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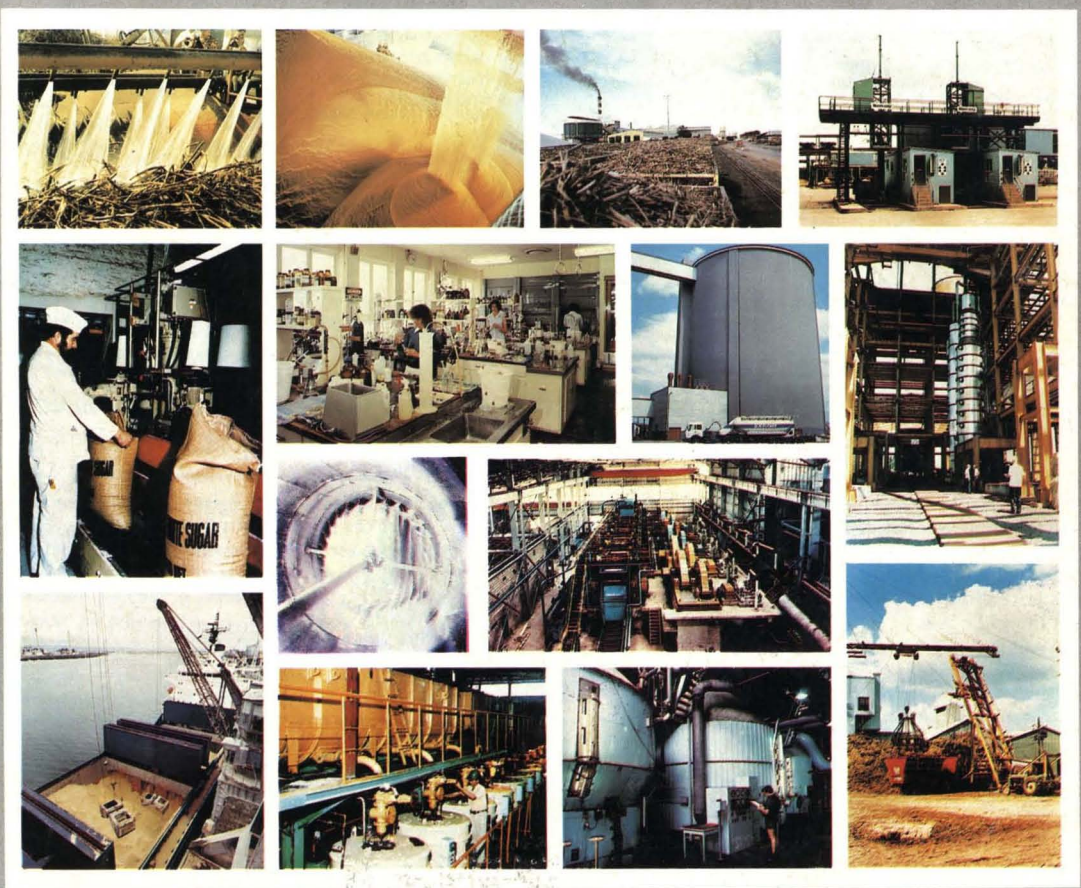

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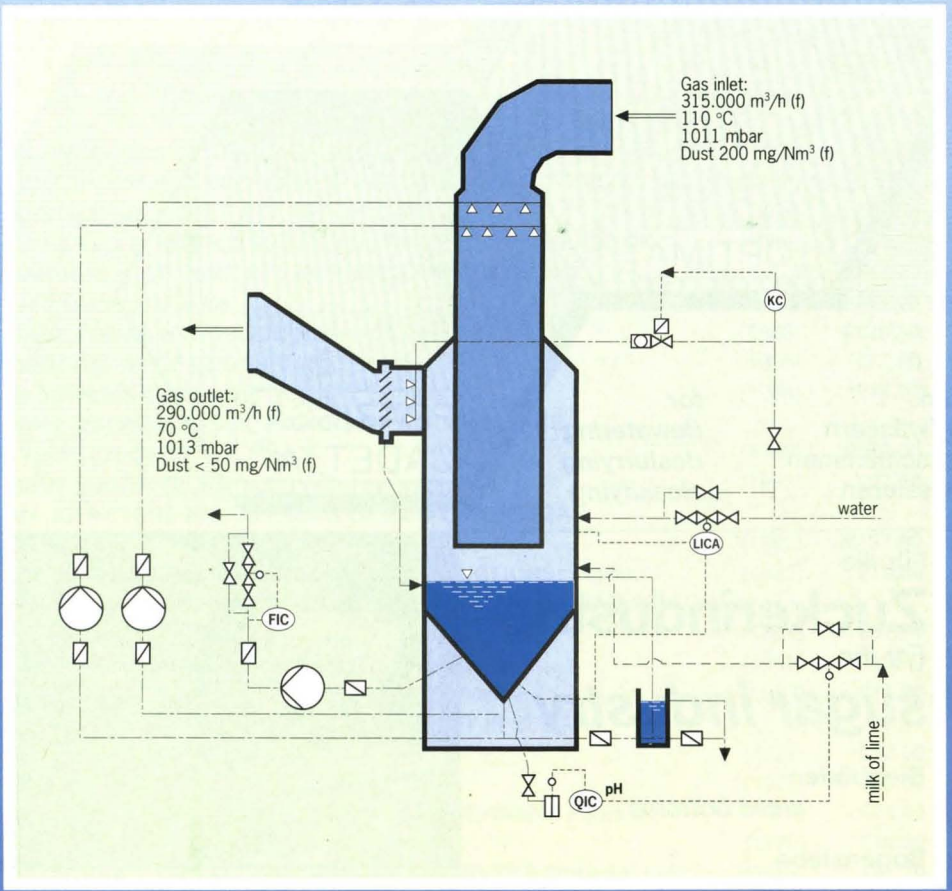

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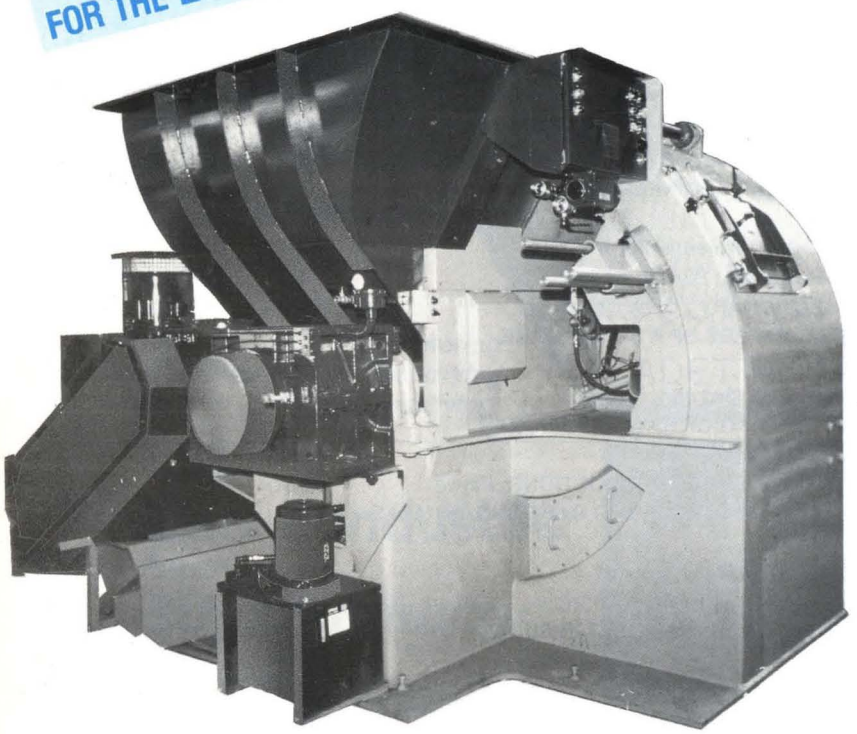

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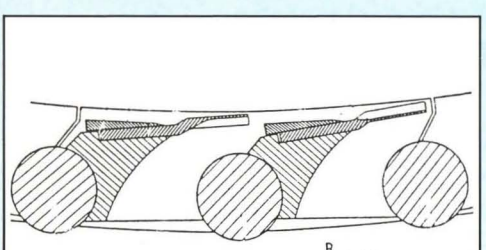

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News and views

World sugar prices

Sugar prices continued their fall in early August, the London Daily Price dropping from $279 per tonne on August 1 to $258 two days later. News of Chinese purchases arrested the fall and the market discounted reports of possible Indian exports. The market started to recover, and news of purchases by Syria and other tenders as well as further Chinese purchases helped to raise the LDP to $288.20 by August 20. Thereafter the market fluctuated but with a general downward trend, because of conflicting views on the likely effects of the Gulf crisis on sugar demand (oil producers such as the USSR gaining higher prices could afford to buy more; oil consumers could not), improved European beet sugar prospects with a broken drought, etc. The month ended with an LDP of $267 per tonne, almost the same as the start.

White sugar values followed those for raw sugar to a certain extent, the differential between the LDP(W) and LDP widening from $89.50 on August 1 to between $95 and $100 for the first half of the month but then shrinking steadily during the second half to only $61 by August 31, when the LDP(W) has fallen to $337 per tonne.

