulses of light illuminate the sugar. The reflected light is gathered by a detector and passed on to a control unit which compares the results with the limits coded in. The system alerts you immediately if the limits are broken. You can also collect and print out your measurement results for further analysis.
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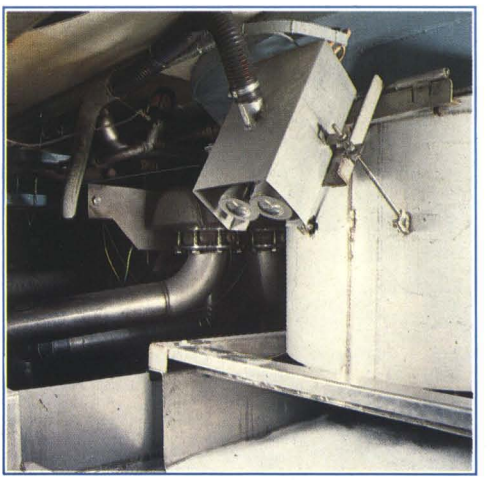
No two sugar factories are exactly the same. This means we need to discuss the best location for your colour control system and how you can best use the measurement results for management and control of your particular sugar house.



A Neltec Colour Control System monitoring the quality of sugar at a factory in Denmark. The system can monitor at a distance, typically 0.7-1.2 metres – no contact with the product means no hygiene problems.

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In the sugar factories, the introduction of steam-conserving process technologies would probably be required, and year-round operation of the cogeneration plant would be beneficial. The development of barbojo recovery systems would be desirable to supply fuel for the off-season. Since investments in a cogeneration plant would typically be large by comparison with traditional investments in the sugar industry, creative financing and ownership arrangements may be desirable, e.g. utility and/or third-party participation.

For candidate GSTIG manufacturers, the potential markets appear large enough to justify the development effort that would be required to commercialize the technology, and the projected growth of the sugar industry worldwide – 1.5% per year through at least the mid-1990's[28] – would ensure secure markets in the future. The potential GSTIG market may be still larger if cane-based fuel alcohol comes into wide use. Preliminary calculations indicate that GSTIG cogeneration would be well-suited for the production of electricity at alcohol distilleries[1]. Although the fuel alcohol industry is developed on a large scale today only in Brazil, this situation may change if oil prices rise considerably in the next 10 - 15 years, as is expected. The US Department of Energy projects rising oil prices in a tightening world market, e.g. residual fuel oil for US utilities is projected to cost $4.3/GJ - $6.4/GJ in the year 2000 compared with $2.27/GJ in 1986[29].

Conclusions

Steam-injected gas-turbine cogeneration at sugar factories, using gasified cane residues as fuel, would be technically and economically attractive. The modern jet-engine-based technology, on which GSTIG cogeneration would be based, would be appropriate technology for firing with biomass in Jamaica and other countries for a number of reasons:

(i) The natural, economical scale of the technology is small (5 - 50 MW), which is well-suited for use with a diffuse energy resource like biomass.

(ii) For a utility, GSTIG capacity additions would typically be small in relation to the size of the utility grid in most developing countries, making it easier to keep evolving demand and supply in balance.

(iii) Widespread operation of GSTIG systems could lead to lower average electricity prices in many countries.

(iv) Because GSTIGs would be based on aircraft-derivative gas turbines, a sophisticated local maintenance capability is not required as a prerequisite for introducing the technology. Most major repairs would be done off-site, while replacement engines (flown or trucked in from centralized facilities) continue to produce power.

(v) Utilizing indigenous, renewable resources, GSTIG technology could reduce dependence on imported energy supplies, leading to savings in foreign exchange.

(vi) For GSTIG suppliers, potential markets exist which could justify the needed commercialization effort. The global market potential with existing levels of cane production is some 50,000 MW of capacity, and sugar demand is projected to grow 1.5% annually through the mid-1990's.

(vii) GSTIG units may also provide favourable economics at fuel alcohol distilleries, even with today's oil prices. The cane processing plant of the future may be one which produces electricity from a GSTIG as its primary product, with sugar and/or alcohol as co-products.

(viii) By producing power at competitive costs in rural areas GSTIG technology installed at sugar factories could help promote rural industrialization, thus providing rural employment and helping to curb urban migration.

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Summary

Considerable amounts of power could be produced at cane sugar factories for export to the utility grid (while meeting on-site energy needs) by adopting more energy-efficient cogeneration and sugar processing technologies. With off-season operation of the power plant using an auxiliary fuel (e.g. stored cane tops and leaves), still larger quantities of electricity could be exported. Modern condensing-extraction steam turbines have been installed in several factories world-wide. By comparison with these, steam-injected gas turbines fired with gasified biomass, which could become commercially available within a few years, offer higher thermodynamic efficiencies, lower unit capital costs, and weaker scale economies. A case study based on the Jamaican Monymusk factory indicates attractive rates of return on gas turbine investiments, compared with those for steam turbines. Gas turbines have the potential to provide some 1000 GWh per year of electricity using the cane residues presently produced in Jamaica. Globally, over 50,000 MW of gas turbine capacity could be supported with the 1985 level of cane residue production. The costs of producing this electricity is

28 Brown: "The international sugar industry: development and prospects." (Commodity Working Paper 18, World Bank), 1987.

29 "Annual Energy Outlook" (Energy Information Administration, US Department of Energy, Washington, DC), 1987.

estimated to be lower than the estimated costs for power from most central station alternatives, including hydro-electricity.

Co-generación de turbinas a gas inyectadas con vapor y alimentadas con biomasa para la industria del azúcar de caña

Cantidades considerables de energía podrían ser producidas en fábricas de azúcar de caña para exportar a la red de servicios (al mismo tiempo que proveer la energía necesaria en el sitio) adoptando la co-generación y tecnologías de procesamiento de azúcar con mayor eficiencia energética. Cuando la planta de poder opera fuera de temporada usando un combustible auxiliar (e.g. cogollos y hojas de la caña guardados), se pueden exportar cantidades aun mayores de electricidad. En muchas fábricas alrededor del mundo se han instalado turbinas a vapor modernas de extracción y condensación. Al ser comparadas con éstas, las turbinas de gas inyectadas con vapor y alimentadas con biomasa gasificada, que podrían estar disponibles comercialmente dentro de unos pocos años, ofrecen una eficiencia termodinámica mayor, costos de instalación unitarios más bajos y alzas más bajas. Un estudio de casos basado en la fábrica Monymusk en Jamaica indica tasas de retorno atractivas en las inversiones de turbinas a gas, comparadas con aquellas de turbinas a vapor. Las turbinas a gas pueden proveer potencialmente alrededor de 1000 GWh (gigawatt-horas) de electricidad por año usando los residuos de caña producidos en el presente en Jamaica. En forma global, más de 50,000 MW (megawatt) como capacidad de turbinas a gas podría ser logrado con el nivel de producción de residuos de caña de 1985. Los costos de producción de esta electricidad se estiman ser más bajos que los costos de energía estimados en la mayoría de las estaciones centrales alternativas, incluyendo la hidro-eléctrica.

Utilisation en industrie de canne d'une turbine à gaz avec injection de vapeur obtenue en brûlant de la biomasse

En améliorant l'efficience de l'utilisation de l'énergie, et des technologies de fabrication de sucre, on a pu produire des quantités considérables de courant pouvant être exporté vers les lignes utilitaires, et cela tout en répondant aux besoins propres en énergie. En mettant la station en route en dehors de la campagne (tout en utilisant une source énergétique auxiliare comme par ex. des feuilles et residus de canne), on a pu exporter encore davantage de courant électrique. Partout dans le monde on a installé dans plusieurs usines des turbines à vapeur modernes à condensation et soutirage. Lorsq'on les compare aux turbines à gaz à injection de vapeur brûlant de la biomasse gazéfiée (machines qui pourront être disponibles sur le marché dans quelques années), ces dernières offrent une meilleure efficience thermodynamique. Elles coûtent en outre moins cher et elles présentent moins d'économie suivant l'échelle. Une étude sur base de l'usine Monymusk en Jamaique indique des rendements financiers attractifs d'un investissement pour une turbine à gaz, comparée aux conditions pour une turbine á vapeur. Les turbines à gaz présentent un potentiel pour la production d/environ 1000 gWh par an d'èlectricité. Elles utiliseraient les résidus de la canne actuellement produite en Jamaique. De manière globale, les résidus de canne produites en 1985 permettraient une capacité des turbines á gaz équivalente á 50,000 MW. On estime que le coût pour produire ce courant électrique serait inférieur au coût correspondant au courant produit par la plupart d'autres stations alternatives, y compris l'électricité hydraulique.

Malawi experience in fuel ethanol production and utilization

continued from page 61

Summary

The history of the fuel ethanol industry in Malawi is discussed and the impact of the decisions made in the early 1980's on the industry today and its future are examined. The experience gained in the use of ethanol in a range of automotive applications is reviewed.

Experiencia Malawi en la producción y utilización del alcohol como combustible

Se discute la historia de la industria del combustible etanol y se examina el impacto de las decisiones tomadas a comienzos de los años 1980 sobre la industria de hoy y su futuro. Se revisa la experiencia ganada en el uso del etanol en un rango de aplicaciones automotrices.

L'expérience au Malawi dans la production et l'utilisation d'alcool-carburant

On discute de l'histoire de l'industrie de l'éthanol-carburant au Malawi et on examine quel en fut l'impact sur l'industrie d'aujourd'hui et quel sera l'avenir des décisions prises au début des années 80. On passe en revue l'expérience acquise dans l'usage de l'éthanol dans le domaine des moteurs pour voitures.

Erfahrung in Malawi mit Ethanolerzeugung- und -verwertung

Der Verfasser diskutiert die Brennstoffethanolindustrie in Malawi und betrachtet den Effekt von in den frühen 1980en gemachten Entscheidungen auf die heutige Industrie und ihre Zukunft. Gegeben wird eine Übersicht über die Erfahrung, die man mit dem Einsatz von Ethanol über eine ganze Reihe von Kfz-Anwendungen gemacht hat.

The new plate evaporator at Sidul refinery

By Mario de Campos Vidal* and F. C. C. Brotherton†

Introduction

Sidul Refinery has operated in Lisbon, Portugal, since 1909. As with any other refinery with a long history, Sidul has passed through many technological modifications during its life. The most important was the installation of a completely new process line by the end of the 1960's, which included affination, melter, carbonatation, crystallization, recovery, drying and 50 kg bagging and 1 kg packing stations. Two old sections of the process were kept: the char house and the evaporation station.

In the second half of the 1970's, the oil crisis started a second phase of renewal, especially aimed at reducing energy consumption. The boiler house and the power station were completely renewed, heat was recovered from some effluents and insulation improved. The next step was the replacement of the evaporation station.

Objectives

The main objectives to be attained when replacing the existing station were:

(1) pay-back in less than 3 years through energy savings,

(2) compact plant arrangement, because the ever-present problem of space shortage,

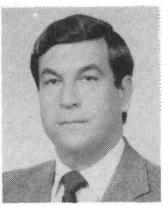
(3) compliance with government regulations for grants for energy conservation, and

(4) easy and reliable operation.

Plant duty

Three suppliers were asked to give quotations, specifications and technical characteristics for a double or triple-effect evaporator to handle 36,500 kg/hr of feed at 63°Brix and 60°C, to give 31,500 kg/hr of product at 73°Brix, corresponding to an evaporation rate of 5,000 kg of water per hour. The proposals were as shown in Table I. All were triple-effects and incorporated automatic control.

The plate-type triple-effect evaporator was chosen for its lower cost, lower steam consumption and the fact



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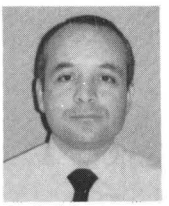

F. C. C. Brotherton

that less space was required. Within the Tate & Lyle Group of refineries there was already experience of a similar equipment running for several years.

Equipment and layout

The plate evaporator selected is an APV climbing and falling film type. It comprises stainless steel plates fitted with rubber gaskets which are mounted in a supporting frame, connected to a vapour-liquid separator. The plates are arranged in units of four, each unit consisting of a steam plate, a product up plate, a second steam plate, and a product down plate. This arrangement is repeated within the frame in order to provide the required heat transfer surface.

APV plate evaporators provide all the advantages of other types of film evaporators, and additionally a compact arrangement, considerable flexibility, and easy access. Unlike plate heat

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* Sidul S.A., Lisbon, Portugal.

† APV Baker, Crawley, England.

Table I

Supplier	A	B	C
Type	Falling-film	Plate-type	Roberts
Minimum evaporation rate	5000 kg/hr	5000 kg/hr	5000 kg/hr
Final Brix	73° min.	73° ±0.5°	73° min.
Maximum steam required	2990 kg/hr	2500 kg/hr	2980 kg/hr
Space required: Area	6 m × 18 m	4 m × 12 m	4 m × 11 m
Height	12.5 m	4.8 m	8.8 m
Ratio of equipment costs	1.65	1	1.58

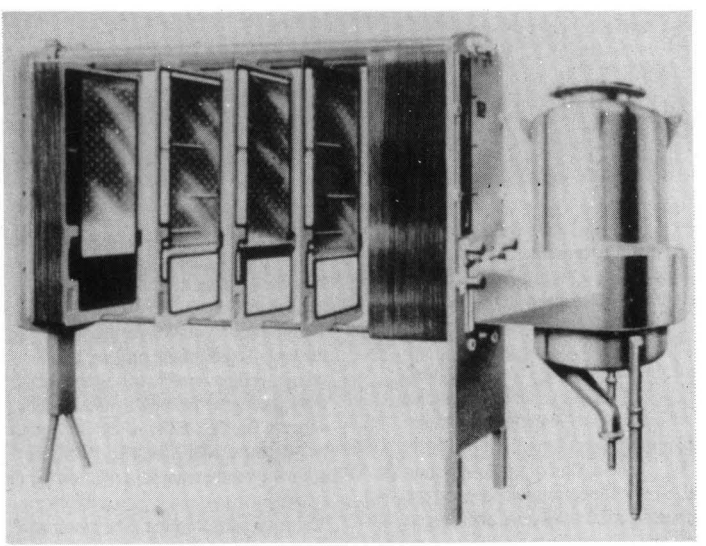


Fig. 1. Evaporator and separator

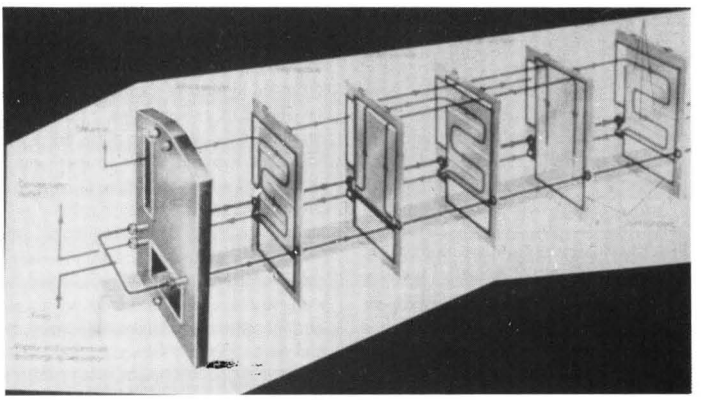


Fig. 2. Plates

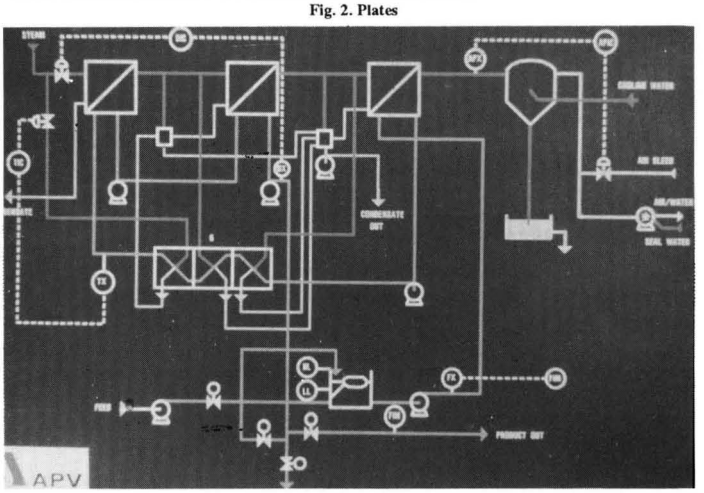


Fig. 3. Flow diagram

exchangers, which have corrugations on the plates to promote turbulence, the evaporator plates are essentially flat, although the shape of the surface is modified in certain areas to give mechanical support, and provide good steam distribution. The evaporator is designed for simple cleaning in place, and no special cleaning devices are required.

The design of the evaporator for this project necessitated very careful consideration of several interrelated factors. The product temperature must be sufficiently high to avoid crystallization and, because of the relatively small concentration change in the evaporator, sensible heat transfer loads assume a large significance. Several alternative configurations were investigated during the early stages of the project, before a mixed feed pattern (3-1-2) was selected, with product re-heating by inter-effect vapour. The flexibility of the AVP plate evaporator was utilized to provide the optimum temperature distribution for the evaporation system, hence minimizing the steam consumption. The automatic control system includes measurement of the feed and product rates by flowmeters. The product concentration is measured by a vibrating tube instrument, and this signal is used to control the steam supply to the evaporator. In the event of a low level condition arising in the feed tank, the evaporator steam supply is automatically shut off, and product is diverted back to this tank. Liquor is circulated around the evaporator at controlled temperature until an adequate feed level is reached in the main feed tank. When this occurs, the evaporator steam supply is automatically re-started, and product is routed out. In the case of a high-level situation in the product tank, the feed and evaporator steam supplies are automatically shut off and the pumps stop. In this case the plant has to be re-started manually.

As has already been mentioned, space is at a premium within the factory. The compact design of the plate evaporator, and in particular its low headroom requirement, enabled the evaporator to be sited on one of the existing floors, with the pumps on the floor below. This arrangement considerably simplified the installation of the evaporator.

Commissioning and testing

Commissioning and testing were carried out with the assistance of an engineer from the supplier. First tests showed the necessity of some piping modifications, namely the pipe from the feed tank to the balance tank, owing to gravity feeding instead of pump feeding. Calibration of the control instruments brought no special problems.

The plant ran experimentally for 2 weeks, only during the day shift (8 a.m. to 4 p.m.). During this period several tests were made to verify guaranteed performances: the flow of syrup through the system was kept constant and the final amount of concentrated syrup measured by tank calibration; samples of syrup in and out were taken every 5 minutes and Brix measured in the laboratory at 20°C; water evaporated was obtained by calculation; and the steam used was determined by measurement of condensate. Results of the tests are given in Table II.

ISJ Abstracts

Cane sugar manufacture

Colour balances around liming, clarifier, filter and evaporator operations

K. M. Onna. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 49 - 50.

Colour balances at three Hawaiian sugar factories are discussed. At Waialua, little colour was generated during liming, clarification and evaporation, but a large amount formed during filtration, although syrup colour was one of the lowest in Hawaii; a 2:1 mixture of CaO:MgO was used for clarification. At Kekaha, most colour was generated in filtration, followed by liming and clarification (as a result, it is suggested, of a high MgO:CaO ratio of 1.2:1), but the syrup colour was about the same as at Waialua. At Hamakua, removal of a large quantity of colouring matter during liming was attributed to the use of lime alone instead of as a mixture with MgO; however, formation of a large amount of colour during clarification may have been due to a relatively high fibre content in mixed juice and to inadequate pH control.

Suspended solids content of syrup and molasses

K. M. Onna. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 51 - 52.

The decision to use flotation clarification or other means to reduce the suspended solids content in syrup should be based on knowledge of the content and establishment of an upper limit. Samples were diluted 1:4 syrup:water and their turbidity measured spectrophotometrically as optical density at 900 nm followed by centrifuging, washing and oven drying of the solids for suspended solids determination. High correlation (r = 0.98) was found between turbidity and suspended solids content; a turbidity of 0.50 corresponded to 0.04% solids or to 0.20% in undiluted syrup, and this was proposed as the maximum permissible. Should it be exceeded, examination and possible adjustment should be made of clarification, filtration and evaporation; if there is then no improvement, flotation clarification should be considered.

Pan control study

D. Hsu and W. K. Hashimoto. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 54 - 55.

In a continuing study of digital control of *B*-massecuite boiling, single-loop feed control was used in preference to steam control since it was affected to a much lesser extent by unexpected fluctuations in vacuum and/or steam supply, and the software used was not programmed to provide any corrective action because of memory limitations. It became apparent that supervisory control using equipment such as a microcomputer and a data acquisition unit was needed to overcome the fluctuations without incurring significant capital outlay.

Sugar extraction from cane - LPE system

W. Leibig. *Zuckerind.* (Special Edition), 1989, **114**, 79 - 84.

The prototype LPE (low-pressure extraction) system described previously[1] has operated for 5 years at the distillery of Gameleira S.A. in Brazil, reaching a maximum daily throughput of 3190 tonnes of cane compared with a design capacity of 2400 tonnes/day. A reduced extraction of 95.2% was obtained at 104 tch, falling to 94.6% at 133 tch. Juice draft was in the range 85 - 96%, yielding a high Brix. The system comprises a rather long lixiviator followed by 5 LP units and a 5-roller medium-to-high pressure bagasse dewatering mill, but in a preferred arrangement the lixiviator is replaced by a simpler maceration carrier (provided with a perforated bottom for juice screening) followed by four modules, each containing two LP units, and a final high-pressure dewatering mill with a Donnelly pressure feed chute. A total extraction time of 3 minutes is predicted as against 6 minutes in the prototype system. Two LPE systems are being installed for expansion of two Brazilian sugar factories, while a system has also been introduced for the production of fermentation syrup from 500 tcd at Bide in Mexico.

Effect of stale cane on clarification

S. Y. Jadhav and M. B. Londhe. *Bharatiya Sugar*, 1989, **14**, (10), 25, 27 - 30.

Investigations of the effects of post-harvest deterioration of cane on clarification showed that mud volume and lime requirements increased and the settling rate decreased with increase in cane storage time from 0 to 120 hr. Other adverse effects noted included an increase in reducing sugars and molasses yield with a resultant fall in sugar recovery and greater production costs.

Mill roller grooving: need for rethinking

M. Anand. *Bharatiya Sugar*, 1989, **14**, (10), 55 - 57.

The various types of cane mill roller grooving are described and the advantages and disadvantages of each indicated. A groove angle of 50° is recommended in preference to one of 55° because of the greater depth and hence roller surface provided, while a uniform angle is preferred to a differential angle because it permits a more accurate and closer mill setting.

Fibre characteristics

P. Atherton. *Australian Canegrower*, 1989, **11**, (14), 17.

Cane fibres range from a long, tough, stringy type which keeps its form after shredding to a short, soft fibre which breaks down to small particles when shredded; in the milling train, the former type of fibre may cause problems by accumulating in conveyors and winding around shafts and chain wheels so that stoppages may occur, while the short, soft fibre may be difficult to convey by elevator and feed to the mills, thus causing increased bagasse moisture

1 Leibig: *I.S.J.*, 1988, **90**, 72A.

contents and sugar losses as well as problems in the boiler furnace. A number of small-scale tests were developed by the Bureau of Sugar Experiment Stations in collaboration with the Sugar Research Institute for application to all new cane varieties. They included: (1) an impact test which measured, by means of a pivoted knife, the energy required to slice through a 10-mm core taken longitudinally from the centre of a cane stalk; (2) a shear test conducted on a shredded sample weighing 5 kg which was prepared in a small hammer mill and pressed into a block, the force needed to separate the block being taken as a measure of cohesiveness; (3) determination of the pith content, for which a weighed sample of the cane prepared for the shear test was screened and the fine material that passed through the rotating 10-mm mesh screen weighed and expressed as a percentage of the original sample; and (4) determination of the fibre content as carried out for plant breeding purposes. A cane which could wind around shafts would be expected to have a high impact and shear strength and a low pith content, while one which could cause a high bagasse moisture content would have a low impact and shear strength and a high pith content; safety limits were set for these properties. Over the past three years, 18 varieties were subjected to the tests and most gave results that fell within the acceptable limits.

The effect of tops and trash on cane milling based on trials at Maidstone

M. J. Reid and G. R. E. Lionnet. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 3 - 6.

See *I.S.J.*, 1990, **92**, 27A.

Sixty-fourth annual review of the milling season in southern Africa (1988 - 1989)

J. P. Lamusse. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 7 - 27.

Performance data for sugar factories in Malawi, South Africa, Swaziland and Zimbabwe are tabulated and discussed. The average raw sugar pol was 99.37 in South Africa, 99.10 in Zimbabwe, 98.86 in Swaziland and 98.44 in Malawi. The average mill and diffuser extraction efficiency in South Africa was 97.60% compared with 97.63% in the previous season and with a record of 97.66% in 1986/87, reflecting a drop in imbibition rate. The proportion of sugar processed by back-end refineries in South Africa rose to 31.6%. The development of back-end refining, the export of power and the by-products utilization of bagasse have led to an inadequate supply of bagasse for use as fuel.

Acetate extraction in a cane diffuser

J. Beckett and W. S. Graham. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 28 - 32.

See *I.S.J.*, 1990, **92**, 28A.

The application of a linear belt filter for cush-cush removal from mill mixed juice at Maidstone

W. M. U. Gierke. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 33 - 35.

A two-stage system for bagacillo (cush-cush) separation from mixed juice, comprising a perforated slat conveyor for coarse particle removal followed by vibrating woven wire screens to separate the finer particles, was costly to maintain, mechanically unreliable and unhygienic (with high levels of lactic acid resulting from microbial growth). DSM screens, the equipment most commonly used for the task in South Africa, were rejected because of the limited headroom available. However, a Delkor linear belt filter (as used in the gold industry to separate wood fibre from cyanide) was tested and, after a number of modifications, installed for normal factory operation, giving an average removal efficiency of 86%. The filter consists of a feed box with perforated distributor plates making up the bottom through which the juice falls onto a continuous coarse monofilament filter cloth travelling at 0.25 - 1.0 m/sec depending on load and juice filtration properties. The juice passes through the cloth under gravity and is collected in a juice tray while the bagacillo is trapped on the top surface of the cloth and is dewatered to about 80% moisture content by a sprung roller after which it is scraped from the belt into a screw conveyor that returns it to the 1st mill discharge. The continuous cloth returns via an automatic tracking system, dynamic tensioner and washing zone to the feed area while the wash water is returned to the final mill feed as imbibition water. The economics of the system and its main benefits are indicated.

Steps taken at Sezela sugar mill during the 1988 crushing season to reduce bagasse moisture

J. P. Hulley. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 36 - 40.

The weekly average bagasse moisture content at Sezela was reduced from an unacceptably high level of 51.5% in 1985/87 to 48.8% in 1988/89 by a number of measures which included solving problems associated with excessive roller lift, tailbar thrust, insufficient hardfacing of the pressure feeder rollers, mill and pressure chute settings, mill speed, prolonged use of trash plates and scrapers, and inadequate cane preparation. These problems and their remedies are discussed. Although it is difficult to pinpoint the major contributor to the improvement, it is believed that correct pressure chute settings played a very important role.

Lightning, a hazard to be considered

F. Calboutin. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 41 - 44.

Electronic weighbridge systems incorporating load cells and linked to a comp-

uter require virtually no maintenance and allow for greater throughputs in contrast to mechanical systems but are at risk from lightning strikes which, through damage to the equipment, may cause delays of at least a few hours. The causes and effects of lightning are explained and means of protecting buildings and electronic equipment are described.

Fly ash and boiler ash handling and disposal at Sezela

S. S. Munsamy. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 45 - 47.

The wet system of screening, clarification and filtration used at Sezela for boiler ash separation from flue gas worked satisfactorily until 1982, reducing the solids content of the recycled water to about 0.02% and giving a filter cake of approx. 50% that was applied to the soil as fertilizer. However, the installation of two diffusers in 1982 caused an increase in cane throughput and in the quantity of sand trapped in the bagasse while the boilers had to burn more coal because of increase in the activities of the by-products plant; this resulted in an overloaded ash handling system with excessive spillage (causing pollution of the water in the nearby estuary and/or plant malfunction), increase in filter cake moisture and hence greater transport costs. In 1984, a new ash handling and disposal system was commissioned that involved pumping the ash-laden water to two settling dams in series and recycling the water to the factory under gravity. The main components of the system are described and their performances discussed. The new system has worked satisfactorily with no spillage, an average discharged water COD of 30 and a suspended solids content of 15 ppm.

Efficient and low-cost effluent treatment using an ash disposal dam

P. L. M. Vermeulen and A. S. Vawda. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 48 - 51.

After serious floods had destroyed most of the aeration control equipment employed for treatment of effluent and water-borne ash at Umzimkulu sugar factory, an ash disposal dam was constructed which incorporates a filter bed of sand and carbon; much of the ash deposited on the bed consists of carbon which becomes activated at the high temperature of the flue gases and adsorbs residual organic matter dissolved in the effluent, while microbial activity occurs when the warm, nutrient-rich effluent comes into contact with the ash bed (most of which is moist). All factory effluent is pumped to the dam at an average rate of 35 m^3/hr together with 330 m^3/hr ash slurry. Over 8 months from the inception of the new treatment in May 1988, an average 87% of COD was removed (78 - 95%), the pH of the treated water averaged 7.8 (7.4 - 8.0) and there was no odour, but about 30% of the water was lost through seepage and evaporation.

Some ideas on the use of chemical methods for improving the colour of *A*-sugar

M. A. Getaz and L. Bachan. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 76 - 80.

See *I.S.J.*, 1990, **92**, 28A.

The effect of VHP sugar crystal size and of method of seeding on sugar colour and payloads

A. R. Bux and S. S. Munsamy. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 81 - 84.

Although investigations showed that the colour of VHP (Very High Pol) sugar was generally lower with smaller crystals, the difference was not significant in the size range tested. While a raw sugar of acceptable colour level could be produced by decreasing the crystal size to <0.6 mm even when the clear juice was of high colour content, this would increase the risk of producing more fines; since the penalty for fines is greater than that for excessive colour, this is not considered a practical solution unless the factory has a back-end refinery. A highly significant correlation was found between affined sugar colour and crystal size, with a 10% decrease in size causing a 17% reduction in colour; however, this finding is merely academic for raw sugar factories since there is no bonus or penalty for affined sugar. No significant difference was found in the colour of raw sugar as a result of the seeding method used (slurry seeding as against use of a *B*-magma footing); however, the use of a seed slurry was found to result in a truckload that was less than 49 tonnes even with high-quality sugar, whereas the magma footing method gave a load greater than 49 tonnes even with a poor-quality sugar containing more than 40% fines. Since transport costs are calculated on the basis of a theoretical 50-tonne load, irrespective of the true load, money was lost during the 3 years since slurry graining was introduced at Sezela to minimize raw sugar colour.

Crystal breakage in continuous *B*-centrifugals

P. W. Rein and R. D. Archibald. *Proc. 63rd Ann. Congr. S. African Sugar Tech. Assoc.*, 1989, 94 - 99.

A high degree of *B*-sugar crystal breakage in continuous centrifugals led to poor crystal size distribution in the *B*-magma used as footing for *A*-massecuite boiling and was almost exclusively caused by impact with the monitor casing. The degree of breakage was greater with larger crystals. Increasing the diameter of the casing of a BMA K850 machine from 1.75 to 3.0 m reduced breakage and gave a crystal size on average 10 - 30% greater than for an unmodified centrifugal, but reducing the speed of a machine from 2100 to 1800 rpm had no statistically significant effect. Improvements also resulted at another two factories where two and three centrifugals, respectively, were surrounded by one common casing.

Beet sugar manufacture

Automatic optimization of sugar extraction from beet

A. P. Ladanyuk and F. V. Negoda. *Izv. Vuzov, Pishch. Tekh.*, 1989, (2), 94 - 97 *(Russian)*.

The stages in development of a mathematical model of the diffusion process are explained and application of the model to optimization is described. Results of tests at a sugar factory demonstrated the efficiency of the model in terms of stabilization of throughput and reduction in losses.