World sugar balance, 1989/90

F. O. Licht GmbH recently published their fourth estimates of the world sugar balance for the year to the end of August 1990, the totals being given below[1]. Opening stocks are set 660,000 tonnes lower and both production and consumption higher by smaller amounts, by comparison with the 3rd estimate[2]. As a consequence, final stocks are estimated at just over 29 million tonnes, a small reduction, and represent 26.85% of consumption instead of 27.05%. The interest lies in the changes in production (up by 4,446,000 tonnes from 1988/89) and consumption (down by 115,000 tonnes), the first time for several years that stocks have not been reduced. Of course, world sugar prices have been higher and many countries are price-sensitive, with the consequence that the world market price for sugar is being automatically regulated. Prospects are good for production in 1990/91 and increased availability of supplies could bring sugar prices lower, when sugar purchases are likely to increase, bringing about a balanced situation.

	1989/90	1988/89
	tonnes raw value	
Initial stocks	28,470,000	32,610,000
Production	109,072,000	104,626,000
Imports	28,147,000	29,341,000
	165,689,000	166,577,000
Consumption	108,018,000	108,133,000
Exports	28,663,000	29,974,000
Final stocks	29,008,000	28,470,000
" "		
% consumption	26.85	26.33

US tariff rate quota scheme[3]

The Bush administration is preparing to abandon the controversial US sugar quota scheme found to be inconsistent with the General Agreement on Tariffs and Trade (GATT) but will retain protection for its sugar producers through the imposition of high tariffs. Under the new program, called a tariff rate quota, some imports will be allowed into the country with very low duties imposed. Higher tariff levels will go into effect when imports reach a specified point designed to maintain high domestic sugar price.

The Administration expects to have the new program in place by October 1, when new quota levels normally go into effect. It is believed by some that 1,250,000 tonnes will be allowed into the country under the low duty although other analysts expect a total of 1.7 - 2 million tonnes[4]. By law, the Administration is required to support domestic sugar prices at 18 cents/lb; it keeps them at 22 cents to avoid loan defaults.

Although US sugar growers will be kept happy by continued protection, the new system is bound to disappoint the low-cost sugar producers, including Australia which brought the successful GATT complaint in 1987. The tariff rate quota is judged to be acceptable under the GATT but is unlikely to mean any increase in imports.

Administration officials, who privately admit to a distaste for the program, are still unwilling to cast off unilaterally any protection which could be used as a bargaining chip in the Uruguay Round of international trade talks. The tariff rate quota is consistent with the US "tariffication" proposal in the Uruguay Round. This would require a shift from quota to tariffs which could then be negotiated to increasingly lower levels and ultimately phased out of existence.

British Sugar plc ownership

In July Tate & Lyle announced that they had withdrawn a contemplated offer for Berisfords, the owners of British sugar plc, because of the risks involved in respect of the other parts of the Berisford group. Subsequently, Berisfords disclosed that they were willing to sell British Sugar without the non-sugar assets of the Group, whereupon Tate & Lyle's interest was rekindled. They announced on September 7 that they were again participating in the sale process and hoped that the Monopolies and Mergers Commission could examine their bid quickly to judge if it is acceptable; approval by the Commission and by Tate & Lyle shareholders would be required for such an acquisition.

The bid will be in competition with one from Associated British Foods, who own 22.9% of Berisfords, as well as others from continental companies, including Südzucker, Générale Sucrière and Ferruzzi.

According to *The Independent* newspaper[5], "even though the Common Agricultural Policy has been amended to iron out some of its worst anomalies, the economics of cane sugar refining are not as good as those of beet processing. Tate's operation are constantly at threat from predatory pricing by British Sugar,

1 *Int. Sugar Rpt.*, 1990, **122**, 403.
2 *I.S.J.*, 1990, **92**, 130.
3 *Financial Times*, August 16, 1990.
4 *Public Ledger's Commodities Week*, September 8, 1990.
5 September 8, 1990.

which is made all the more likely by the availability of cheap beet sugar grown on the continent. In the last couple of years, British Sugar has not indulged in predatory pricing because Berisford has needed the cash produced by the jewel in its crown. But that was not always the case. Owned by a financially strong parent such as Associated British Foods, British Sugar could well be prepared to see its profits slip for a couple of years in order to weaken Tate permanently.

"Tate's biggest fear is that British Sugar could be sold on the cheap. Therefore it has to do what it can to push the ultimate selling price toward the top of the £700 - £1000 million range mentioned in the city. The problem is money; Tate's market capitalization is a shade over £1000 million, it has gearing of more than 100% and its shareholders would be unlikely to desire either significantly higher borrowings or a rights issue. It is forced into a position of having to make a bid it can hardly afford because it cannot afford not to do it."

Presidential backing for Brazil's alcohol program[6]

Brazil's President Collor gave strong backing to his country's alcohol fuel program (Proalcool) in a speech to an international conference on energy from sugar cane, which took place in August at Maceio in the heart of the North-Northeast sugar producing area of Brazil. The program is not exhausted but has entered a period of growth, he said. In recent years the program has been criticised for high cost and frequent supply shortages. The car assembly companies had almost ceased to produce alcohol-fuelled vehicles but, owing to increase demand as a result of the Gulf crisis, General Motors and Volkswagen have both increased output. President Collor said that expansion of the program should come about by increased yields rather than planting more land to cane, and it was important not to put pressure on food supplies.

The possibility of large-scale generation of electricity by the use of gas turbine technology[7] was also discussed at the conference. The President of Copersucar, the big sugar and alcohol cooperative, said that this could come within five years and would give a much higher contribution than the 6% of installed electricity capacity possible with existing steam turbine technology.

The Gulf crisis and the sugar market[8]

So far the Gulf crisis has had little tangible impact on the sugar market. In order to aid a balanced assessment, the basic facts concerning sugar are set out below. In 1988 there was a sharp increase in imports by Jordan which coincided with a decline in exports to Iraq. It is virtually certain that the additional quantities reported by exporters as destined for Jordan were in fact transshipped to Iraq. If such trans-shipments of 200,000 tonnes are included, the average imports by Iraq over the past three years amount to some 637,000 tonnes. The corresponding average for Kuwait is 64,000 tonnes, all raw value. The two together make up about 3% of the world market so that a sharp reduction in their imports would therefore have little impact and more serious would be any disruption of surrounding states (Iran, Jordan, Saudi Arabia, Syria, etc.) which currently account for about 6% of the world market.

The most immediate effect is likely to be to shipping, both in terms of the reluctance of vessels to enter the area, and the possible effect on freight rates. The most lasting effect on the sugar market may be medium term; bodies such as the World Bank are already expecting the rise in oil prices to trigger or reinforce falls in GDP growth, or even bring recession in developed countries which could have serious consequential effects for the developing countries which are the main market for sugar.

Czechoslovakia sugar situation[9]

Czechoslovakia, embarking on an ambitious restructuring of its sugar industry, expects a sharp drop in its sugar beet crop this year because of the dry summer weather. At the same time, the country is scouting around for alternative sources to replace the traditional sugar supplies cancelled this year by Cuba. Only 40,000 of the 150,000 tonnes agreed this year has been supplied and Cuba wishes to benefit from higher prices and sell its sugar on the open market. Domestic output could drop to around 590,000 tonnes this year from about 680,000 tonnes in 1989 so Czechoslovakia is hoping to buy sugar from the Soviet Union, Brazil and possibly the Dominican Republic to fill its needs. These include sugar for export; Prague has some good markets, e.g. Swiss chocolate manufacturers, and the Czechs are doing all they can to keep them.

In the long term, Czechoslovakia hopes to guarantee its domestic and export needs by improving beet yields and modernizing its industry. About 80% of the country's output is from the Czech Republic, the bigger of the two states; its beet area has fallen to around 121,000 ha from 127,000 in 1989 and beet yield will be at most 35 tonnes/ha after 35.5 tonnes/ha in 1989. Sugar content is also expected to be lower, at 13.5% against 14.95% so that sugar output is estimated at 450,000 tonnes against 518,800 tonnes in 1989.

The beet area in Slovakia is about 55,000 ha and beet yields and sugar content tend to be lower, so that white sugar output is estimated at about 140,000 tonnes, down from 160,000 tonnes last year. Before World War II, Czechoslovakia was one of the world's leading sugar producers but its industry has declined under four decades of Communist rule. Some sugar factories have applied to become independent companies and western firms may be able to invest in all of them. By the year 2005 the government plans to have eight factories with daily average capacity of 8000 tonnes, against an average capacity of 1300 tonnes/day for the current 54 factories.

6 *Public Ledger's Commodity Week*, September 1, 1990.
7 See *I.S.J.*, 1990, **92**, 49 - 54, 62 - 66.
8 *ISO MECAS Review*, September 11, 1990.
9 *Public Ledger's Commodity Week*, August 18, 1990.

Total energy integration at Ipswich factory

By K. L. Carter and P. D. Thompson
(British Sugar plc)

Introduction

The installation of a six-effect falling film evaporator station, a coal-fired boiler and turbo-alternator, together with the associated heaters and condensing circuits, was part of a major capital investment program at British Sugar's Ipswich factory that will have amounted to over £40m.

These installations include the continuation of company policies relating to the type of fuel to be used and the progression of the Central Control Room concept in order to further reduce operating costs.