Cracking of brass tubes in the evaporator at Pruszcz sugar factory

W. Serbinski and S. Lawnicki. *Gaz. Cukr.*, 1989, **97**, 125 - 128 *(Polish)*.

Analyses and tests conducted on brass tubes used in the quadruple-effect evaporator at Pruszcz followed stress corrosion, cracking and leaking of a large number of them after they had replaced steel tubes; the latter type of tube had lasted only 4 - 6 years, and the costs of labour involved in installing replacements and the shortage of personnel suited to the task had led to the decision to use brass tubes, particularly in view of 40 years of trouble-free operation of such tubes in an earlier evaporator. It was found that the cracked tubes were unable to cope with the aggressive conditions of the juice and the potassium carbonate, ammonia and SO_2 in it because of the inadequacy of their microstructure and hardness (which differed from those of the earlier brass tubes), and use of more suitable brass was recommended.

New possibilities of chemically protecting stored sugar beet. III. Investigation of residues of Benomyl during storage and processing of beet treated with Fundazol 50-WP

J. Zahradnicek, M. Bohuslavska, M. Duffek, J. Jary and J. Stanek. *Listy Cukr.*, 1989, **105**, 145 - 150 *(Czech)*.

Spraying stored beet with 30 g/tonne Fundazol 50 WP (50% benomyl fungicide) as a 0.3% water suspension at 0.3 MPa reduces sugar losses by 30 - 60% depending on the condition of the beet and on the storage period and method; efficiency increases with storage period but falls with greater mechanical damage and impurities content. Reverse phase gas-liquid chromatography on C-18 silica gel using 1:1 methanol:water and 9:10 acetonitrile:water as mobile phases, extraction with hexane and ethyl acetate and detection by U.V.-spectrophotometry were applied to untreated and treated samples of beet cossettes before and after diffusion and flume water. Results showed no residue of benomyl or its conversion product, carbendazim, at above the detection limits; the carbendazim is removed with flume-wash water and is absorbed by the soil in the lagoons where it undergoes biodegradation.

Plant for biological treatment of waste water at sugar factories. II. The Anamet system

J. Rejsek, L. Budicek, M. Kubin and I. Spoustova. *Listy Cukr.*, 1989, **105**, 151 - 154 *(Czech)*.

The Anamet process and plant are described and results obtained at Euskirchen and Jordberg sugar factories in West Germany and Sweden are discussed[1,2].

Electro-ion exchange control of pH of sugar solutions

M. P. Kupchik, V. V. Mank, A. M. Poznanskii, L. D. Bobrovnik and Ya. F. Trachevskaya. *Sbornik Pishch. Prom.*, 1989, **35**, 8 - 11 *(Russian)*.

In experiments on the use of electrodialysis to raise or lower the pH of 2nd carbonatation juice and 15% sucrose solution containing varying concentrations of Na acetate as electrolyte, a central chamber filled with anion exchange resin in Cl^- form or with cation exchange resin in Na^+ form had walls formed by bipolar membranes made of titanium (cathode) and platinum (anode). Efficiency of pH adjustment in the range 1 - 12 rose with increase in current density (5 - 25 mA/cm^2) and with fall in flow rate through the central chamber (5 - 30 cm^3/min at 15 mA/cm^2) and was highly dependent on the conductivity ratio between the resin and test solution. The treatment, which is of value for invert syrup manufacture, removed up to 90% of the colouring matter.

The effect of acetylated monoglycerides on the viscosity and surface tension of molasses and its solutions

V. F. Sukhodol, A. M. Kuts and I. S. Shukatka. *Sbornik Pishch. Prom.*, 1989, **35**, 67 - 69 *(Russian)*.

Experiments involving 15 molasses samples taken from various sugar factories and alcohol distilleries demonstrated the positive effect of acetylated glycerol monostearates in reducing their viscosity and surface tension. Their efficiency rose with increase in temperature and with fall in concentration of the molasses solutions and was maximum at pH 5 - 6.

The electrokinetic potential of particles of carbonatation mud and the filtrability of its suspensions

L. M. Khomichak, M. Kh. Likhitskii and M. I. Barabanov. *Sbornik Pishch. Prom.*, 1989, **35**, 97 - 99 *(Russian)*.

Carbonatation mud and pure $CaCO_3$ obtained by gassing limed sugar solution with CO_2 were used in a study of the effect of the zeta-potential of the particles on filtrability. Contact for 30 minutes between a small amount of added citric acid and the carbonate caused change in the size and sign of the original positive charge without increasing the viscosity after which the filtration coefficient was determined and the zeta-potential measured by electro-osmosis, allowing for surface conductiv-

1 Huss & Reinholdtzon: *I.S.J.*, 1983, **85**, 243.
2 Huss: *ibid.*, 1984, **86**, 47A.

ity. Results showed that maximum filtrability occurred at minimum zeta-potential; filtration improved when juice was preheated to 85 - 90°C since the rise in temperature and simultaneous fall in viscosity coincided with increased hydrolysis of the carbonate ions and hence minimization of the zeta-potential.

Optimization of batch centrifugal operation

M. Patacq, N. Francou and P. Le Lerre. *Ind. Alim. Agric.*, 1989, **106**, 555 - 557 *(French)*.

Tests were conducted at Berneuil-sur-Aisne sugar factory on control of centrifugal charging based on continuous measurement of the thickness of the massecuite layer[3]. When a given threshold value is reached, the feed valve automatically closes; however, that massecuite already in the feed chute continues to enter the basket and climb the wall, so that the final thickness of the massecuite layer will be greater than the threshold value by an amount which is not constant with time but is a function of the characteristics and quality of the massecuite. With the patented system, the threshold value for the next cycle is automatically adjusted by comparison between the final thickness value and a target value; if the amount of massecuite charged is insufficient, feeding in the next cycle will continue to a greater layer thickness than in the previous cycle and the two values will be re-compared and a new correction made if necessary. By allowing for any difference between the charging speeds in the two cycles, the correction can be made more rapidly. The system has permitted greater use of basket capacity by more than 2%, and has been used successfully to minimize wash water consumption by calculating the quantity of water as a proportion of the volume of sugar given by the massecuite thickness sensor. Further tests on optimization of washing are also reported. In the normal washing process in a centrifugal, about 50% of the water consumed is constant regardless of the massecuite charge since it is fed before the massecuite has entered the basket and is wasted on washing of the basket and feed chute. By automatically adjusting the time interval to a minimum between the two centrifugalling cycles, regulating the time during which the basket operates at maximum speed and then adjusting the washing time to accord with this, it has been found possible to reduce the amount of water and to reduce sugar losses (a 1 sec reduction in the washing time reducing the amount of sugar dissolved by 1.5%). The effects on sugar colour and ash content of variation in the washing and spinning times are indicated.

Evolution of automatic monitors in the sugar industry. Technico-economic impacts

E. Burzawa, M. Melle and C. de Wilde. *Ind. Alim. Agric.*, 1989, **106**, 587 - 591 *(French)*.

Advances made by Groupement Technique de Sucreries (GTS) in the field of automatic on-line analysis are described. The approaches made to automatic sampling, initial dilution, sample conditioning and analysis proper are outlined, and details are given of specific systems. A prototype of the near-infrared analyser for Brix and sugar[4] has been tested for on-line purity determination. Automatic determination of juice alkalinity is carried out by a scheme in which a balance is used instead of an automatic burette to meter the acids and soda used as reagents; a microprocessor-controlled system samples the various turbid and clear juices, and the apparatus also determines the total lime content and provides a constant measurement of the quantity of recycled mud. A lime salts analyser for juice before and after deliming uses a specific Ca electrode which, however, can operate correctly only in a juice of standardized temperature and ionic strength that has been treated with formalin, rinsed, etc. The advantages and disadvantages of automatic monitoring are briefly discussed.

Automation of a multiple-effect evaporator in a sugar factory. Development and methodology

M. Daclin. *Ind. Alim. Agric.*, 1989, **106**, 595 - 607 *(French)*.

The role of the evaporator as juice concentrator and vapour distributor is examined and its static and dynamic equilibrium discussed. Algorithms are presented which describe static equilibrium with and without 1st effect vapour compression and a model which includes interactions between the evaporator and vapour consumers; a simplified 1st order model is given of dynamic equilibrium which allows for juice lag. Vapour bleed is divided into that amount that is in proportion to the pace at which the factory operates and random quantities which are principally fed to the pan station or are used for supplementary juice concentration. It is stressed that any automatic control algorithm must allow for the differences in characteristics between juice and vapour, including their residence time in the evaporator. A computerized feed-forward automatic control scheme developed by GTS and introduced at two sugar factories using thermocompression is described. Sections of charts from one of the factories demonstrate the relative smoothness of automatic as against manual control.

Flow chart modelling in sugar factories

P. Dauvois and G. Sasia. *Ind. Alim. Agric.*, 1989, **106**, 609 - 611 *(French)*.

The application of the flow chart to process modelling is described and its value indicated in regard to beet sugar factory operations and in analysing the crystallization scheme at Marseilles refinery.

Continuous crystallization at Jesi sugar factory

C. A. Accorsi, D. Falessi and F. Zama. *Ind. Alim. Agric.*, 1989, **106**, 613 - 617 *(French)*.

3 Leconte: *I.S.J.*, 1989, **91**, 62A.
4 Burzawa & Melle: *ibid.*, 75A.

A continuous *A*-massecuite boiling system installed at Jesi factory in Italy comprises four Fives-Cail Babcock horizontal pans linked in a cascade in which massecuite flow is controlled by a single pump at the exit port of the final pan. Magma used as footing has a purity of 90 - 92 and is made up of low-grade sugar and thin juice. Forced circulation is brought about by injections of incondensable gases mixed with vapour. The performance of the system in 1987 and 1988 is discussed. A major problem was the formation of considerable quantities of incrustation in each unit; occasional occurrence of large deposits above the calandria was attributed either to operation at excessive supersaturation or to inadequate circulation when massecuite consistency was too high. The authors express the desirability of operating with propeller-type massecuite stirrers. The M.A. and C.V. of the final sugar were >0.8 mm and 35%, respectively. Advantages of the system include: constancy of vapour bleeding from the evaporator, a reduction in steam consumption normally used for cleaning after each cycle in a batch pan and increase in the pan station capacity as a result of elimination of dead times and improved heat transfer (a consequence of the lower massecuite level in the pan).

Multivariable predictive control of an evaporator station in the sugar industry

J. L. Testud and O. Rankowski. *Ind. Alim. Agric.*, 1989, **106**, 629 - 639 *(French)*.

The procedure adopted in creating a mathematical model of evaporation in the quintuple-effect unit at Abbeville sugar factory, in simulating the process with the intention of providing a system of automatic control and in installing the final computerized control scheme in 1988 is described. Tests showed that control of Brix and of the level in the pre-evaporation juice tank saves energy, reduces sugar losses and improves thick juice colour by comparison with manual control previously used.

Fluidized-bed drying and cooling of sugar

J. Schlachter and E. Vanssons. *Ind. Alim. Agric.*, 1989, **106**, 648 - 649 *(French)*.

The benefits of sugar drying in vibratory and static fluidized-bed units and of cooling in static units are discussed. A Comessa system is described that consists of a vibratory pre-dryer followed by a static dryer in which air is heated for final drying in the first of two zones leading directly to the second zone where the sugar is cooled. Seven of these units have been installed in Thailand.

The current level of waste water treatment in the sugar industry

C. Nähle. *Zuckerind.*, 1989, **114**, 703 - 705 *(German)*.

Methods used in West Germany for sugar factory waste water treatment are reviewed. Aerated lagooning is still the most widely used system, often combined with anaerobic or activated sludge plants. A high level of removal of organic matter is attained in all the processes mentioned. Future efforts will be concentrated on testing and optimizing techniques for removal of ammonia-N.

Measurements of redox potential for control of trough-type diffuser disinfection

J. Dobrzycki, M. Ludwicki and S. Wawro. *Zuckerind.*, 1989, **114**, 706 - 708.

The relationship between redox potential and infection at various points in a DDS-type diffuser was determined by measuring cells which housed a platinum measuring electrode, a depolarizing electrode (found in pre-tests to be necessary because of instability and poor reproducibility caused by polarization of the Pt electrode) and a porous glass stopper connected to a reference electrode by a tube containing 3% KCl solution under hydrostatic pressure. The potential was found to depend on the site of the cell and on the degree of infection of the juice-cossettes mixture. However, statistical analysis of a number of measurements gave a positive correlation (r = 0.84) between the thermophile count and the potential: a count in the range between 10^4 and 10^5 corresponded to a redox potential in the range between –72 and –100 mV; the higher of these two potentials was adopted as the critical value at which formalin was dosed while a count of 10^4 was considered an acceptable level of infection.

A calculation procedure and relations needed for the design of a modular tubular condensate-juice heat exchanger

P. Hoffman. *Listy Cukr.*, 1989, **105**, 173 - 179 *(Czech)*.

The process parameters of a tubular juice heater described earlier[5] are indicated and a procedure is described for calculation of its dimensions. A worked example is presented.

Tightening the grain during the automatic boiling cycle in a batch pan

S. Mioduski. *Gaz. Cukr.*, 1989, **105**, 183 - 187 *(Czech)*.

The value of a detailed analysis of the boiling process and of a resultant simplified mathematical model for creation of an automatic control program is discussed with attention focused on the stage in the cycle when the grain is tightened and where it is important to maintain equilibrium between the increase in massecuite Brix and level and the amount of water evaporated while achieving a desired crystallization rate. Worked examples demonstrate the effect of variation in the rate of change of any one of the parameters.

Process optimization of a multiple-effect evaporator system in the sugar industry

M. Bayramoglu. *Chim. Acta Turc.*, 1988, **16**, (1), 33 - 44; through *Ref.*

5 Hoffman *et al.*: *I.S.J.*, 1989, **91**, 105A.

Zhurn. AN SSSR (Khim.), 1989, (19), Abs. R1420.

Results are given of application of the flexible tolerance method to optimization of multiple-effect evaporation at Erzurum sugar factory in Turkey; six easily controllable process variables were chosen, with steam and energy savings as the two target functions. It was found that under optimum conditions the steam consumption could be reduced by 7.3% and the energy consumption by 14.3%.

Trends in sugar crystallization

D. Schliephake and B. Ekelhof. *Zuckerind.* (Special Edition), 1989, **114**, 59 - 65.

See *I.S.J.*, 1990, **92**, 32A.

Automation and the computer at Hodonín sugar factory

O. Vorechovsky. *Listy Cukr.*, 1989, **105**, 207 - 214 *(Czech)*.

Details are given of the measuring and automatic control system installed as a prototype at the reconstructed Hodonín sugar factory; the scheme is based on the use of electronic PID and programmable controllers centred on a Yokogawa Electrofact computer (for both control and optimization) selected for a number of given reasons. Various aspects of the system, including beet slicer speed and level control, are described and the overall performance discussed. Once experience has been gained with this approach to automatic process control and optimization, it is intended to install a comparable system in other Czechoslovak factories.

Effect of beet cleaning on juice quality

V. S. Shterman, E. V. Ivchenko, A. R. Sapronov, M. S. Zhigalov, L. G. Belostotskii and I. V. Zakharova. *Sakhar. Svekla*, 1989, (5), 42 - 44 *(Russian)*.

It has been found that removal of the surface layer from beets leads to a considerable rise in juice quality and increase in sugar yield since it contains less sucrose than the rest of the beet but a considerable proportion of non-sugars. The chemical composition of peelings representing 3%, 5% and 10% of beet weight is discussed. Peeled and unpeeled beets were sliced into cossettes, the juice extracted by conventional diffusion and the juice carbonatated; where peelings represented only 3% of the beet weight, juice purity was higher and the colour, reducing matter, total N, (Na + K) and lime salts contents lower than with unpeeled beet. Peeling also increased the settling rate and reduced standard molasses purity. Subjecting beets to saturated steam at approx. 130°C and 0.3 MPa pressure for 40 sec softened the top 1 - 2 mm layer and allowed its removal (equivalent to removal of 4 - 5% of the beet weight) in a drum-type washer, giving the same type of beneficial effects as found in the tests above.

Progressive prelimers in a conventional juice purification scheme

L. F. Krasnitskaya, P. V. Stepanov, N. I. Zharinov, V. Z. Semenenko, V. V. Folomeeva, R. G. Zhizhina and T. V. Likhogrud. *Sakhar. Svekla*, 1989, (5), 44 - 48 *(Russian)*.

The trough of the RZ-PPD counterflow prelimer described is divided longitudinally into 6 or 8 sections (depending on the model in the series of four) by fixed baffles; each section is provided with a pivoted guide flap (above the fixed baffle) communicating with the next section and is closed at the top by a semi-hermetically sealed cap. A motor-driven rotary shaft carries paddles which, together with the guide flaps, mix the lime with the juice. The juice flows forward against the lime stream but tends to follow a reverse path as it is mixed with the lime and finally resumes forward flow along the bottom of the vessel beneath the fixed baffles to the discharge port. Means are provided for feeding recycled carbonatation mud or juice. The positive performance of the prelimer is discussed.

Improvement in the performance of a juice purification station

A. K. Gromkovskii, V. A. Golybin, Yu. I. Zelepukin, V. E. Apasov, T. E. Luk'yanova, V. I. Danilushkin and L. P. Bashmanova. *Sakhar. Svekla*, 1989, (5), 48 - 49 *(Russian)*.

The poor performance of the carbonatation station at Dobrinskii sugar factory is discussed and a number of recommended remedial measures indicated, including: raising to 60 - 62°C the temperature of the first stage in fractional cold-hot liming, reducing the number of 1st carbonatation vessels from two to one, and supplementary liming of juice before 2nd carbonatation with a corresponding reduction in the quantity of lime used in fractional liming. Introduction of these various modifications reduced juice colour by 8 - 9% and considerably decreased the lime salts content while increasing thermostability, which resulted in a higher thick juice pH and thus led to stable alkalinity in pan house products and hence reduction in unknown losses. There was also a 0.14% fall in molasses losses (on beet) and a 5.6% increase in the daily beet slice by comparison with the previous campaign. It is recommended to recycle unfiltered 1st carbonatation juice to a point in the progressive prelimer where the pH is low and to extend this particular zone.

Genappe sugar factory is equipped with a continuous vacuum pan

Anon. *Betteravier*, 1989, **23**, (245), 6 *(French)*.

A brief account is given of the installation of a continuous horizontal vacuum pan for *A*- and *B*-massecuite boiling at Genappe in Belgium. The decision to replace the previous batch system was made because of the age of the equipment and the restricted sugar output which has been raised from 1000 to 1500 tonnes/day. The factory has facilities for loading sugar direct onto rail.

Laboratory studies

The determination and role of raffinose in sugar manufacture

J. Gerse and L. Parádi. *Cukoripar*, 1989, **42**, 44 - 50 *(Hungarian)*.

The formation of optically active substances other than sucrose in beet and molasses is discussed with attention focused on raffinose. Changes in the role and quantity of raffinose during the manufacturing process are examined and methods for its determination in molasses are reviewed, including those such as Clerget double polarimetry based on inversion, paper and thin-layer chromatography and enzymatic techniques. Comparison between TLC measurements and values given by the ICUMSA-recommended enzymatic method using α-galactosidase and β-galactose dehydrogenase showed that the enzymatic method was the more accurate and was particularly suitable for very small quantities of raffinose, while TLC gave sufficiently accurate values at raffinose concentrations of 15 - 60 mg/cm^3; at lower concentrations, raffinose was not visible while separation was unsatisfactory at concentrations above this range. Yearly average raffinose contents in molasses in Hungarian sugar factories are given for 1984/87 and briefly discussed. Because of its effect on optical rotation and hence on the non-sugars: water and sugar:water ratio, it is important to measure the raffinose content in molasses and apply a correction when calculating massecuite exhaustion.

The use of entropy to evaluate the state of the raw material, semi-products and products of sugar manufacture

D. E. Sinat-Radchenko. *Sbornik Pishch. Prom.*, 1989, **35**, 61 - 64 *(Russian)*.

Formulae are presented for calculation of the entropy of crystalline sucrose, sugar solutions and massecuites as a function of Brix, purity, temperature and crystal content; numerical examples and a nomogram are also given. Calculation of the entropy of beet tissue is also analysed, with the beet regarded as a complex open system in a steady state but where no equilibrium exists although there is a tendency towards a balance between the processes of synthesis of complex molecules (leading to a reduction in entropy) and those of degradation; the effects of various factors are taken into account. The value of entropy change as an indicator of change of state and structure is discussed.

Sucrose hydration in solution

R. Ts. Mishchuk and A. A. Lipets. *Sbornik Pishch. Prom.*, 1989, **35**, 102 - 105 *(Russian)*.

The degree of sucrose hydration was calculated for concentrations up to 84% and temperatures up to 90°C from the specific molar and hydrodynamic volumes. The mathematics are presented and data tabulated. The minimum degree of hydration occurred at 80°C, the temperature at which new crystal nuclei form.

Sucrose enzyme electrode

Y. Xu, G G. Guilbault and S. S. Kuan. *Anal. Chem.*, 1989, **61**, 782 - 784; through *Anal. Abs.*, 1989, **51**, Abs. 9J130.

To prepare the sucrose electrode, an oxygen electrode was covered by a PTFE membrane, 40 µl of 0.2M phosphate buffer (pH 6.88) containing 0.25 mg of bovine serum albumin, 24 i.u. of glucose oxidase, 580 i.u. of aldose 1-epimerase and 500 i.u. of β-fructofuranosidase was applied to the membrane, 10 µl of 2.5% glutaraldehyde solution added with vigorous stirring for 30 sec and, after >3 hr at room temperature, the immobilized enzyme layer washed with the buffer and covered by a Spectrapor 2 external membrane. The electrode was stored in the buffer at 0 - 4°C when not in use. Values for sucrose had to be corrected for glucose present, which was determined using a similar electrode containing only glucose oxidase. Measurements were made by immersing the electrode in 2 ml of phosphate buffer and applying a constant potential of – 0.65 V *vs.* Ag-AgCl until the baseline was steady, then injecting 1 ml of standard or sample solution and reducing the change in potential. No interference was caused by such reducing sugars as fructose and maltose at concentrations <8 mM and the electrodes were stable for >300 days. Results correlated well with those obtained using the AOAC standard method. The permeability of the membrane to oxygen is proposed as criterion for selecting membranes for electrode construction.

Determination of assimilated phosphorus in molasses culture media

V. P. Kuklina and E. S. Mints. *Pishch. Prom.*, 1989, (5), 50 - 52; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (18), Abs. 18 R1435.

Dissolved (assimilated) phosphorus was determined in molasses (applicable for citric acid production), without prior deashing, by a colorimetric method using ammonium molybdate in the first stage followed by reduction of the resultant phosphomolybdic acid by ascorbic acid in the presence of potassium antimonyl tartrate or by Na sulphite in the presence of hydroquinone. Examination of the biochemical activity of *Aspergillus niger* in various molasses media revealed a jump in the citric acid removal at a P_2O_5 content in the medium of 8 - 9 mg/100 ml, the removal reaching a maximum at 11 mg/100 ml P_2O_5. The possibility is indicated of monitoring and regulating the rate of phosphorus feed to molasses media of varying composition.

Apparent dextran levels in factory juice streams

K. M. Onna. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 50 - 51.

While the official haze method of dextran determination used in Hawaii requires the use of the total sample without prior removal of suspended solids, findings have indicated a substantial reduction in reported dextran contents where the sample is prefiltered. Results

of a study suggested that some of the apparent dextran could be adsorbed by the suspended solids, some of which may be desorbed or dissolved when trichloroacetic acid is added, while filtration reduced not only the measured apparent dextran content but also the amount destroyed by dextranase. Hence, since clarified juice that is substantially free from suspended solids is processed to sugar and molasses, the suspended solids in juice samples should be removed before analysis for dextran.

Analysis of sucrose in final molasses with glucose analyzer

D. Hsu and M. H. Bagley. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 52 - 53.

A Beckman Instruments glucose analyser (found, on the basis of ease of operation and long-term stability to be more suitable than one manufactured by Yellow Springs Instrument Co.) was used for repeated sucrose determination in diluted final molasses and the results compared with those of the Jackson & Gillis (Clerget) Method IV. Statistical analysis showed that, although the two methods were of comparable precision, the Jackson & Gillis method gave significantly higher values, with raffinose and starch affecting the results, and was less accurate than the glucose analyser.

Repeatability for whole raw colour and affined raw colour as determined by the modified ICUMSA methods of analysis

T. Moritsugu and S. Goya. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 53 - 54.

Since about half of the raw sugar produced in Hawaii is sold under Amstar Raw Sugar Contract No.14 which specifies using modified ICUMSA methods of colour analysis as a basis of payment, the standard HSPA methods for whole raw colour and crystal colour determination at pH 7 were replaced in 1989 by the ICUMSA methods for whole raw colour and affined raw colour at pH 8.5. While the methods are essentially the same (apart from the difference in pH) for whole raw colour, there are considerable differences in raw sugar washing for affined raw colour determination; the ICUMSA procedure involves mingling the raw sugar with a 64% sugar solution followed by spinning in a special laboratory centrifuge in contrast to mingling with a 66% sugar solution and filtration through a metal screened funnel (both stages repeated four times) according to the HSPA method. Experiments to establish the repeatability of the results gave ± 4.4% for whole raw colour by the ICUMSA method compared with ± 5.1% using the HSPA method; for affined raw colour, the repeatabilities were ± 12.2% (ICUMSA) and ± 6.6%. These values provided the limits within which control analysis must agree with the original analysis.

Routine analysis of final molasses

M. H. Bagley. *Ann. Rpt. Hawaiian Sugar Planters' Assoc.*, 1988, 54.

Weekly composite final molasses samples from each Hawaiian factory were analysed routinely by the HSPA over a 6-month period and the results compared with those obtained by the factory laboratories. Examination of the data for the first 6 weeks showed that, in general, the HSPA analyses gave higher values for refractometric Brix and sucrose purity and, hence, for purity above expected (PAE).

Use of near-infrared spectroscopy in raw cane sugar moisture analysis

G. Vaccari and G. Mantovani. *Zuckerind.* (Special Edition), 1989, **114**, 75 - 78.

For determination of raw sugar moisture content by NIR spectroscopy, 50-g samples were rapidly weighed in a stoppered 100-ml flask on a laboratory balance and acetone added (in a quantity equal to that of the sugar) to extract the water surrounding the crystals without dissolving the sugar; the contents of the flask were then vigorously shaken for several minutes to ensure that no sugar lumps remained, and the suspension rapidly filtered using a syringe and a disposable 0.50 μm filter (the optimum number of filters was found to be three). The resultant clear, colourless solution was injected into a cell held at a constant 20°C and a calibration curve obtained from 15 samples representing the entire moisture range using a Bran & Lübbe Infralizer 450 equipped with a HP-85 computer. Comparison of NIR readings with values obtained by oven drying at 105°C showed a difference of ± 0.02 for more than 50% of the differences, results similar to those which would be expected where different laboratories were analysing the same sugar samples. The differences between the mean moisture content as determined by oven drying and the values obtained at different laboratories for 10 samples (covering a moisture range of 0.05 - 0.43%) were of the same order of magnitude as those obtained by the NIR method.

Enzymatic determination of lactic acid in sugar factory juices

J. Copikova, F. Kvasnicka, T. Buriankova and J. Kas. *Listy Cukr.*, 1989, **105**, 220 - 223 *(Czech)*.

In the method described, L- and D-lactic acid were oxidized with NAD in the presence of L- and D-lactate dehydrogenase, respectively, and glutamate-pyruvate transaminase to yield pyruvate and NADH; the NADH, in stoichiometric equilibrium with lactic acid, was determined spectrophotometrically at 340 nm. Comparison of the results for raw and thin juice with those given by isotachophoresis showed that the enzymatic method gave lower values; this was attributed to measurement of absorbance at higher values and to the use of Carrez reagents (potassium ferrocyanide and zinc sulphate) to decolorize the samples. Further tests are to be conducted with the enzymatic method which has the advantage of being able to determine both forms of lactic acid.

By-products

The effect of ionizing radiation on micro-organisms in beet molasses

P. N. Volovik *et al. Izv. Vuzov, Pishch. Tekh.*, 1989, (2), 34 - 35 *(Russian)*.

Irradiation of molasses with up to 100,000 roentgen and of pure cultures of *Leuconostoc mesenteroides, L. agglutinatus, Bacillus megaterium* and *B. subtilis* isolated from it reduced the total bacterial count and the populations of the individual species as well as their activity, and increased the final degree of fermentation, the amount of yeast biomass formed and the alcohol yield while reducing the quantity of unfermented sugars. The basic fermentation process parameters were unaffected by irradiation.

Manufacture of gelling pectins from sugar beet

K. Vukov. *Cukoripar*, 1989, **42**, 60 - 62 *(Hungarian)*.

The requirements of pectin suitable for use as gelling agent in the manufacture of jams and other food products are outlined and details given of the process used at a factory in the Ukraine for pectin manufacture from beet pulp.

Resistance of molasses micro-organisms to ionizing radiation

P. N. Volovik, V. S. Zubchenko, V. N. Isau and A. A. Tatarov. *Sb. Pishch. Prom.*, 1989, **35**, 42 - 45 *(Russian)*.

The resistance of molasses *Leuconostoc* and *Bacillus* micro-organisms (of major negative importance in relation to alcohol fermentation) to irradiation with up to 300 roentgen was determined in terms of the dose at which 37% of the original number of each species survived; the value was 50, 68, 186 and 230 roentgen for *L. agglutinatus, L. mesenteroides, B. megaterium* and *B. mesentericus*, respectively. The effect of the radiation on the bacteria is explained by the target-hit theory; it is a complex process with a large number of probabilities, so that the results are valid only for a given set of conditions.

Molasses, raw material of the distillation industry

G. Hajdú, G. Jenei-Király and P. Deák. *Cukoripar*, 1989, **42**, 108 - 113 *(Hungarian)*.

The chemical composition and physico-microbial properties of molasses from each of the Hungarian sugar factories in 1988/89 are tabulated and compared with values for the previous campaign and, in some cases, with results for the last 5 years. Comparison is also made between conventional raw molasses and that treated by the Quentin process. The suitability of the different molasses for use in fermentation is discussed on the basis of their analyses.

Survey and importance of products derived from beet and the branches of industry that utilize them

B. Bourges. *Sucr. Franç.*, 1989, **130**, 249 - 257 *(French)*.

A survey is presented of beet and sugar by-products. While pulp is of value as an animal fodder, its lack of protein has led to attempts to use it as a substrate for cultivation of *Trichoderma* spp. which are capable of degrading and consuming cellulose and hemicelluloses and converting them to protein; although this fermentation process has proved successful, it is uneconomical by comparison with the use of soya cake and is not considered to have any commercial future. Although pectin is obtainable from pulp, its gelling properties are inferior to those of pectin from apple or citrus fruits; however, research has yielded a modified beet pectin of high water retention capacity. The advantages of pulp over wheat bran as a source of dietary fibre are also mentioned. Glucose and fructose produced from sucrose by isomerization can be hydrogenated to yield, respectively, sorbitol and mannitol, which at present are produced in Europe from cereal substrates; fermentation of sorbitol with *Acetobacter suboxydans* converts it to L-sorbose, the starting point of vitamin C. The production and surface-active and emulsifying properties of sucroglycerides and sucrose esters are mentioned as are certain dietary properties of sucrose esters. Fermentation products mentioned include ethanol, organic acids (of which only citric acid is produced in large quantities), lysine and glutamic acid. Brief reference is also made to an ICI product, polyhydroxybutyrate (PHB), which has properties near to those of polypropylene while being biodegradable; however, the amount of sugar used is very small.

New technological advances in Brazilian ethanol production. Increase in the energy balance by using biogas from alcohol stillage

C. Ebeling. *Zuckerind.* (Special Edition), 1989, **114**, 17 - 24.

Advances made in ethanol fermentation technology in Brazil and factors contributing to the improvements are surveyed and measures adopted to reduce energy consumption in the distillery listed. Details are given of the 2-stage treatment of vinasse in a UASB reactor to yield biogas containing 80 - 85% v/v methane which can be used for various purposes in the distillery and possibly as a substitute for diesel fuel in trucks.