Background

The five-effect evaporator station at Ipswich comprised eleven Roberts bodies connected in series juice flow. Some of the bodies were at the end of their useful life, as was the condensate system. This configuration had prevented any substantial energy saving schemes being implemented at Ipswich.

Steam and power were produced from a combination of four oil-fired boilers and two 3.5 MW turbo-alternators. Three of the boilers operated at 18 bar, the fourth at 32 bar. The low power output per kilogram of steam required a large 2MW import of power from the public supply. This factor, combined with high oil prices and boiler age, suggested that replacement of the boiler plant was a priority.

Investment plan

To meet the company objectives of moving towards coal firing and reducing operating costs of electricity import the decision was taken to install new 72-bar coal-fired boiler plant with a new turbo-alternator, to be commissioned for the 1989 campaign.

This raised the question of forecast process steam demands and their interaction with the boiler project. Substantial cost savings are possible if a boiler can be assembled in a workshop, rather than on-site. The breakpoint between the two methods of construction is at about 60 tonnes/hr steam flow. At the design slice rate of 6000 tonnes/day and 1987 steam demands the long-term steam flow would be some 80 tonnes/hr, well above this breakpoint.

An additional factor is the dependence of boiler costs on steam flow; two suppliers quoted prices of £3.6m and £3.7m, respectively for 60 tonnes/hr boilers and £4.0m and £4.3m for 80 tonnes/hr boilers. These costs suggested that capital investment in energy saving could save substantial amounts in boiler costs, in addition to the annual fuel saving.

To allow operation at lower energy usage and solve the problem of evaporator age, a new evaporator station was to be designed alongside the energy saving project.

Energy saving philosophy

A comprehensive analysis of energy demands at Ipswich was carried out using Process Integration methods. This technique identifies the minimum process energy demand for a given value of ΔT, where ΔT is the minimum approach temperature in any heat exchanger. It is possible to determine the optimum value of ΔT for a given fuel cost and equipment cost. In view of the interaction with boiler costs a low value was used, viz. 5°C. It is not appropriate in this paper to detail the analysis, step by step, but the principal conclusions are summarized below:–

(1) Heating of cold streams to 55°C should be done using waste heat recovery.

(2) Hot streams should be cooled to 60°C by heat exchange, without using cooling water.

(3) Heat exchange should not occur between hot streams above 60°C and cold streams below 55°C.

These are the three "golden rules" of heat exchanger network design, applied to the beet sugar process. Practical implications of these rules are:–

(a) A prescalder should be used to heat cossettes and create a cold raw juice stream which can absorb heat from pan vapour, etc. (Rule 1).

(b) Pan vapour from white pans, assumed to be at 200 mbar, is used to heat raw juice to 55°C (Rule 1).

(c) Condensate from the evaporators should be cooled to 60°C by heat exchange with raw juice (Rule 2).

(d) No vapour from the last effect should be passed to a condenser (Rule 2).

(e) Heat recovery from carbonatation tank gas should be used, rather than losing heat to the atmosphere (Rule 2).

The above considerations led to the heat exchanger systems shown in Figures 1, 2 and 3. Some small compromises were made to keep the system simple, principally the decision to recover only a part of the carbonatation gas heat.

All of this analysis was done before considering the evaporator plant. The thermal duty of the evaporator station is simply to distribute energy from exhaust steam to the various energy users. The second duty of the evaporators – concentration of the thin juice – is considered later.

Heat exchanger selection

One of the difficult areas in a project of this nature is to select the best type of heat exchanger, a decision made difficult by the fact that no single manufacturer offers the full range of types. British Sugar specify heat exchangers by defining the duty in terms of flow, pressure drop, temperature profile, etc. Sizing of the unit is the supplier's responsibility but we do impose maximum acceptable values of the overall heat transfer coefficient (OHTC).

A summary of the heat exchanger types chosen and the reasoning is given below:–

Thin juice: Plate heat exchangers (Alfa-Laval).

The liquid is free of suspended solids and of low viscosity so that, for this duty, a conventional plate heat exchanger is economical and occupies little space.

Clarified juice: Plate heat exchangers (GEA).

The high turbulence of the plate

Paper presented to British Sugar Technical Conference, 1990.

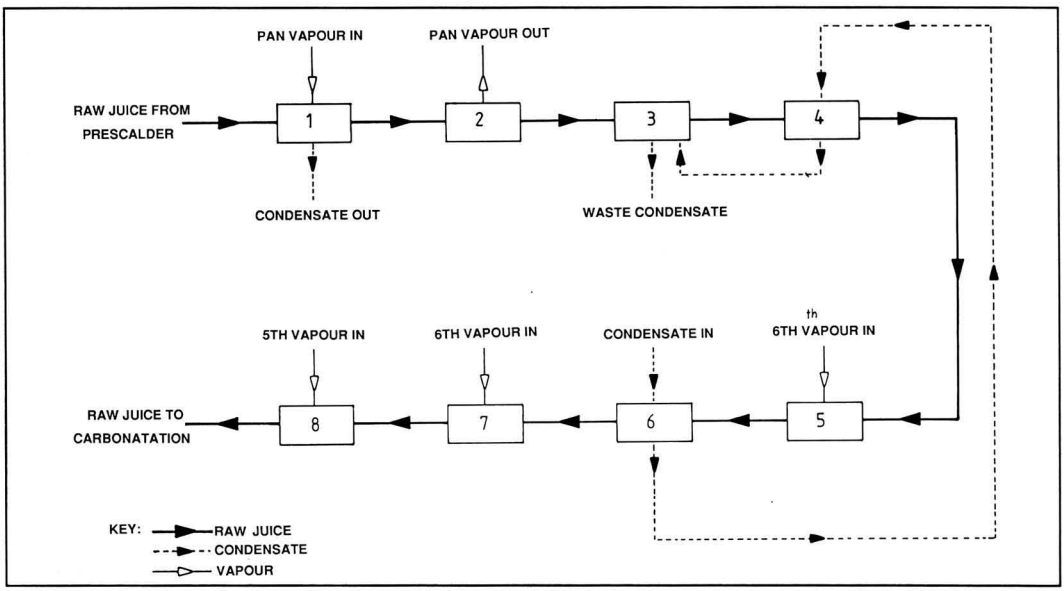


Figure 1. Raw juice heating

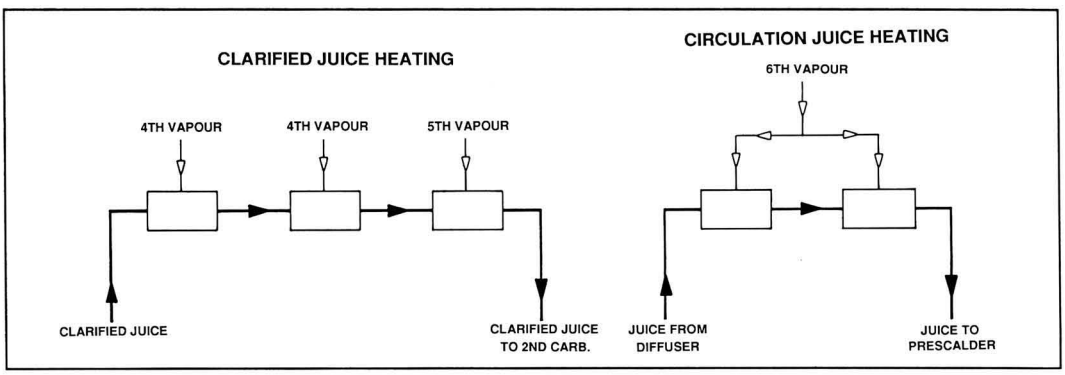


Figure 2. Clarified juice and circulation juice heating

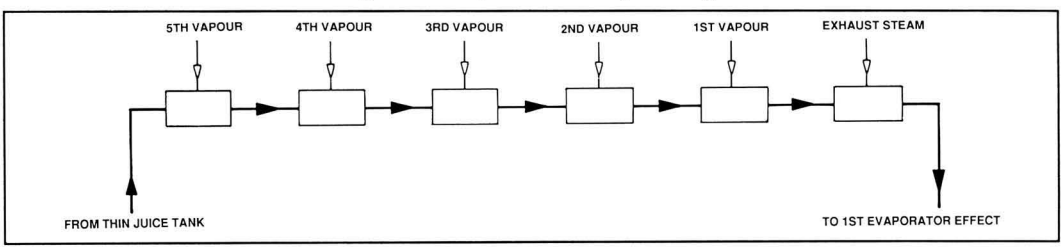


Figure 3. Thin juice heating

minimizes calcium scale formation. GEA units were used as Ipswich already had two of the three required. As the suspended solids level is low, a conventional plate design is used.

Raw juice/Vapour heater: Wide-gap freeflow plate heat exchangers (GEA).

This design is capable of handling the suspended solids found in raw juice providing velocity is kept above 0.5m/sec. Some of the equipment required was already in use at Ipswich.

Raw juice/Condensate heat exchangers: Platular heat exchangers (Barriquand).

The thermal design called for a large heat transfer capacity which implies a large heat exchange surface. To provide this surface in a freeflow or similar design requires a large number of plates, the size of each plate being fixed. If the juice flow passed over all the plates in a single pass the velocity would be low, causing fouling and blockage. Increasing the number of passes to improve velocity gives a high pressure drop as the juice turns through 180° in the tight confines of the plate pack. This made it impossible to achieve a good velocity and reasonable pressure drop without using two parallel streams. Barriquand heat exchangers have more design flexibility and can be custom-built for any duty. They have no plate gaskets and are easy to open for cleaning.