New continuous fermentation processes in the production of alcohol

H. Wunsch. *Zuckerind.* (Special Edition), 1989, **114**, 39 - 44.

A survey is presented of alcohol fermentation processes with flowsheets and assessment of their advantages and disadvantages. Included are Vogelbusch and Codistil batch cascade fermentation, the Biostil continuous one-step technique developed by Alfa-Laval for molasses processing, the Hoechst-Uhde one-step process that uses cane juice as substrate, and the Lurgi Contiferm six-stage and the Starcosa membrane two-stage processes based on the use of

immobilized yeast. Mention is made of some distilleries in Europe and Brazil where the various techniques are used to ferment substrates including beet and cane molasses and cane juice.

Aerobic bacteria in fermentation media based on cane juice

B. Ganou-Parfait, L. Fahrasmane, P. Galzy and A. Parfait. *Ind. Alim. Agric.*, 1989, **106**, 579 - 585 *(French)*.

Details are given of the species of bacteria isolated from fermentation media used for rum manufacture and from the cane and soil in which it grew as well as of their populations, metabolism and growth characteristics. References are given to the literature on each specific micro-organism.

Tests on yeast growth on molasses vinasse with effluent addition in the production of erythromycin

Z. Wlodarczyk, S. Gwardys and K. Zieminski. Zesz. Nauk. Technol. Chem., 1988, (41), 127 - 134; through Ref. Zhurn. AN SSSR (Khim.), 1989, (19), Abs. R1364.

Investigations are reported on the effect of adding effluent on supression of bacterial infection during yeast growth on molasses vinasse in the production of erythromycin. It was found that the amount of antibiotic in the effluent had no inhibitive effect on the development of bacterial infection but that the effluent itself contained substances that underwent biodegradation only with difficulty during yeast cultivation.

Sugar cane as forage for milk production. I. Effect of star grass (*Cynodon nemfuensis*) inclusion on feed consumption and digestibility

R. González, E. Muñoz, F. Alfonso, R. M. González and A. V. Enrique. *Cuban J. Agric. Sci.*, 1989, **23**, 145 - 149.

It has been found that consumption of dry matter (DM) in cane used as animal fodder is low relative to its high digestibility and is even lower if cane tops are not included. Supplementation with sweet potato, cassava and banana leaves has brought about an improvement. However, in experiments involving non-lactating cows, addition of star grass did not increase cane DM and cell wall digestibility, suggesting that the fibrous structure of cane restricts rumen degradation.

B-molasses for lactating sow feeding

J. Díaz, P. Lezcano and B. Román. *Cuban J. Agric. Sci.*, 1989, **23**, 163 - 167.

There were no differences between the performances of sows and litters fed a ration containing (1) maize meal plus a protein supplement containing torula yeast, (2) *B*-molasses plus torula yeast alone and (3) *B*-molasses plus the protein supplement, although the piglets consumed more of feed (2). While these results demonstrated the possibility of using molasses as energy source for lactating sows, the molasses feeds were more costly than the standard feed (1); however, they would allow imported feedstuffs to be replaced by products available in Cuba.

Investigation of vinasse occurring in the manufacture of fodder yeasts from molasses

V. S. Polishchuk, L. N. Kalinskaya, T. N. Pukhovaya and A. A. Dudnik. *Tez. Dokl. Vses. Konf. Soversh. Tekhnol. Protsessov Proizv. Nov. Vidov Pishch. Prod. i Dobavok*, 1989, 22; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (21), Abs. 21 R1406.

Laboratory investigations were conducted on concentration in a double-effect evaporator having a moisture evaporation capacity of 5 litres/hr. The vinasse was concentrated to 50% dry solids. It was found inadvisable to evaporate it to a higher concentration because of the deposition of suspended matter. Samples of concentrated vinasse gave positive results when used as a plasticizer.

Improving the procedure for molasses preparation for fermentation

V. N. Golovchenko and O. N. Naumenko. *Tez. Dokl. Vses. Konf. Soversh. Tekhnol. Protsessov Proizv. Nov. Vidov Pishch. Prod. i Dobavok*, 1989, 32; through *Ref. Zhurn. AN SSSR (Khim.)*, 1989, (21), Abs. 21 R1415.

A procedure has been devised for lowering the concentration of calcium ions in molasses wort by as much as 80% and creating the right microbial conditions for fermentation. Sulphuric acid is added to a molasses solution of 40% dry solid to give a pH of 4.5 and the mixture heated with steam for 1 - 2 seconds to 130°C; the calcium salts precipitate formed is then removed. An arrangement of equipment for this scheme has been worked out and a study conducted on the effect of the molasses pretreatment on the fermentation process (i.e. on the accumulation of yeast biomass, alcohol and of by-products) and on the mineral composition of the wort (Ca^{++}, K^{+}, Na^{+} and Mg^{++} concentrations). There was practically no change in the K^{+} and Mg^{++} concentrations whereas Na^{+} increased with the amount of sulphuric acid added to the wort. The pretreatment process had no major effect on the alcohol fermentation dynamics nor on by-product accumulation but increased biomass yield by 3 - 5% and improved its quality.

Kinetic characterization of product inhibition in ethanol fermentation

C. Y. Chang and L. H. Wang. *Taiwan Sugar*, 1989, **36**, (4), 9 - 13.

See *I.S.J.*, 1990, **92**, 11A.

Continuous fermentation of ethanol using immobilized growing yeast cells

M. C. Hsie. *Taiwan Sugar*, 1989, **36**, (4), 14 - 22.

See *I.S.J.*, 1990, **92**, 11A.

Colour formation

Experience with the old evaporators showed that colour formation (as % on initial colour) was 14.5% on average. Measurements made subsequently with the new station have shown an average increase of 10%. All measurements were made at pH 7 using the ICUMSA method.

Table II. Performance tests

Brix in, 20°C	Flow out, kg/hr	Brix out, 20°C	Water evaporated, kg/hr	Steam used, kg/hr	Steam/water ratio
61.9	33,782	72.2	5621	2335	0.42
62.6	31,309	73.0	5202	2115	0.41
62.9	34,520	73.0	5543	2039	0.37
63.0	30,792	72.5	4643	2101	0.45
63.0	32,915	73.2	5329	2173	0.41

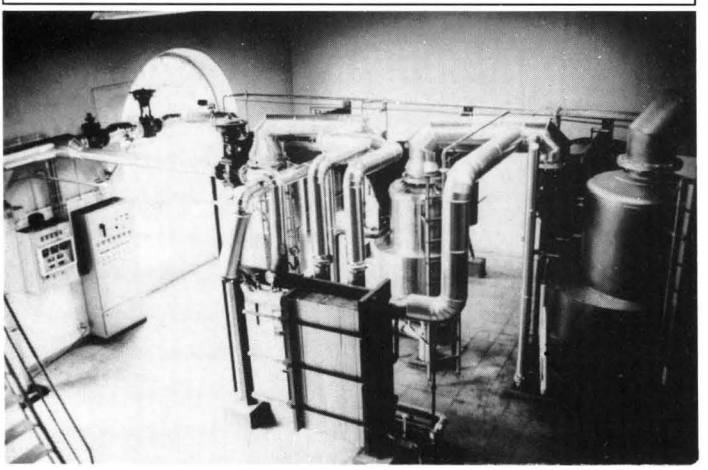


Fig. 4. General view of the main floor

Conclusions

The evaporator fully satisfies all the objectives. The apparent improvement in steam economy compared with the design value, which included an allowance for the accuracy of measurement, is one of the effects of a feed temperature that is higher than that expected. The feed temperature is normally 70°C rather than 60°C. This considerably increases the flash evaporation in the third effect. Beneficial effects of the higher feed temperature also include an increase in the evaporation capacity of the plant.

Design heat transfer coefficients ranged from 1150 W/m²/°C in the first effect to 700 W/m²/°C in the third effect, and measurements show that these are consistently achieved.

Calculations suggest that it may be possible to take further advantage of the higher feed temperature to achieve a reduced steam consumption by modifying the product re-heating system. Thus, instead of using vapour take-offs between the effects, the third effect

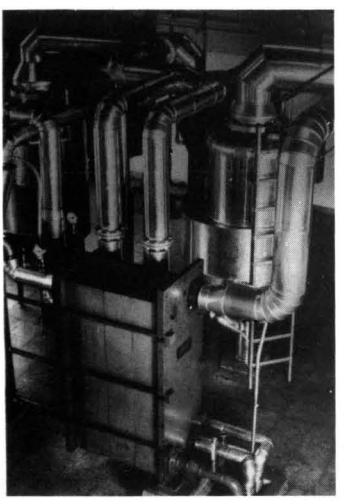


Fig. 5. Re-heater

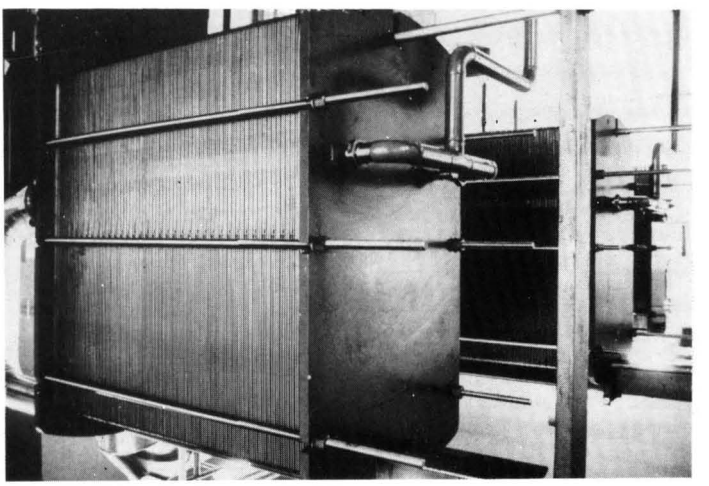


Fig. 6. Evaporators

The new plate evaporator at Sidul refinery

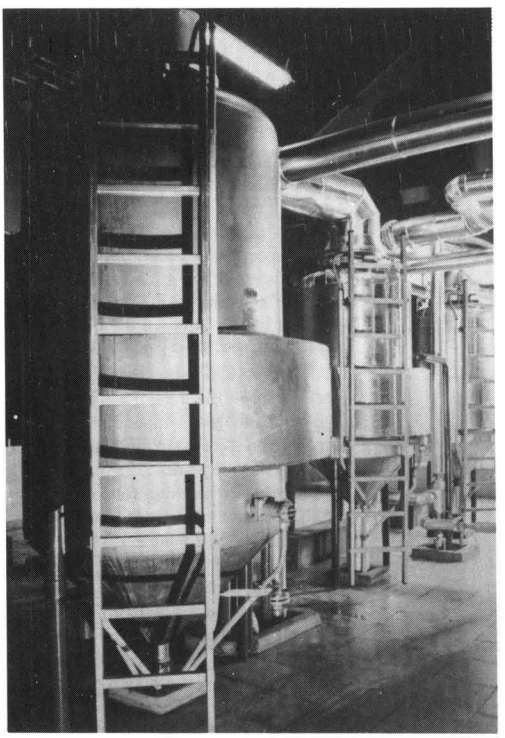


Fig. 7. Separators

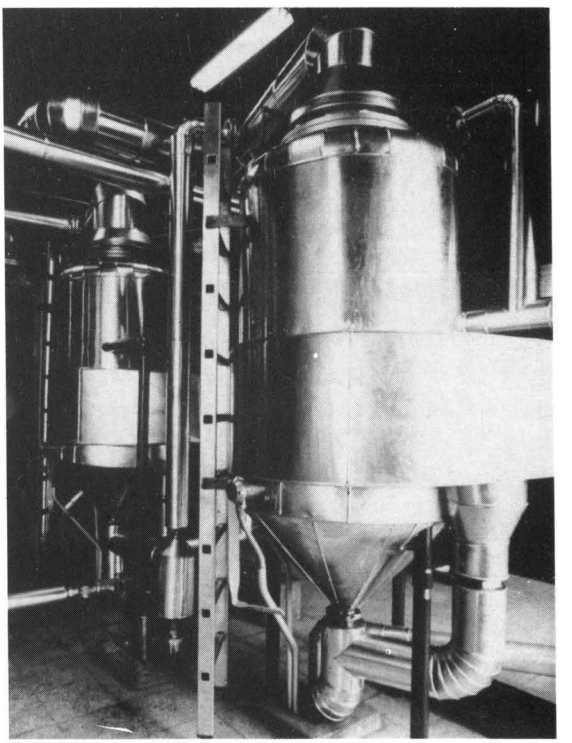


Fig. 8. Separators

product would be heated by the feed, and then the first effect product, and finally a small amount of steam.

Cost and performance allowed Sidul to receive a subsidy from the government of about 15% of the total cost of the installed station.

Summary

The evaporation station of the Sidul sugar refinery in Lisbon has recently been replaced as part of the phased renewal of equipment. The main objectives were to achieve energy savings, a compact plant arrangement, easy and reliable operation and compliance with government regulations for grants for energy conservation. A number of alternatives were considered and an APV evaporator was eventually selected and has now been commissioned. Measurements confirm that it fully satisfies all the objectives.

El nuevo evaporador de placa en la refinería de Sidul

La estación de evaporación de la refinería de azúcar de Sidul en Lisboa ha sido reemplazada recientemente como parte de la renovación en etapas de su equipo. Los objetivos principales eran lograr ahorrar energía, un arreglo de la planta compacto, operación fácil y confiable y cumplimiento con las regulaciones gubernamentales para préstamos para la conservación de energía. Varias alternativas fueron consideradas y un evaporador APV fue eventualmente seleccionado y ahora ha entrado en servicio. Las mediciones confirman que satisface completamente todos los objetivos.

Le nouvel évaporateur à plaques à la raffinerie de Sidul

Comme partie des travaux de rénovation à la raffinerie Sidul à Lisbonne, on a récemment remplacé la station d'évaporation. Les objectifs majeurs se rapportaient à la réalisation d'économies d'énergie, à avoir une installation compacte, facile et fiable dans son opération et qui devait être en accord avec les réglémentations gouvernementales pour l'obtention de subsides quant à la conservation d'énergie. On a examiné un certain nombre d'alternatives et finalement on a choisi un évaporateur APV qui maintenant a été accepté. Les mesures confirment que l'appareil répond pleinement à l'ensemble des objectifs.