Raw juice/Pan vapour heaters: Platular heat exchangers (Barriquand).

The large volumetric flow of white pan vapour passing through the heater restricts choice to either platular or shell-and-tube. British Sugar have had poor experience with spiral heat exchangers owing to high pressure drop and fouling of solids on the pins. Shell-and-tube heaters are used successfully at Bury and Newark factories, but their disadvantage is physical size and slightly higher cost. Barriquand units had the additional advantage of removable baffles to adjust for different slice rates.

Carbonatation gas heat recovery: Spray condenser.

The gas leaving the tanks at 85 - 90°C is saturated with water vapour. By cooling the gas and condensing some of the water vapour it is possible to recover over 1MW of heat. To avoid any pressure drop problems a simple spray condenser was selected. This creates a fine spray of pulp press water using centrifugal action nozzles which do not have small orifices which could block with pulp or sand.

Evaporator design

The energy saving of the heating systems can reduce steam consumption to below 22% on beet. This requires a maximum use of low grade vapours to achieve 69% DS thick juice without vapour to condense.

The constraints on evaporator design were:–

6th vapour at 90°C minimum
Exhaust steam pressure 3.1 bar abs (maximum)
Thin juice of 16.5% DS
Thick juice of 69.5% DS

It is clear from the first two constraints that a temperature difference of less than 6°C is available across each effect. This forces the selection of falling film evaporators, as conventional Robert evaporators do not work well at low temperature differences because of the static head effect of juice in the tubes.

Additional advantages of the falling film evaporator are higher heat transfer coefficients, shorter juice residence time and ease of installation. The new evaporators were installed between two buildings on a simple concrete foundation block. A comparison between the areas and cost of Ipswich and Peterborough evaporators is given below:–

Effect	Ipswich (Falling film)	Peterborough (Robert)
1	2000 m²	3000 m²
2	2300 m²	3600 m²
3	2750 m²	3600 m²
4	2300 m²	2000 m²
5	2300 m²	2000 m²
6	1500 m²	805 m²
Cost, £m (1988 prices)	1.25	1.47

This comparison is based on the cost of vessels, tubes and condensate system but excluding the cost of installation and instrumentation.

As British Sugar had little experience with falling film evaporators it was decided to limit tube length to 6 m and to use juice recirculation on all bodies, together with control systems to prevent the tubes becoming dry. Specification of the evaporators and process guarantee was based on the heat transfer capacity of each body, rather than on evaporation. It is not realistic to expect a certain thick juice Brix if the vapour demands are not correctly configured.

Some details of the evaporator system which are common to recent British sugar designs include:

(a) Exhaust condensate totally returned to boilers without flashing down.

(b) Thin juice heaters on 5th – 1st vapour and exhaust steam with 3°C approach.

(c) Vapour to thin juice heaters supplied from the steam chest of the next evaporator (e.g. 3rd vapour from 4th effect) to purge incondensable gases.

(d) Incondensable gas venting on 1st – 3rd vapour direct to atmosphere.

(e) Condensate not flashed to 6th vapour; heat recovered by heat exchange.

(f) 6th vapour heater condensate returned to 5th vapour condensate vessel by barometric leg.

A design balance is given in Figure 4.

Process control philosophy

The control systems used at Ipswich are supplied by Turnbull Control Systems of Worthing, England. The system is based on the use of plant-mounted electronic instrumentation communicating to Maxivis computers (DEC VAX) in the central controlroom. The plant-mounted instrumentation includes programmable advanced controllers to perform analogue control, programming signal processors for digital signals and integrating instruments for flow totalization, etc.

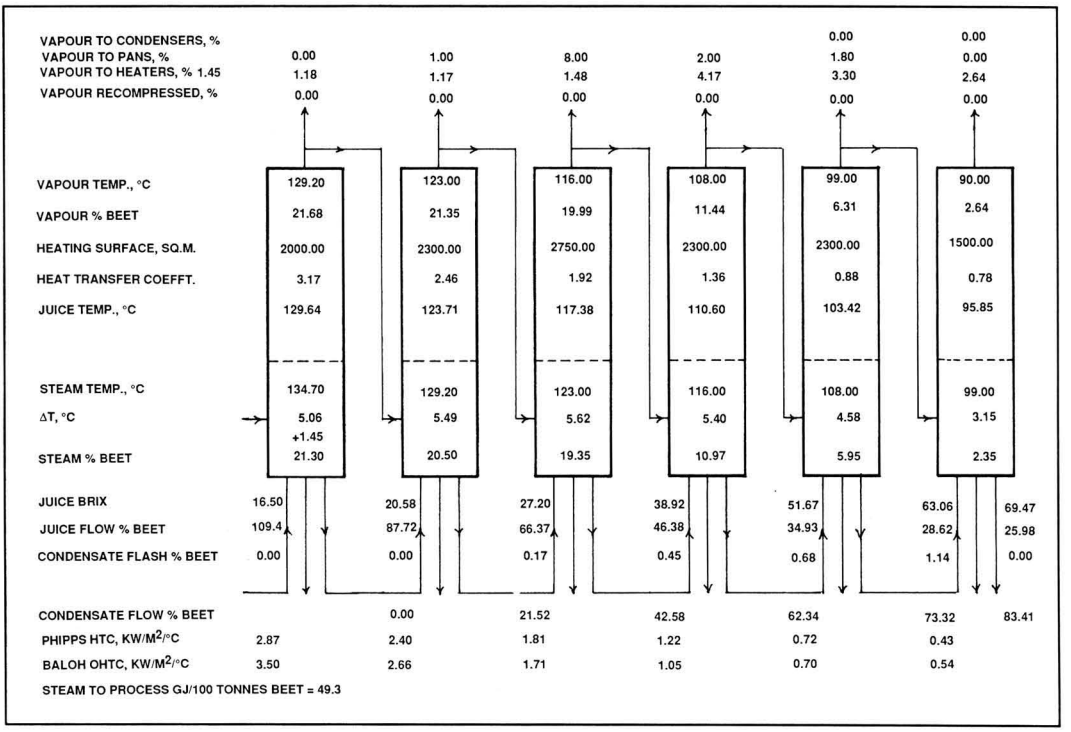


Figure 4a. Evaporator heat balance calculation and heater requirements, 1989/90

The instrumentation is mounted in cubicles and each area is connected to the central computer through a communications buffer. Three Maxivis (VAX) computers are housed in the central control room and a data highway (DECNET) allows for communication between the three units (Figure 5). Generally they are dedicated units to give an even distribution of information and control points, the split being beet end, sugar end and power plant. With the installation of the third computer dedicated to the power plant it was intended that the boiler operator would work from the central control room and therefore become a more integrated member of the shift team.

In practice, the operational problems associated with the boiler plant (described below) made achievement of this aim extremely difficult and only the satisfactory resolution of the boiler problems will allow the overall control of the plant from the central control room. Despite not being able to integrate all the people as planned, the ability to oversee the boiler operation together with all the process control was invaluable and reinforced our belief in the benefits to be gained by Central Control Room operation. By utilizing the central computers it is possible to control nearly all the areas of the process from one room, thereby gaining a high degree of flexibility and good communications with all operators. The high degree of communication is further advanced by the use of radio communication equipment for two-way speech, together with alarm transmission direct to operators.

Evaporators – process control

The control strategy for the six falling film evaporators, shown in Figure 6, is based on controlled flows between vessels in conjunction with control of thin juice to the first effect and thick juice forward to the dissolver. Circulation juice flows at the individual evaporators require monitoring to prevent caramelization and, where necessary, water is added to the vessels to remove sugar from the evaporator heating surfaces. In addition, water injection on a timed basis is required for the vapour demisters.

The flow control is based on a forward-loop system by which thick juice is controlled from the 6th effect in response to the thin juice supply tank level. The level of each evaporator is then controlled by alteration to the inlet valve. In the event of processing problems, either before or after the evapor-

JUICE FLOW, % B.S.	OUTLET TEMP., °C	INLET TEMP., °C	HEATING AREA	STEAM REQUIRED	HEATER DUTY	VAPOUR GRADE	H.T.C.
125.0	85.0	78.7	150.0	1.31	Raw juice 6th	6	1.81
125.0	90.0	85.0	80.0	1.06	Raw juice 5th	5	1.84
114.0	90.4	86.0	100.0	0.85	2nd carb. 5th	5	1.26
114.0	97.0	90.4	200.0	1.29	2nd Carb. 4th	4	0.72
109.4	95.0	87.5	100.0	1.40	Thin 5th	5	3.10
109.4	105.0	95.0	100.0	1.89	Thin 4th	4	4.33
109.4	112.7	105.0	100.0	1.48	Thin 3rd	3	3.57
109.4	118.7	112.7	100.0	1.17	Thin 2nd	2	2.60
109.4	124.7	118.7	100.0	1.18	Thin 1st	1	2.53
109.4	132.0	124.7	100.0	1.45	Thin exhaust	0	3.92
45.0	90.0	80.0	100.0	0.52	Standard liquor	4	0.37
48.0	80.0	71.0	30.0	0.47	A/B syrups	4	0.77
80.0	80.0	70.0	220.0	1.32	Mingler circn.	6	0.67

Heater vapour consumption

Exhaust	1.45
1st	1.18
2nd	1.17
3rd	1.48
4th	4.17
5th	3.30
6th	2.64

Figure 4b

ator station, the control scheme is designed to deal with the large alterations in flow conditions possible. A failure of juice flow to the evaporators will be dealt with by water being added to the thin juice tank and a reduction of juice flow from the 6th effect will effectively reduce the total flow across the evaporator station.

Part of the control sequence is designed to monitor the recirculation flow in each evaporator. The recirculation flow is measured in each evaporator circuit and if the flow drops to a low level a signal processor starts the standby circulation pump in an attempt to restore flow. If the flow is not re-established within a specified time the emergency water valve opens and remains open for 5 minutes to ensure all sugar is removed from heating surfaces.

Instrumentation

For close monitoring of the evaporator station performance a large number of instruments are fitted to the vessels and this will allow for heat balance measurements to be taken on-line.

Below is the scope of measurement of parameters:–

(1) *Temperature* [Measurement by resistance bulb with integral 4-20mA

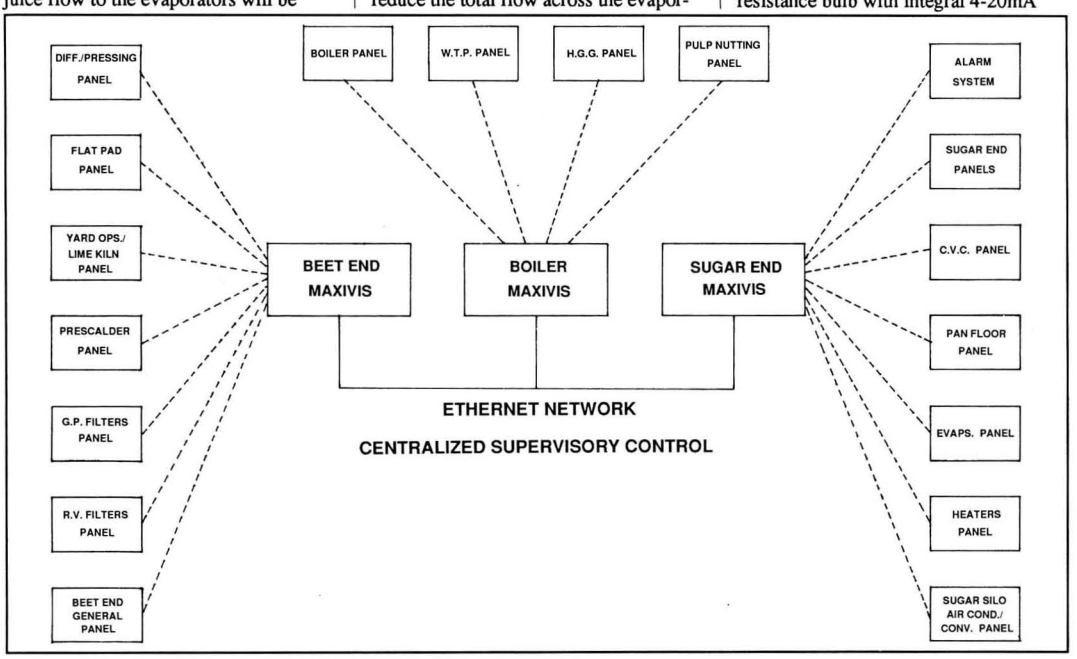


Figure 5. Central control network

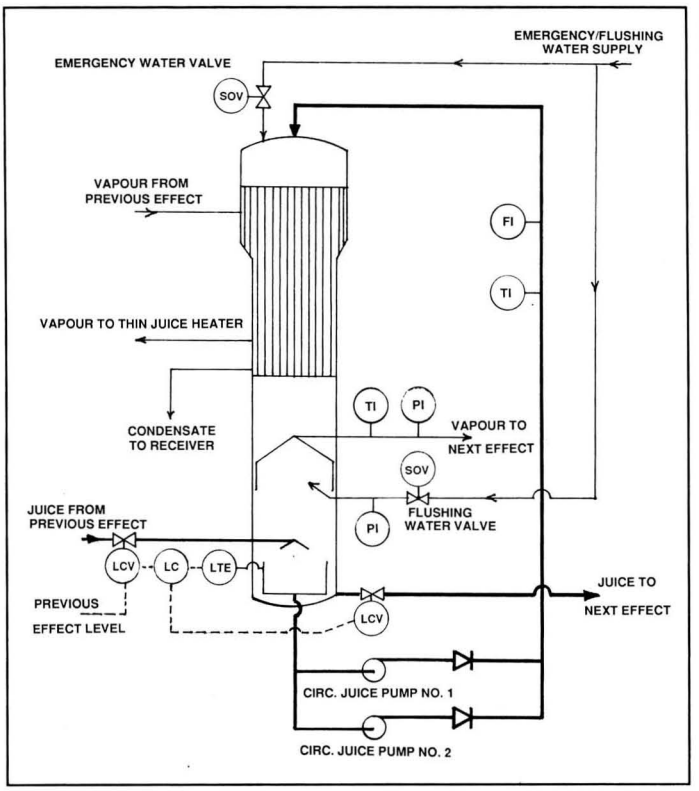


Figure 6. Evaporator control scheme

transmitter (Manufacturer : Status Instruments).]

Steam inlet.

Vapour leaving evaporator.

Juice between evaporators.

Juice in recirculation system.

Condensate.

(2) *Pressure* [Measurement by pressure sensor (Manufacturer : Foxboro).]

Steam inlet.

Vapour leaving evaporator.

(3) *Flow* [Measurement by magnetic flow meter (Manufacturer : Fischer Porter Copa X).]

Juice to 1st effect evaporator.

Juice leaving 6th effect evaporator.

(4) *Density* [Measurement by Solartron vibrating tube (Manufacturer : Schlumberger).]

Juice between evaporator bodies.

Juice leaving 6th effect evaporator.

Antiscalant addition

For the past two years the evaporator station has been run without decalcification but with the addition of antiscalant. Two types of antiscalant have been used: Nalfloc 1124 (polymaleic acid) and Nalfloc 7400 (acrylamide/acrylonitrile copolymer). The dosing rates from the 1989/90 campaign were 10 ppm of Nalfloc 1124 to the thin juice tank to treat thin juice heaters and the 1st effect evaporator and a total of 50 ppm Nalfloc 7400 to the 2nd to 6th effects.

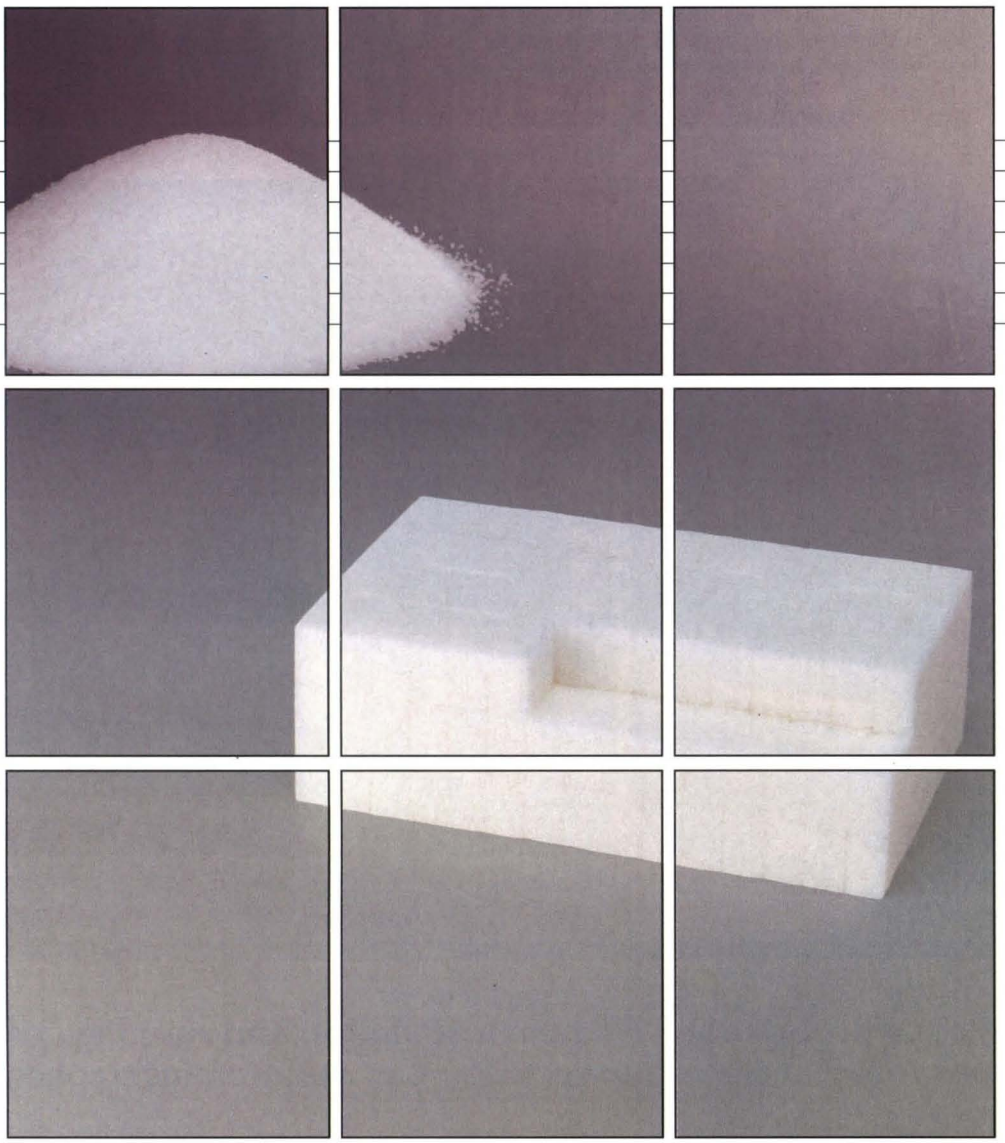
The average lime salts contents experienced in the 1989/90 campaign was 0.024 grams CaO per 100°Bx. The overall heat transfer across the evaporators was maintained throughout the campaign and on opening up the bodies only a very small amount of scale has been found in the 6th effect.