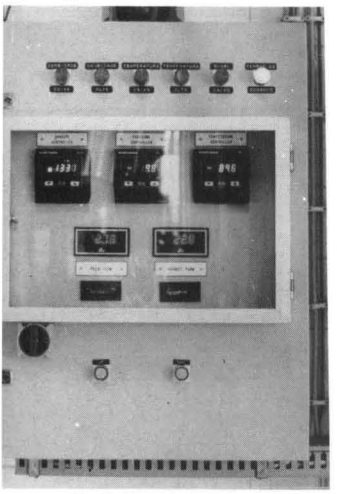


Fig. 9. Control panel

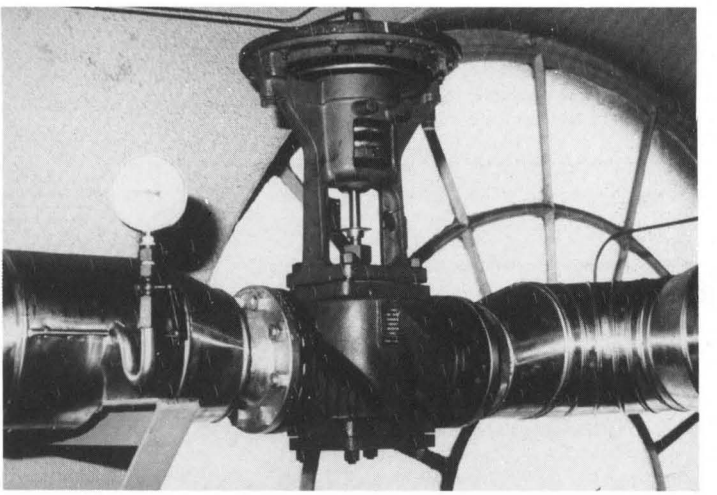


Fig. 10. Main steam valve

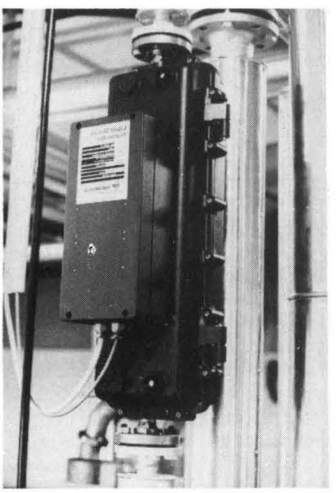


Fig. 11. Product flowmeter

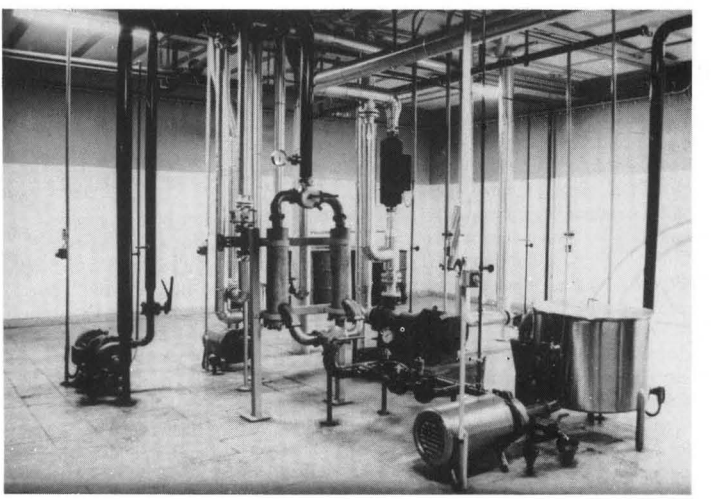


Fig. 12. Pumps floor

Der neue Plattenverdampfapparat in der Raffinerie Sidul

In letzter Zeit wurde die Verdampfstation in der Zuckerraffinerie Sidul in Lissabon ausgetauscht als Stufe einer schrittweisen Geräteerneuerung. Hauptzwecke waren eine Energieeinsparung, eine kompakte Anordnung von Anlagen, einfacher und zuverlässiger Betrieb und Einhaltung der Regierungsverordnungen hinsichtlich Subventionen für Energieeinsparungen. Ein paar Möglichkeiten wurden erwogen; ein APV-Verdampfer wurde schliesslich gewählt und ist schoen in Betrieb genommen worden. Messungen haben gezeigt, dass er allen Anforderungen völlig entsprach.

Finland sugar imports, 1989[1]

In 1989 Finland imported a total of 83,740 tonnes of sugar, raw value, of which 71,220 tonnes came from Cuba, 12,497 tonnes from Swaziland and the balance of 23 tonnes from other suppliers.

1 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, S84.

Affination of beet low raw sugar

By M. F. Cleary
(Western Division, Holly Sugar Corporation, Emeryville, California, USA)

Introduction

The earliest reference to the affination of raw sugars in the American beet sugar industry is a report by Lott & Memmott of the Utah-Idaho Sugar Company in 1962[1]. In contrast to this paper, which will repeatedly promote lower molasses purity as the chief benefit of affination, they did not mention molasses purity once in their paper. Their focus was the energy saved by:
(1) not operating a low raw sugar melter,
(2) not recycling low raw sugar to the second boiling stage, and
(3) reducing the amount of second boiling massecuite by 30%.

This paper will not discuss the impact that affination has on the energy savings in the factory, other than to list it as an advantage for the affination scheme. This deliberate understatement is not meant to disparage those benefits; they are sufficient to justify fully the modest investments required to install an affination system. Rather, the present comments will be concerned with the sucrose and non-sucrose balances within the crystallization stages.

The basic procedure in affination of low raw sugar is to mix impure sugar with a saturated sugar syrup of relatively low viscosity (usually the mother liquor from the second boiling) to form an affination magma. When this magma is separated into affination syrup and affined sugar by centrifugation, the resultant purities and colours are such that the sugar can be recycled to the first boiling instead of the second. A physical separation occurs of sucrose from non-sucrose components in the supernatant syrup. Since the purity of the raw sugar is raised, the purity of the syrup is lowered correspondingly. This leads to two pairs of "balances". The sugar balances without and with affination are presented schematically in Figures 1a and 1b.

The changes in the sugar balance between the two schemes are straightforward – the sugar which was taken from the third boiling is returned to the first boiling instead of the second (intermediate) boiling. Since less sugar is routed through the second boiling, the total amount of material which the second and third stages of crystallization handle is reduced (note the size of the "vessels" in the diagrams). Correspondingly, the first (white) boiling must handle more material.

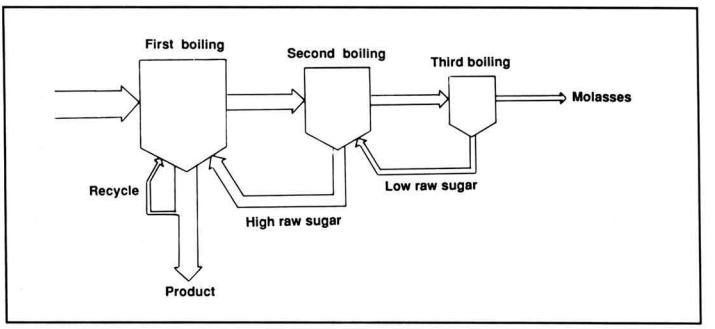


Fig. 1a. Sugar balance without affination

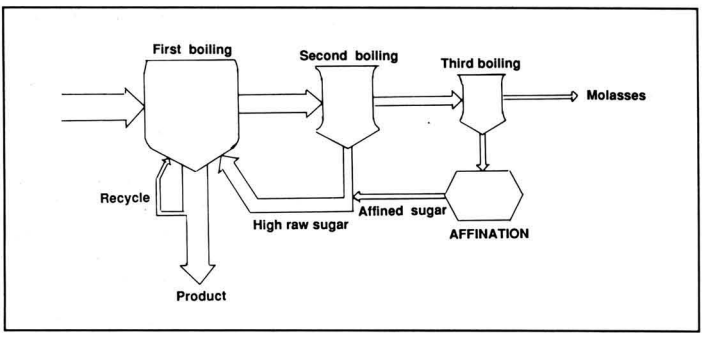


Fig. 1b. Sugar balance with affination

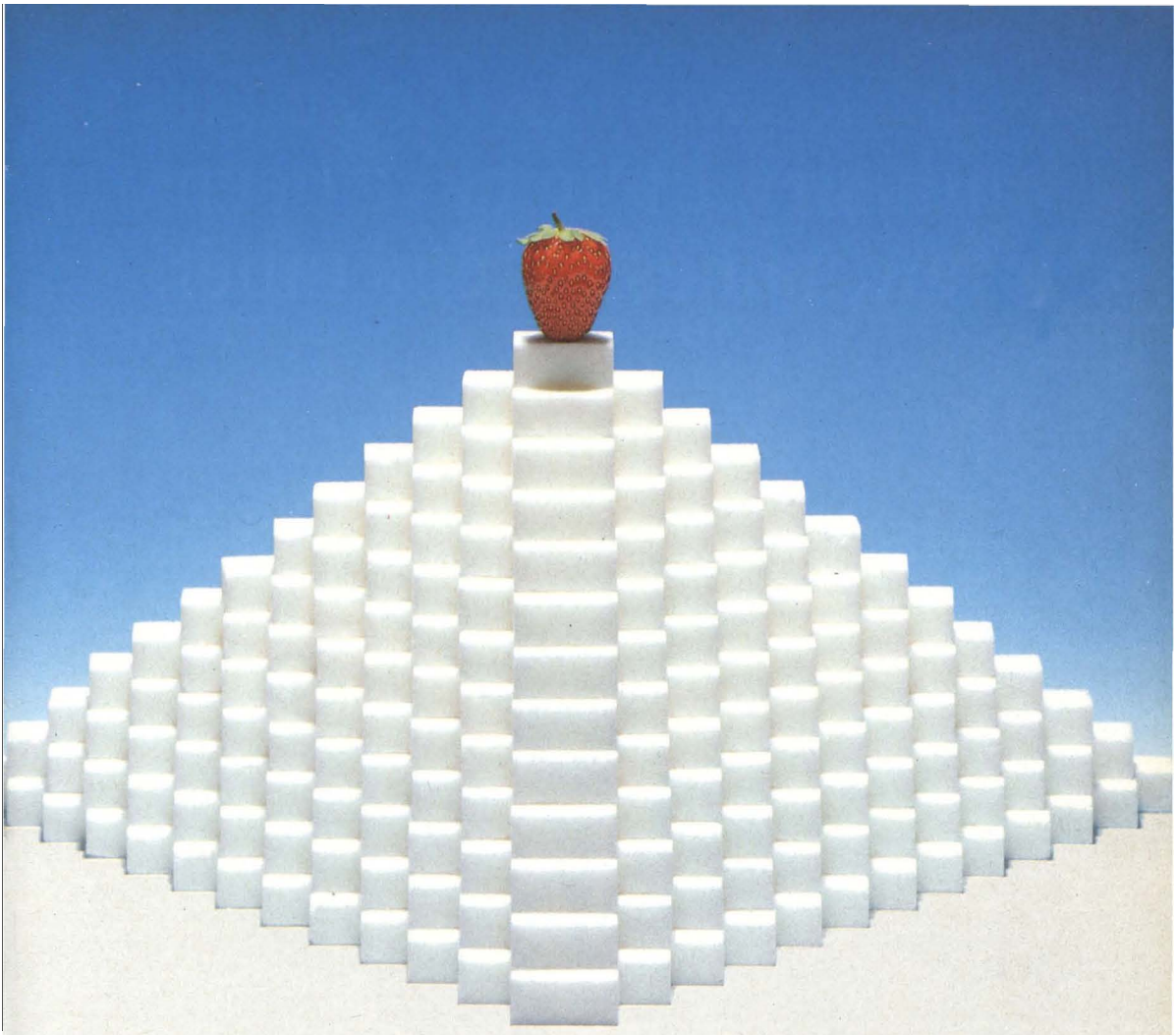
The non-sugars balances, Figure 2a and 2b, present quite a different picture. Note that almost all of the non-sugars are carried straight through to the molasses stream. (In order to examine the recycled non-sugars, the recycle lines – all of the smaller lines – are not drawn to the same scale as the preponderant flow through the pans, but rather expanded about five-fold.) The salient feature is that, in affination, most of the non-sugars in raw sugar which are normally sent to the second boiling are cycled to the third boiling. Since these non-sugars are accompanied by a negligible amount of sugar, the third boiling is of lower purity and hence the purity of the final molasses is also lower. This is the real pay-back of affination: *lower molasses purity.*

The theme of lower molasses purities is a recurring one in the beet sugar industry because of the heavy impact sugar in molasses has on the profitability of the process. Figure 3 depicts the dependence that the extraction (excluding diffusion and purification losses) has on the final molasses purity.

Note that the range indicates that from 13 to 15% of the sugar entering crystallization exits with the molasses. Also, as the purity of the incoming stream diminishes, the effect that molasses purity exerts on the extraction increases. At the other end of the

Paper presented to Sugar Industry Technologists Inc., 1989.

1 *J. Amer. Soc. Sugar Beet Tech.*, 1962, **12**, (3), 216 - 224.



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spectrum, the typical cane sugar refiner may deal with incoming purities of 98 to 99%, and expect extraction losses of only 1.5 to 3% for 60% purity molasses. To exacerbate the situation further, beet molasses is a low value product. While the "impurities" from the cane sugar refinery are often sold for more than the sugar, beet molasses typically sells in the $50 to $100 per short ton range, equivalent to $3 to $6 per hundredweight for the solids.

Many well-formulated treatises have been presented on the chemistry of sucrose crystallization and the behaviour of sucrose in technical aqueous solutions. While it is beyond the scope of this work to present a detailed summary, a few principles should be kept in mind:

(1) Under industrial conditions, kinetic rather than thermodynamic conditions prevail. None of the crystal-syrup mixtures ever have time to come near equilibrium. Thus, conditions which favour the kinetic processes (time, temperature, low viscosity) will lead to higher overall crystal yields.

(2) In a magma of crystals and supersaturated syrup, the lowest purity syrup is on the face of the crystal; this is the most exhausted material since it has just deposited some of its sucrose on the crystal face, thus lowering the purity.

(3) Sucrose in solution will hydrolyse to glucose and fructose, which will further react to give organic acids. In technical beet solutions, this is always associated with the formation of colour bodies which affect the colour of the final product. The hydrolysis reaction is facilitated by acid, salts, temperature, and base. Although the base-catalysed pathway is of little importance, the other three occur to some extent even in a well-engineered process.

Discussion

A typical factory flow scheme is presented in Figure 4. Low raw sugar is dropped into a mingler where it is mixed with machine syrup, the mother liquor from the second boiling. From there the affination magma is pumped to a receiver above the affination centrifugals. These separate it into affination syrup and affined sugar. The former is returned to the machine syrup tank (and thence eventually to the low raw pan) while the latter is taken to the first boiling via the high raw melter.

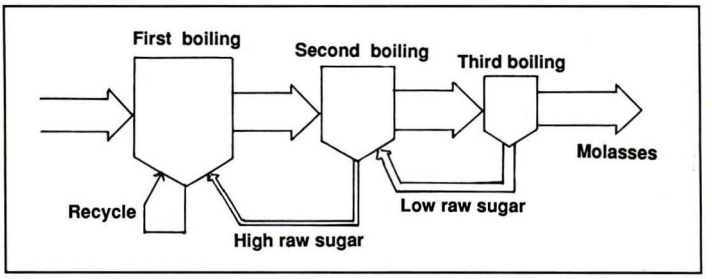


Fig. 2a. Non-sugar balance without affination

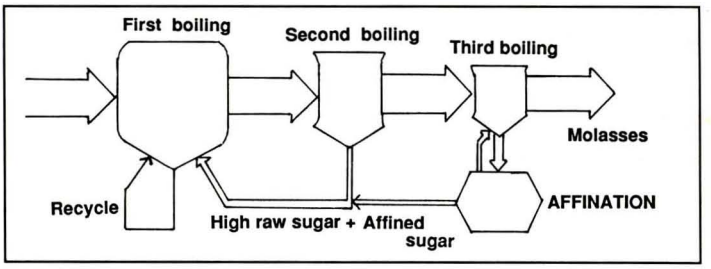


Fig. 2b. Non-sugar balance with affination

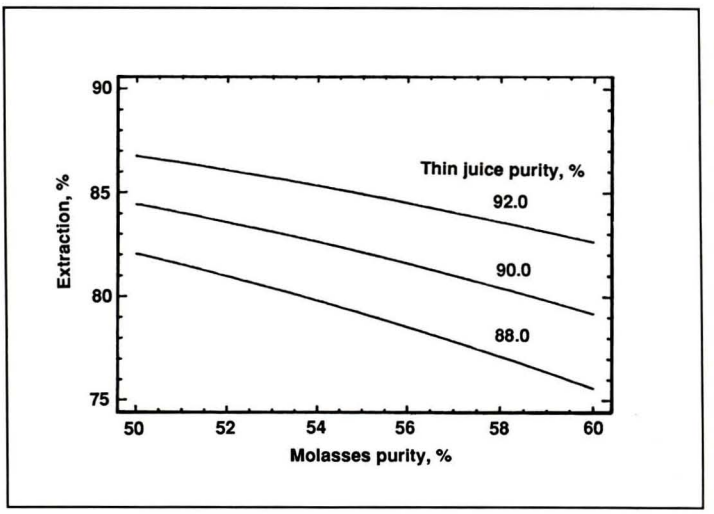


Fig. 3. Extraction versus molasses purity at various thin juice purities

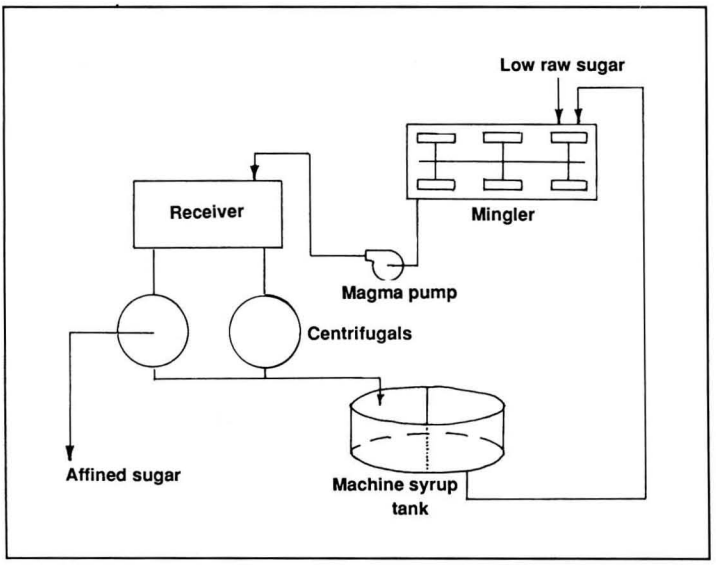


Fig. 4. Affination flow scheme

In addition to the usual complement of heaters, pumps, and scrolls, a few special pieces of equipment are required. The first of these is an affination vessel or mingler. Many US beet sugar factories have simply converted their low raw melter, which affination makes superfluous, into a mingler; it fulfils the requirements and is usually strategically placed. Residence time does not seem to be critical since some installations consist only of a six foot long by one foot wide scroll placed underneath each low raw centrifugal.