Although the bodies have been kept clear of scale by the antiscalant addition, this may be having a serious adverse effect on the evaporator bodies. On opening up the bodies a very high metal wastage of the bodies was evident which was extremely severe on the juice distributors and the tube plates. This very significant wear will require replacement or major refurbishment of the distributors in the first five bodies and investigation of the reason for the metal loss with ways to eliminate the problem.

Operational experience

For the 1988/89 campaign it was necessary to take all the steam from the old turbo-alternators. This was the first year of operation of the evaporator station and, despite lengthy commissioning, unforeseen problems occurred. Major problems were experienced with the variable speed drive of the new prescalder just after slicing started. This was followed over the next 7 days by further failures of variable speed drives on both the draft raw juice and raw juice forward pumps. The stop/start operation of the factory soon gave rise to problems of juice flow to the evaporator station. In addition to the flow problems the inability to get the prescalder to the operating temperature and produce cold raw juice made a large change in the vapour requirement to the heaters and, in particular, to the 6th vapour requirement of the circulation raw juice heaters. The large increase in 6th vapour to the heaters increased the Brix of the thick juice leaving the evaporator station. Densities up to 80°Bx were experienced during this period and the high densities resulted in poor standard liquor filtration. The low flows of juice at other times, coupled with the high densities, also gave rise

SUGAR MOULDING



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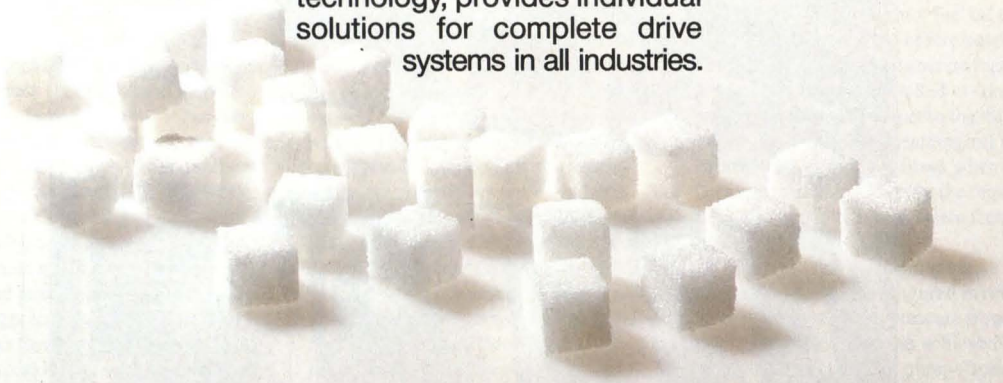

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to high colour thick juice and resultant high colour sugar that had to be remelted. The low flows to the evaporator station, coupled with a large amount of steam from the old turbo-alternators, required a lot of water both to the thin juice tank for the 1st effect and, via the emergency water system, for the other effects. It was obvious that, in order to reach some stability of operation, it was necessary to maintain a flow through the evaporators.

This could only be achieved by ensuring that thick juice was able to leave the 6th effect and there were no restrictions due to standard liquor filtration, etc. No buffering capacity was available between the 6th effect and the standard liquor filtration as this had previously been achieved by storing juice in the 5th effect of the old Robert evaporator system. As it was essential that a buffer tank be used with the falling film station, a 400-tonne capacity former molasses tank was piped to allow hot thick juice to enter and then pass for-ward to standard liquor filtration if available.

The introduction of the buffer tank was extremely successful and helped to stabilize the factory operation. Further water from the condensers was also made available to the 1st effect evaporator in order to maintain a good flow through the evaporator system. It was soon possible to sweeten-off the evaporator system quickly without a large build-up in juice colour and without the loss of sugar to remelt. The change to continuous flow across the evaporator station also did away with the need for closing the inlet valves and making up the individual levels through the emergency water system.

One problem that continued throughout the campaign was the necessity to condense all the steam from the two old turbo-alternators. Electricity from the public supply was limited by the feed cable to the factory and the remaining electrical requirement had to be generated despite the exhaust steam quantity being considerably higher than that required for the process.

In addition no desuperheating was available on the old power generation plant and exhaust steam at over 172°C had to be taken to the evaporator first effect. As the steam temperature in the first effect was only 136.4°C the amount of superheat in the exhaust steam was in excess of 36°C. Nevertheless, with the new evaporator station, the increase in colour across the evaporators was reduced to less than 20% of the thin juice colour compared with nearly 25% across the Robert evaporators during the previous campaign.

The recirculation pumps were supplied by Girdlestone Ltd. of England and were specified with standard packed glands. It was very quickly found that the juice leakage from this type of packed pump was unacceptable and, despite trying many types of gland packing, these pumps have now had to be fitted with mechanical seals to prevent the loss of sugar.

Juice density was controlled by the vapour requirement to the heaters either by changing the vapour used on a heater or by changing the quantity of heat recovered from pan vapour and condensate. The main difficulty in this area was the inconsistent performance of the prescalder for a large part of the campaign. No alternatives were available other than 6th vapour to the circulation juice heaters maintaining the prescalder and diffuser temperature. The large variations in temperature of the diffusion systems therefore gave rise to large fluctuations in final density of thick juice leaving the evaporators.

It was not appreciated, when the falling film evaporators were installed, what the effect would be of having such a small volume of juice in each evaporator. The control system was required to act quickly to maintain levels and, together with erratic running of the beet end, it took some time to set up the control systems to cope with the large variations.

The control concept of modulating the thick juice flow from the 6th effect to regulate the level of the thin juice tank was not very successful owing to the lag across the evaporator level controls. The control of the thin juice tank level was further made worse by problems with evaporator supply pump suction conditions. The outcome of these two problems was that on numerous occasions water had to be added to the thin juice tank in order to maintain flow to the 1st effect evaporator. Water addition to the evaporators was high throughout the campaign.

During the following off-season several modifications were made to improve the operation of the evaporator and heater system. These included:

(1) The lifting of the thin juice tank to increase the suction head to the evaporator supply pump.

(2) The fitting of a screen in the thin juice tank to filter out small particles of molten sulphur-carbon from the sulphitation tower that fouled the first (5th vapour) thin juice heater.

(3) All the condensate after the last heater passed into a former fuel oil tank of 1200 tonnes capacity before passing to the cooling tower. A separate pumping system was then installed to take water from this tank direct to the thin juice tank to enable sweetening-off and maintaining evaporator flows when the beet end is unable to supply the required flow rate to condense the steam from the power house.

(4) The raw juice pumping arrangement was reconfigured in order to relieve the required pressure from the raw juice pump. This was achieved by using the first raw juice pump (from the prescalder) for pumping through the pan vapour heaters and the first two heat exchangers operating on condensate. The raw juice then passed to a small raw juice tank where first carbontation slurry and second carbonatation slurry are added before being pumped to the remaining raw juice heaters and into the first carbonatation stage.