Continuous centrifugals were not designed with affination in mind; as sugar leaves the interior basket of a continuous low raw centrifugal it is flung against the outer wall. This presents no problem if the sugar is simply taken to the low raw melter and dissolved; however, in order to affine low raw sugar properly, the integrity of the crystal must be preserved. In an effort to reduce this battering of low raw sugar crystals, Braunschweigische Maschinenbauanstalt AG have modified their continuous centrifugals such that the sugar is flung into a wall of machine syrup. This not only affords some protection for the crystals but also effects the mixing of the machine syrup with the sugar to the extent that an affination mingler is unnecessary. Western States Machine Co. have also made similar modifications to their continuous centrifugals.

Since most factories have been designed with the low raw sugar production physically at the lowest point in the crystallization scheme, the affination massecuite has to be lifted to the centrifugal station. This requires a magma pump, specially designed to move this mass of crystals and syrup. Typical designs, as supplied by Braunschweigische Maschinenbauanstalt AG or by Plenty & Sons Ltd., include a positive displacement rotary piston fitted with a scraper flap as shown in Figure 5.

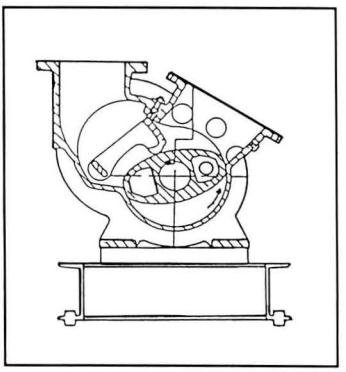


Fig. 5. Typical magma pump design features

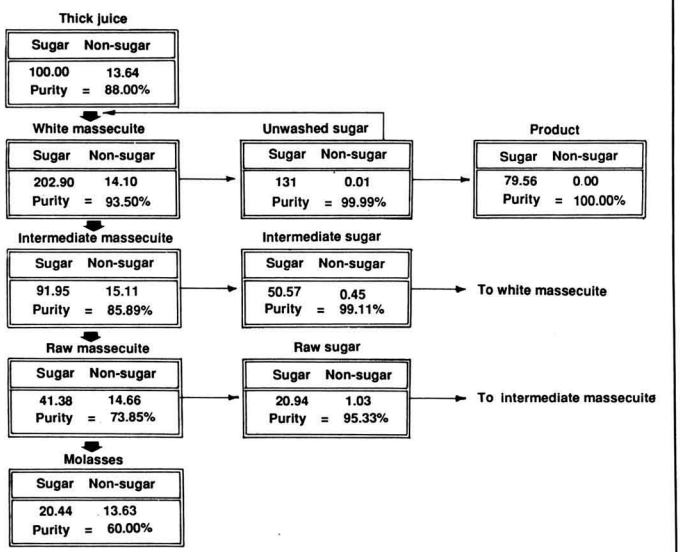
After the low raw sugar has been combined with the affination syrup and developed into a magma, it is centrifuged to produce a sugar which is normally of high enough quality to take to the standard liquor melt tank. This magma is sufficiently different that it cannot be combined with intermediate massecuite and taken through the same centrifugals. Since it contains essentially low raw sugar crystals of intermediate purity and viscosity, the affination magma requires its own receiver(s) and centrifugal(s). In many cases this represents a major hurdle in implementation of the system, either in terms of capital cost, engineering, or space. An examination of Table I reveals that an inventory of the total of white, intermediate and raw massecuites and affination magma is not much different whether or not affination has been installed (All of these data are taken from the material balances presented in Appendix I, which are discussed below). The conclusion is that an additional centrifugal is perhaps unnecessary, depending on the existing equipment.

Most locations which have

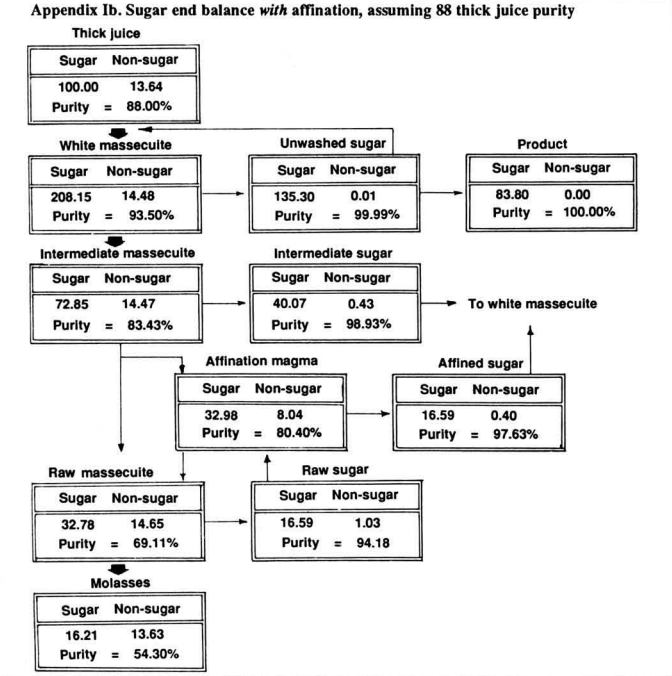
Table I. Massecuite and magma solids

	Without affination	With affination	Difference	
White massecuite	165.4	169.8	4.4	11%
Intermediate massecuite	74.9	59.4	-15.5	-21%
Low raw massecuite	33.7	26.7	-7.0	-21%
Affination magma	-	26.9	26.9	-
Total	274.0	282.8	8.8	3%

Appendix Ia. Sugar end balance *without* affination, assuming 88 thick juice purity



Appendix Ib. Sugar end balance *with* affination, assuming 88 thick juice purity



installed an affination centrifugal station (or better still, have installed the centrifugal-mingler described above) use one end of the intermediate mixer instead of providing a separate affination mixer. This is accomplished by simply placing a baffle in the now over-capacity intermediate mixer and installing the new centrifugal(s) beside the existing intermediate centrifugals. This also provides an overflow safeguard for the affination mixer.

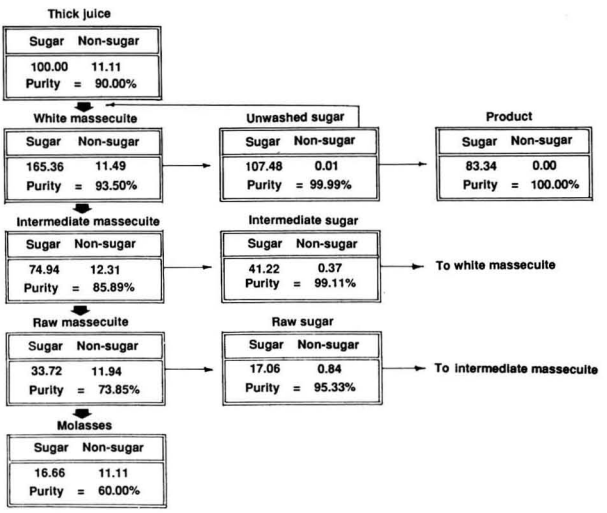
Occasionally operators are misled by the assumption that an affination system will allow less attention to the low raw end of the factory. The presumption is that, since there is a system in place to separate further sucrose from non-sucrose, the grain does not have to be as coarse, or the CV as tight, or the centrifugal adjusted as carefully as circumstances might otherwise dictate. In fact the opposite is true. All of the practices which lead to well-purged low raw sugar, are required for an effective affination operation.

Those companies which have reaped the most benefit from affination have begun with a low raw pan/crystallizer optimization project. Since the chemistry requires washing the surface of the crystal with intermediate machine syrup, the engineering depends on the amount of surface that has to be washed. Small crystals with wide size distribution will overload the process.

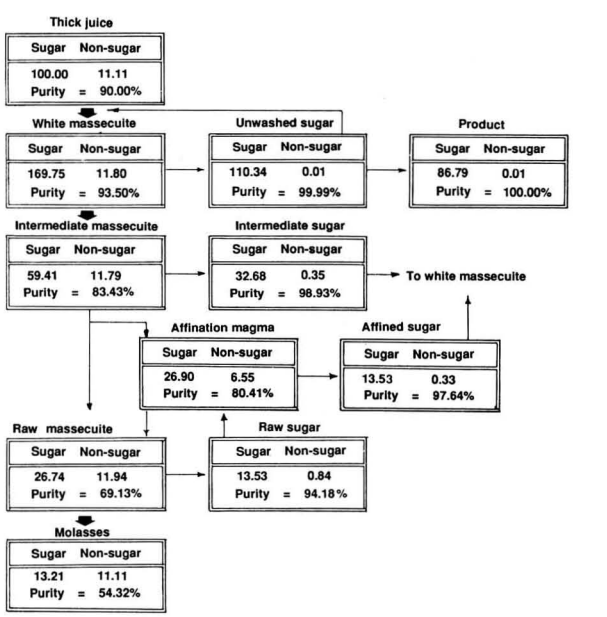
In an effort to save sugar by not washing it into molasses, some operators have done away with the low raw centrifugal wash. The latent syrup which normally would have been removed is then recycled to the low raw pan with minimum effect on the affined sugar. This overlooks the fact that the lowest purity syrup in the entire sugar factory sits on the crystal surfaces of the low raw sugar mass as it leaves the crystallizers. The addition of an optimum amount of water will wash away non-sucrose rather than sucrose. The use of an affination process does not alter this.

As soon as possible after the washed low raw sugar leaves the centrifugal it is combined with inter-

Appendix Ic. Sugar end balance *without* affination, assuming 90 thick juice purity



Appendix Id. Sugar end balance *with* affination, assuming 90 thick juice purity



mediate machine syrup in the mingler. The viscosity of the affination magma is lowered in two ways. First, the syrup is pre-heated; and second, the syrup is diluted so that the final magma will have a total solids content of 88 to 92°Brix. In cases where the machine syrup contains entrapped air and purging of the affination magma is difficult, the diluted heated machine syrup must be deaerated.

After centrifugation, the affination syrup, now of considerably lower purity than the machine syrup, is returned to the machine syrup tank. This tank is normally fitted with baffles to assure that most of the affination syrup will be taken to the low raw pans, while still providing an overflow mechanism for sugars (see Figure 4).

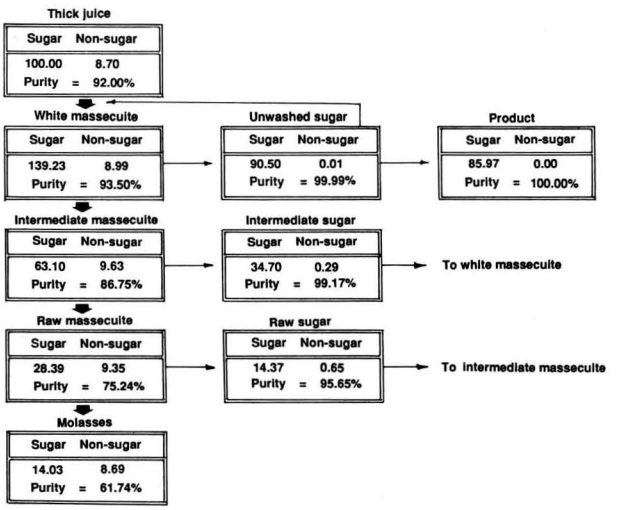
The controls required for affination are quite minimal. They consist of temperature and Brix controls on the machine syrup to affination, level controls in the machine syrup tank, and a density indicator in the mingler.

For purposes of modelling, the three-boiling system typical of most North American beet sugar factories has been selected and the following assumptions have been made:

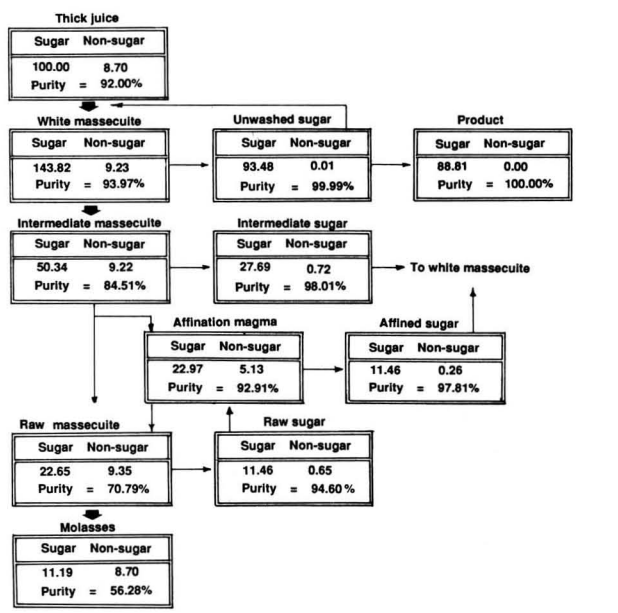
(1) The minimum purity of the standard liquor or syrup feed to the first white boiling step is 93.5%. In some of the examples, especially when the incoming stream has a purity of less than 90% substantial amounts of what would otherwise be product must be recycled to the standard liquor melter in order to maintain this value. A small amount of material is always recycled from the wet sugar to standard liquor when the sugar is washed. In cases of really high purity incoming streams, no additional recycle is required to boost the purity and values in excess of 93.5 may occur.

(2) Sucrose degradation throughout the process is negligible. This is perhaps the most erroneous assumption, since even in a well-run process measurable conversion of sucrose to non-sucrose takes place during crystallization and reboiling. This constraint requires some rather optimistic crystallization

Appendix Ie. Sugar end balance *without* affination, assuming 92 thick juice purity



Appendix If. Sugar end balance *with* affination, assuming 92 thick juice purity



yields to reduce the standard liquor to a molasses of 60% purity in three stages.

(3) Each of the pans is assumed to provide a constant crystallization yield. Specifically, the first boiling yield is 65% (some of which is recycled to standard liquor), the second boiling yield is 55%, and the third boiling yield is 50.6%. As will be shown, affination leads to smaller amounts of intermediate and low raw massecuites, which should provide the additional boiling and crystallization times necessary to maintain the same yields at lower purities.

(4) There are no other side streams or diversion lines. In practice, one would normally have to deal with remelted sugar, sluiced filters, leaks, spills, and similar issues.

About half of the sucrose is crystallized and separated in each of the three stages. Thus, the yield should be about (50% + 25% + 12.5%) or 87.5% of the sugar entering crystallization. At the same time the purity should drop from 88.5% to 49.0%. Neither set of figures takes into account the fact that the 25% and the 12.5% are recirculated back to the process. Also, a starting purity of 88.5% is insufficient to assure saleable product.

"Balanced" three-stage crystallization schemes are present in Appendices Ia - If which represent the following: (1) flow without and with affination; (2) incoming purities of 88%, 90%, and 92%; and (3) mass balances for both sugars and non-sugars.

For instance, Appendix Ic represents the case in which the second (intermediate) strike is recycled to incoming thick juice (purity = 90%) to make standard liquor, and the third strike (low raw) is brought back to the intermediate stage. Note that even through the individual crystallization yields have been set at more than 50%, the combined recycle scheme produces an overall yield of just over 83% on sugar entering.

Appendix Id presents the same flow diagram with an affination step added. Conceptually, the low raw sugar which was 95% purity has been separ-

ated into a higher purity sugar suitable to send to the first boiling (via the high raw melter, not shown) and a lower purity syrup which is returned to the low raw pan. The split in this diagram is set such that all of the low raw sugar goes to the first boiling accompanied by only a third of the non-sucrose. Table II summarizes the data from all six cases presented in Appendix I.

Table II. Summary of material balances at various incoming purities both with and without affination

Thin juice purity	88.00	90.00	92.00
Molasses purity			
Without	60.00	60.00	61.74
With	54.30	54.32	56.28
Extraction			
Without	79.60	83.30	86.00
With	83.80	86.80	88.80

The point was made earlier that lowering the molasses purity has more effect on the extraction when the incoming purity is lower (Figure 1). This table provides some values; in all cases affination lowers the molasses purity and raises the extraction. This benefit amounts to + 4.2, +3.5, and +2.8 extraction points for thin juice purities of 88%, 90%, and 92%, respectively. The benefit is eventually half again as much for 88% purity thin juice as for 92% purity thin juice.

Conclusions

Affination of low raw beet sugar offers several advantages, viz. (1) lower molasses purity (higher extraction); (2) a greater benefit when the incoming purities are the lowest, i.e when the process needs it the most; (3) less sucrose degradation; (4) elimination of the low raw melter; (5) lower energy consumption; and (6) more boiling time in the intermediate and low raw pans.

The last of these benefits – longer boiling times for the lower purity crystallization – affords the opportunity to develop a coarser grain which will purge more efficiently and should also allow the use of lower temperatures in those pans. This is particularly important when one considers that the sucrose degradation reactions,which are invariably associated with formation of colour, are enhanced by high temperature even more than long retention times.

There are also a few disadvantages associated with affination: (1) more equipment is required; (2) some space is required; (3) a consistent large-grained low raw sugar is mandated; (4) the low raw sugar must be handled gently to avoid damage; and (5) more white pan capacity may be required.

Probably the most serious of these is item number 3. If the operation is characterized by troublesome low raw centrifugal purging, the addition of an affination system is likely to make things worse rather than better. Sugar which purges poorly in the first set of centrifugals will not get any better by the time it reaches the affination centrifugals.

Since Lott & Memmott's paper in 1962, most of the American beet sugar factories have implemented affination schemes, some as recently as 1988. Those few that have not installed affination equipment, have initiated low raw pan optimization schemes which will eventually include an affination.

Summary

Affination within the United States beet sugar industry is practised by all producers at nearly all locations. Contrary to its namesake in a cane sugar refinery, the process is located at the final stages of sugar recovery instead of as the initial step. Beet low raw sugar is affined up to levels of both colour and purity which allow it to be taken to the first (white) boiling stage instead of the intermediate stage. In addition to energy savings from reduced reworking of raw sugars, the factories which have implemented this scheme have also realised improved intermediate and low raw crystallization efficiencies because more sugar has been moved to the white crystallization stage.

Afinación del azúcar de remolacha crudo bajo

La afinación dentro de la industria de azúcar de remolacha, en los Estados Unidos, la practican todos los productores en casi todas las localidades. Al contrario del proceso equivalente en la refinería de azúcar de caña, el proceso está ubicado en las etapas finales de la recuperación del azúcar y no en las etapas iniciales. El azúcar de remolacha crudo bajo es afinado hasta los niveles de color y pureza que permiten llevarlo hacia la primera etapa de cocción (blanca) en vez de a la etapa intermedia. Además del ahorro de energía proveniente del reprocesamiento reducido de azúcar crudo, las fábricas que han implementado este esquema han observado también un mejoramiento en los rendimientos de cristalización del azúcar crudo bajo e intermedio debido a que más azúcar es llevado a la etapa de cristalización blanca.

L'affination du sucre arrière-produit de betteraves

Dans l'industrie sucrière des Etats-Unis l'affinage est pratiqué dans presque toutes les usines. Contrairement à ce qui passe dans le raffinage du sucre brut de canne, où l'affinage constitue l'étape initiale, les sucriers de betteraves l'appliquent au stade finale de l'extraction de sucre. Le sucre arrière-produit est affiné jusqu'à un niveau de couleur et de pureté tel qu'on peut le réintroduire dans le premier jet de la cristallisation, plutôt que dans un stade intermédiaire. On réalise ainsi des économies d'énergie provenant du fait qu'on recycle moins de sucre brut. En plus, les usines avec ce schéma réalisent aussi un meilleure efficience dans leurs cristallisations de second et troisième jet. En effet, plus de sucre a été envoyé vers la cristallisation du sucre blanc.

Affination von Rübennach-produktrohzucker

In der Rübenzuckerindustrie der

continued on next page

Facts and figures

Cane alcohol project for North Queensland[1]

A consortium comprising Transfield Construction (Qld.) Pty. Ltd., Crooks Michell Peacock Stewart (Qld.) Pty. Ltd. and Queensland Science & Technology Ltd., is proposing to establish an industry in North Queensland for production of fuel extender alcohol from cane. Growers will be offered long-term contracts at a cane price linked to the price of fuel and it is planned to establish within 18 months three production facilities. Two of these will be annexed to existing sugar factories and will have capacities of 50 million litres; these will cost $Aus 37 million. The third will be a stand-alone facility in the Burdekin area and will cost $236 million for a 250 million litre output. Sweet sorghum will also be a feedstock for the plants and will, in fact, be preferred because it can be grown throughout the year and shows better economics.

Fall expected in Réunion sugar crop[2]

The 1989 cane crop in Réunion suffered from a cyclone in January and subsequent drought as a consequence of which output in the 1989/90 season is set at only 175,000 tonnes, white value, against 245,629 tonnes in 1988/89.

Affination of beet low raw sugar

continued from previous page

USA wird die Affination allen Herstellern in beinahe allen Fabriken durchgeführt. Im Gegenteil zur Affination in der Rohrzuckerraffinerie, findet das Verfahren in der endlichen Stufen der Zuckergewinnung und nicht als die Anfangsstufe statt. Rübennachproduktrohzucker wird bis zu Farben- und Reinheitsniveaus affiniert, wobei er zur ersten (weissen) Kochstufe anstatt zur Zwischenstufe geführt werden kann. Ausser Energieeinsparungen zur Folge verringerter Wiederbearbeitung des Rohzuckers, haben dieses Schema benutzende Fabriken verbesserte Leistungen der Zwischen- und Nachproduktrohzuckerkristallisation erhalten, weil mehr Zucker zur Weisszuckerkristallationsstufe geführt wird.

Spanish sugar companies merger moves[3]

The Boards of Directors of the two major Spanish sugar companies Ebro and Cía. de Industrias Agrícolas have approved the beginning of negotiations for the fusion of the two companies. Each company will stick to its territory, as well as respecting the rights of growers. The national character of the companies will be maintained and jobs guaranteed for the workers. Ebro's president has asserted that none of the companies' factories will be closed as a result of the merger. Banks holding minority stakes in both companies are the driving force behind the proposed merger.

Ethiopia bagasse pulp and paper project[4]

The Ethiopia Pulp and Paper Company is negotiating a loan from the World Bank to finance a pulp and paper plant to be built adjacent to its paper plant located 100 km from Addis Ababa. Planned capacities are 22,000 tonnes per annum of bleached bagasse pulp and 30,000 tonnes of writing and printing papers, with a bagasse pulp content of 70 - 80%, the balance being kraft pulp derived from conifer wood.

Kenya sugar imports requirement[5]

Although total sugar production in Kenya is expected to increase slightly by about 3%, large levels of unofficial sugar exports and higher consumer demand made Kenya a net sugar importer in 1989, according to the US Agricultural Attache. Sugar shortages occurred in both rural and urban areas and may continue into 1990. The projected production level of 420 - 425,000 tonnes will not be sufficient to cover demand which has been set at 520,000 tonnes this year, and future growth has become a government priority if only to keep up with the country's 3.8% population growth rate.

Swedish sugar factory closures[6]

Following the decision to contract the sugar industry in Sweden reported earlier[7], the 2300 tonnes/day factory at Mörbylanga and the 2400 tonnes/day factory at Roma will be closed while a third factory may also be closed later.

West German sugar production, 1989/90[8]

The 1989/90 beet sugar campaign in West Germany ended with a total of 20,767,000 tonnes of beets delivered to the factories, up nearly 2.2 million tonnes or 12% on the previous campaign. Sugar content was slightly down at 16.91% against 16.98% in 1988/89. Sugar production reached 3,315,000 tonnes, raw value, which compares with 2,985,000 tonnes in 1988/89 and 2,947,000 tonnes a year earlier. A further 21,000 tonnes of sugar was extracted from molasses.

Argentina project for animal fodder from bagasse[9]

The "Bagadiet" project, put into operation at Ingenio Florida, in Tucumán, Argentina, includes a bagasse hydrolysis plant and a pilot module for feeding 172 head of cattle. The investment cost was approximately $100,000 and it has a production capacity of 12 - 14 tonnes per day. Technology has been acquired from Brazil, Cuba and GEPLACEA. It is believed that the project will provide 30% of current feed requirements in the province.

Brazil cane crop reduction forecast[10]

Instead of an expected cane crop of 227 million tonnes, only 205 million tonnes are now expected, according to Brazilian press reports. However, a significant

1 *Australian Canegrower*, 1989, **11**, (22), 5.
2 *Sucr. Franç.*, 1989, **130**, 314.
3 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 52.
4 *GEPLACEA Bull.*, 1989, **6**, (12), Sugar Inf. 2.
5 F. O. Licht, *Int. Sugar Rpt.*, 1990, **22**, 33.
6 *Zuckerind.*, 1989, **114**, 1011.
7 *I.S.J.*, 1989, **91**, 140.
8 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 53.
9 *GEPLACEA Bull.*, 1990, **7**, (1), Sugar Inf. 1.
10 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 56.

recovery is expected in the 1990/91 crop year which begins in May. Currently, Brazil is struggling with a critical shortage of sugar cane which has resulted in a substantial decrease in alcohol output, causing a shortage at the fuel stations and necessitating imports of alcohol and methanol. Unusually dry weather and increased crop damage by pests have reduced yields in the current season. Prices set by government decree and a shortage of credit forced farmers to reduce spending on fertilizers and pesticides, while some growers have replaced unprofitable sugar cane with grains, further reducing output.

ISSCT Workshops

A series of workshops are to be held under the aegis of the International Society of Sugar Cane Technologists during the period between the 1989 20th Congress and the 21st Congress to be held in Thailand in March 1992. These will include one on crop nutrition for the Agronomy Section, in Florida in February 1991, one on cost-effective cane mechanization for the Agricultural Engineering Section in Cali, Colombia, in April 1991, one on biotechnology for the Physiology Section, in Texas in February 1991, one on data management in cane breeding and germplasm studies for the Breeding Section in Louisiana in July/August 1991, one on the rating of germplasm in relation to important disease quarantine measures and biotechnical disease detection for the Pathology Section in Mauritius in July 1991, one on cane borers for the Entomology Section in Florida in February 1991, one for the Processing and Factory Engineering Sections in Durban in June 1991, one for the By-products Section in Havana in April 1990, and one for the Energy Section in Brazil in September 1991.

British Sugar ownership

The Chairman of Beresford International, Mr. Ephraim Margulies, resigned in March following the annual general meeting of the company – owners of British Sugar plc – in which the Board was criticized over the activities and losses of its US subsidiary. The company announced that it was holding preliminary talks which might or might not lead to an offer for its shares and Tate & Lyle later confirmed that exploratory discussions had taken place concerning the feasibility of combining its sugar business with British Sugar. A definite proposal would, among other things, depend on Tate & Lyle being satisfied as to the value and status of Berisford's non-sugar interests.

Sugar Processing Research Conference, 1990

The 1990 Conference on Sugar Processing Research will be held during May 29 to June 1 at the Mark Hopkins Inter-Continental Hotel in San Francisco, California. This Conference will be held by S.P.R.I. (Sugar Processing Research Inc.) and will celebrate the 50th Anniversary of the founding of S.P.R.I.'s predecessor, the Bone Char Research project. Further information on registration and the program may be obtained from Dr. Margaret A. Clarke, Managing Director of S.P.R.I., 1100 Robert E. Lee Boulevard, New Orleans, Louisiana 70124, USA.

Chinese international sugar manufacturing and utilization exhibition

Guangdong in South China is a centre of cane sugar manufacture, accounting for about one-third of national output. There are 116 cane sugar factories in the province while, with the industries of the other provinces there are several hundred factories which need advanced technology and equipment from abroad. An exhibition is to be held at the China Foreign Trade Centre in Guangzhou during September 7 - 11 next, at which entrepreneurs and engineers from China and from developing countries will be able to learn about the technology available and can negotiate business. Exhibits will feature new cane raw sugar and refinery technology, cane diffuser and mill design, filters, vacuum pans, etc., bagasse and molasses utilization equipment and processes, as well as technology for starch-based sweeteners, etc. Information may be obtained from Ms. Shu Xian Jin, Guangdong First Light Industry Science & Technology Development Ltd., 116 Yue Hua Road, Guangzhou, China (Telephone 338763, Telex 44483 Gdlib, Telefax 330404) or, concerning exhibition stands, from Mr. Larry Tang or Ms. Teresa Lee, Tradeshow Consultant International Ltd., Suite 925, Ocean Centre, Canton Road, Tsimshatsui, Kowloon, Hong Kong (Telephone 7351698, Telex 49690 Expco, Telefax: 73007007).

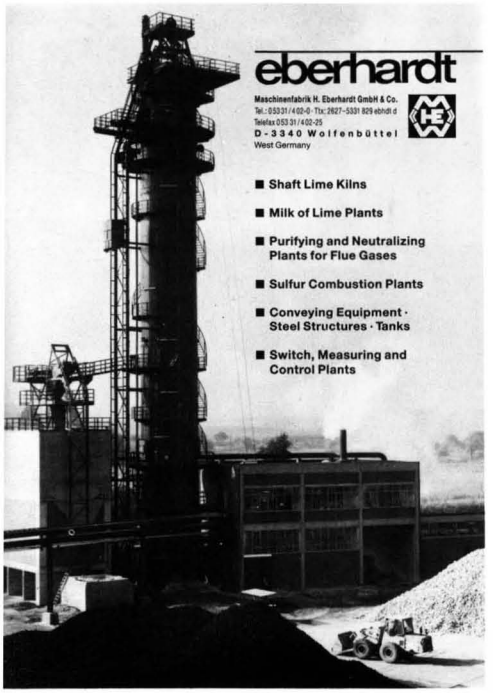
Morocco sugar production, 1989/90[11]

Moroccan sugar production in the 1989/90 crop year totalled 500,155 tonnes, raw value, down 25,000 tonnes from the year before. Beet sugar production totalled 403,387 tonnes and cane sugar production 96,768 tonnes, against 407,612 and 118,974 tonnes, respectively, in the year before. A drought in the Gharb area hampered beet growth and the sugar content was low in the crop from the Tadla and Basse Moulouya regions, so that the beet slice was reduced from 2,995,000 tonnes in 1988/89 to 2,890,000 tonnes. The cane crop was also lower at 985,929 tonnes in 1989 against 1,086,259 tonnes in the previous year.

New Turkish sugar factories[12]

Three new sugar factories were in operation for the 1989 campaign in Turkey; these included a 3000 tonnes/day plant at Carsamba-Samsun, a 6000 tonnes/day plant at Eregly-Konya and a 1500 tonnes/day plant at Van-Ercis. The new installations bring the total to 26 sugar factories in the country. Another factory is under construction at Corum and five others are planned at Yozgat, Sivas, Cankiri, Hakkari-Yüsekova and Kars.

11 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, 56 - 57.
12 *Zuckerind.*, 1990, **115**, 73.



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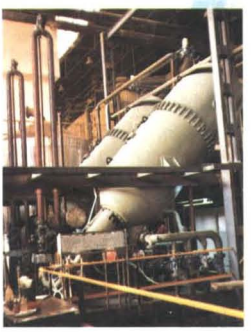

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