In pumping terms this was successful but the intended final temperature after the first pumping stage was not always achieved, resulting in a juice

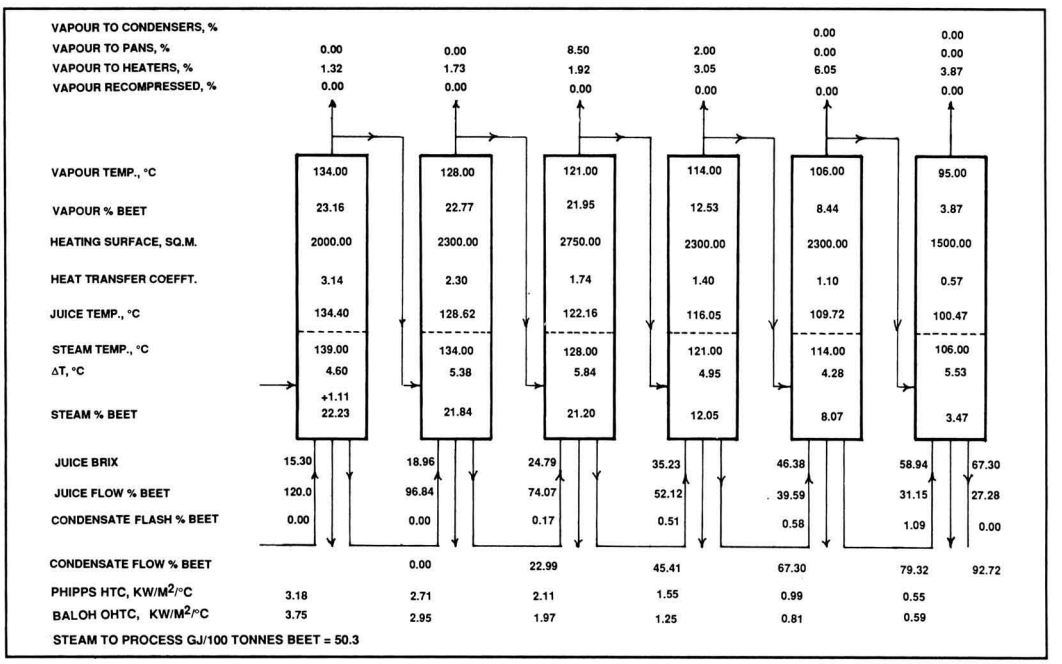

Figure 7a. Evaporator heat balance calculation and heater requirements, 1988/89

temperature of about 60°C within the depulpers and the raw juice tank. This lower than expected temperature gave rise to microbiological action with the breakdown of sugar to lactic acid. It will therefore be necessary to rearrange the raw juice circuit to increase this temperature further to alleviate the problem.

JUICE FLOW, % B.S.	OUTLET TEMP., °C	INLET TEMP., °C	HEATING AREA	APPROACH	STEAM REQUIRED	HEATER DUTY	VAPOUR GRADE	H.T.C.
135.0	70.0	61.0	117.0	25.0	2.00	Raw juice 6th	6	0.82
135.0	90.0	82.0	117.0	16.0	1.84	Raw juice 5th	5	1.09
125.0	94.0	84.0	71.0	12.0	2.14	Second carb.	5	2.50
120.0	99.0	89.0	115.6	7.0	2.07	Thin 5th	5	2.16
120.0	108.0	99.0	115.6	6.0	1.89	Thin 4th	4	2.25
120.0	117.0	108.0	115.6	4.0	1.92	Thin 3rd	3	2.90
120.0	125.0	117.0	115.6	3.0	1.73	Thin 2nd	2	3.21
120.0	131.0	125.0	115.6	3.0	1.32	Thin 1st	1	2.73
120.0	136.0	131.0	115.6	3.0	1.11	Thin exhaust	0	2.44
5.0	85.0	55.0	42.0	29.0	0.16	Wash syrup	4	0.13
30.0	85.0	65.0	75.0	29.0	0.64	Syrups	4	0.31
60.0	90.0	85.0	100.0	24.0	0.35	Std. liquor	4	0.18
160.0	77.1	70.0	254.0	18.0	1.86	Circ. juice	6	0.48

Heater vapour consumption

Exhaust	1.11
1st	1.32
2nd	1.73
3rd	1.92
4th	3.05
5th	6.05
6th	3.87

Figure 7b

(5) The prescalder de-foamer circuit was modified to allow only foam to go forward to the defoamer tank rather than the juice-foam mix that Krupp had designed for.

(6) Cossette quality was changed by using 17-division knives rather than the 19-division knives which were the norm prior to the installation of the prescalder. This change to a bolder cossette increased the drainage within the prescalder and decreased the packing. The result was a decrease in shaft power loading which kept the stirrer within its power limit. The number of electrical overloads was thereby significantly reduced, which gave for a more stable operation.

(7) The general hot water pumps pumping the final condensate from the condensate vessels through the heater were uprated as these had proven to be undersized for the duty, resulting in high condensate levels in the condensate

system and flooding of heaters.

(8) As a further precaution against condensate flooding of heaters, sight glasses were fitted to both condensate and noxious gas outlets. These allowed a quick check that condensate was clearing the heater and also that condensate was not being pulled through the noxious gas system by too great a pull-off of gas to the condensers.

(9) The main noxious gas line that originally joined the main vapour line to the condenser near a raw vacuum pan was redirected to the condensers as water was being introduced into the vacuum pan, owing to the main line having its lowest point adjacent to this pan.

(10) Control of the thin juice to the first evaporator effect was changed to try to control the level in the thin juice tank.

(11) The thin juice plate heat exchangers were uprated from 90 m² to allow for a higher juice flow by virtue of the higher draft and also to reduce the pressure drop across the system.

Evaporator performance

Following the operational problems of the 1988/89 campaign, the 1989/90 campaign, although problematic for other reasons, ran particularly well as far as the evaporator performance was concerned. The thin juice draft remained high at 120.0%, compared with the designed 109.4% on beet. Despite the higher flow rates the thick juice Brix was maintained at 67.3°C.

The overall energy requirement of the evaporators decreased to 23.34% on beet for the 1989/90 campaign, compared with 26.07% for the 1988/89 campaign. This was achieved by greater utilization of the energy-saving equipment made possible by the introduction of the new power generation plant. The energy performance at Ipswich is now approaching the design level of 22.75% exhaust steam on beet and with a further reduction in thin juice draft the design parameters should be achievable. Figure 7 shows the heat balance for the 1989/90 campaign and this should be compared with the design balance shown in Fig. 4.

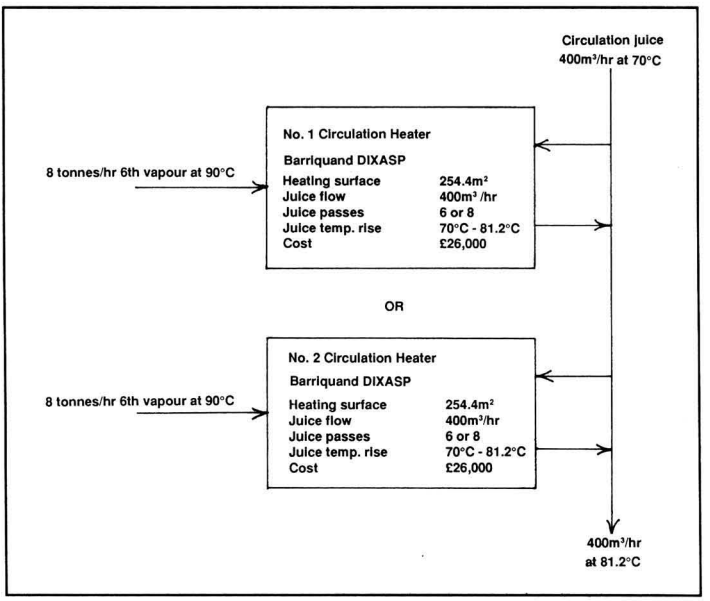

Figure 8. Circulation juice heating

The overall ΔT of the system proved to be 44°C compared with the 44.7°C design.

Below is a table showing the overall heat transfer coefficients of the individual effects for the 1989/90 campaign compared with the design figures.

	OHTC, kW/m²/°C	
Effect	Design	1989/90
1	3.17	3.14
2	2.46	2.30
3	1.92	1.74
4	1.36	1.40
5	0.88	1.10
6	0.78	0.57

Heater station

As part of the evaporator and vapour distribution system a new heater station was built utilizing some existing heaters together with new heaters for waste heat recovery. In addition, heat recovery from carbonatation gas was achieved with a spray condenser running on diffusion supply water.

Circulation of raw juice is shown in Figure 8. The new Barriquand platular heat exchangers, each of 254 m² heating surface, were installed. The design called for only one heater on line using 8 tonnes per hour of 6th vapour to heat 400 m³/hour of juice from 70°C to a maximum of 81.2°C. The cost of the heaters was £26,000 each.

Raw juice heating is shown in Figure 9. The prescalder performance was designed to achieve raw juice outlet temperature of 12° above that of cossettes. The 300 m³/hour of raw juice then passed to two heaters supplied with vapour from the first product vacuum pans only. Each Barriquand platular heater has 254 m² heating surface and the design is based on the heaters running in series to raise the raw juice temperature from 20°C to 56°C using 25 tonnes/hour of vapour at 200 mbar absolute and 60°C. Each heater cost £26,000.

The raw juice is then passed to two further Barriquand platular heaters, each of 224.4 m² heating surface, operating in series to raise the raw juice temperature

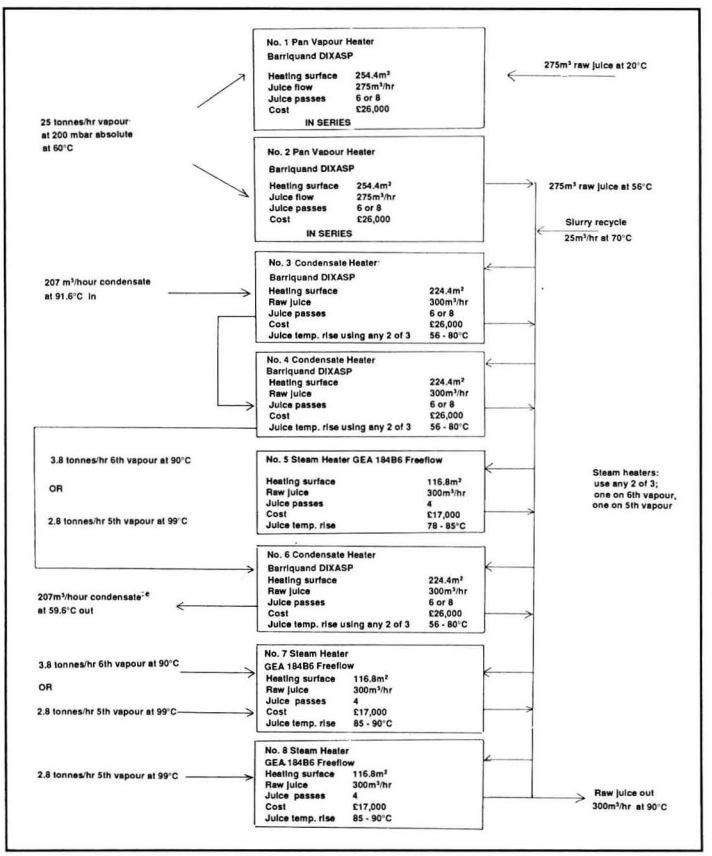

Figure 9. Raw juice heating

from 56°C to 80°C. The design called for 207 m³/hour of condensate at 91.6°C.

Raw juice then passes to a GEA Freeflow heater of 116.8m² heating surface which can be run on either 5th or 6th vapour. The design is for raw juice to be heated from 78°C to 85°C and this will require 2.8 tonnes/hour of 5th vapour at 99°C or 3.8 tonnes/hour of 6th vapour at 90°C.

As the original design for the evaporators was not to flash condensate to 6th vapour the heat is recovered in the next raw juice heater. Again, a Barriquand platular heater of 224.4 m² heating surface is used and this heats the raw juice to a maximum of 80°C. It is used in conjunction with the other condensate heaters to alter the vapour requirement to the heaters for evaporator density control.

The overall performance of the condensate heaters on raw juice is to heat the juice from 56°C to 80°C and the effect is to lower the temperature of 207 m³/hour of condensate from 91.6°C to 59.6°C.

The last two raw juice heaters are both GEA Freeflow units, with a heating surface of 116.8m² each, supplied with either 5th or 6th vapour. The raw juice is heated by either or both heaters from 85°C to a maximum of 90°C. Again, the ability to change vapours on this duty is used to control thick juice density and 3.8 tonnes/hour of 6th vapour at 90°C is required or 2.8 tonnes/hour of 5th vapour at 99°C. The GEA Freeflow heaters cost £17,000 each.

Carbonatation juice heating

Clarified first carbonatation juice is heated (Figure 10) with either 4th or 5th vapour using GEA conventional plate heaters. Three heaters are available, each of 69.6m² heating surface. The design called for the use of two heaters out of three with a juice inlet temperature of 84°C and an outlet temperature of 98°C before passing to second carbonatation. 5th vapour was to raise the juice from 84°C to 90°C and 4th vapour to achieve the final temperature of 98°C. The vapour requirement was 3.2 tonnes/hour of 4th vapour and 2.1 tonnes/hour of 5th. The heaters cost £6500 each.

Thin juice heating

Thin juice is pumped at 300 m³/hour through six Alfa Laval plate heat exchangers in series (Figure 11), each of 90m² heating surface. The temperature rise across the heaters brings the thin juice from 87.5°C to 132°C before entering the 1st effect evaporator. All vapours except 6th vapour are used as well as exhaust steam. The vapour temperatures ranged from 5th vapour at 99°C to exhaust steam at 134.7°C. Total cost of the heaters was £29,500.

Heater operation

The problems of waterlogging of raw juice and circulation juice heaters were overcome by the uprating of the condensate pumps and the flow of condensate was good when viewed through the newly fitted sight glasses. In addition, good control of noxious gas venting was made possible by the fitting of sight glasses on the line to the condensers. The much improved prescalder operation ensured the designed operation of the 6th vapour Barriquand

ISJ Abstracts

Cane sugar manufacture

Evaluation of syrup clarification on a laboratory and industrial scale in the manufacture of direct-consumption white sugar

A. Egido M., I. Machado L. and C. Pérez B. *Centro Azúcar*, 1988, **15**, (4),11 - 18 *(Spanish)*.

The costs of syrup treatment with trisodium phosphate, detergent, phosphoric acid, anionic flocculant, quaternary amine and hydrogen peroxide in tests at three Cuban sugar factories producing direct-consumption white sugar were considered unjustified in view of the poor results achieved in terms of removal of colour, insoluble solids, ash and reducing sugars and the resultant purity rise.

Alkalizing model juices with different agents

O. Vega R., A. M. Rodríguez P. and R. Santana M. *Centro Azúcar*, 1988, **15**, (4), 19 - 25 *(Spanish)*.

The effects of treatment of model juices with Na carbonate, bicarbonate and hydroxide and with Ca hydroxide were examined. It was found that the lower the pH of the agent, the higher were the settling and filtration rates and mud volume, so that Na carbonate and bicarbonate gave better results than the other two agents. The presence of magnesium tended to accentuate the differences in the effects of the agents.

Method of designing equipment for primary coagulation of non-sugars

N. Martínez, M. Martínez, I. R. Chacón, B. Cabrera, P. Fabregat, A. P. Nikolaev, L. D. Bobrovnik and P. Nemirovich. *Centro Azúcar*, 1988, **15**, (4), 26 - 29 *(Spanish)*.

A technique is described for calculating the design parameters of vapour-juice mixers in which primary coagulation of non-sugars takes place.

Brix transducer

F. Pantuso N. *Centro Azúcar*, 1988, **15**, (4), 31 - 36 *(Spanish)*.

The main features of a Brix/conductivity transducer for determination of masse-cuite supersaturation are described and tuning and installation aspects discussed.

Results obtained in the separation of suspensions in a centrifugal field using a "Ciclo Per"

P. Pérez E., P. M. Fabregat P. and A. P. Nikolaev. *Centro Azúcar*, 1988, **15**, (4), 37 - 41 *(Spanish)*.

The "Ciclo Per" for removal of suspended solids from mixed juice is described and its performance at a Cuban sugar factory discussed. Similar in principle to a hydrocyclone but having a number of advantages over it, the "Ciclo Per" gave an average 28.6% separation at a feed pressure of 64.74 kPa, a juice flow rate of 5.87 m/sec and a residence time of 0.029 sec.

Study of the effect of different liming agents on settling

T. Prieto F. *Centro Azúcar*, 1988, **15**, (4), 42 - 46 *(Spanish)*.

Calcium saccharate prepared from mixed, clear and filtered juice, respectively, was compared with Ca hydroxide in laboratory settling tests which showed that the mud height and settling rate were greater with the hydroxide, while there was relatively little difference between the results obtained with the saccharates.

Burning of bagasse in boilers: elimination of particulate matter

J. C. Fabiano. *STAB*, 1988, **6**, (6), 15 - 18 *(Portuguese)*.

An account is given of the success of Usina Ester in the elimination of smuts from its chimney gases when a new automatic boiler was installed. Wet gas cleaners were installed, later modified to meet the CETESB control standards.

Industrial processing of untopped cane: experience at Usina Ester

F. Zarpelon. *STAB*, 1988, **6**, (6), 37 - 38, 40, 42 *(Portuguese)*.

Studies carried out in the 1987 season showed that, by comparison with topped cane, untopped cane gave an increase in weight of 19%, 9% more Brix, 6% more pol, 8% more recoverable sugar and 38% more fibre. More mineral impurities entered the factory, resulting in an increase in lost time due to carrier stops. The effect on sugar quality and fermentation was irrelevant. The surplus of bagasse was of the order of 50% but the calorific value was reduced below that from topped cane so that the surplus was nullified.

Comparison between the sulphitation and carbonatation processes in regard to removal of phosphates and the clear juice sedimentation characteristics

I. V. Aoki and F. A. Tavares. *STAB*, 1988, **6**, (6), 43 - 49 *(Portuguese)*.

In laboratory experiments, mixed juice limed with 1% CaO on solids was clarified by double carbonatation and sulphitation and the removal of phosphate and sedimentation characteristics of the precipitate were compared. Carbonatation removed the phosphate more efficiently but the sulphited juice showed faster settling and smaller mud volume. However, the latter differences were not so different from those of carbonatation that the carbonatated juices could not be clarified by sedimentation.

Usina Cresciumal S.A.

Anon. *STAB*, 1988, **7**, (1), 4 - 6, 8, 10 - 11 *(Portuguese)*.

The title company operates a 6500 t.c.d. sugar factory/distillery at Leme, São Paulo, and an account is given of its history since its foundation in 1964, personnel, edaphoclimatic conditions and the cane area, 7475 ha of which is estate cane providing 650,000 tonnes of cane and 2252 ha that of growers who supply 155,000 tonnes of cane. Planting

and cultivation practices are described with details of varieties, soil preparation, fertilization, etc., and also cane cutting, loading and transport. Industrial equipment is described including that for weighing, unloading, preparation and milling of cane, clarification of the juice for sugar and alcohol manufacture, evaporation, boiling, fermentation, distillation, etc. Data are given from part of the 1988 season.

Process of recovering shafts by metallization

M. A. C. de Toledo. *STAB*, 1988, **7**, (1), 43 - 44 *(Portuguese)*.

An account is given of the practices adopted at Usina Barra Grande whereby the worn surfaces of mill roller shafts are built up by metallization.

Recladding of mill rollers in sugar and alcohol plants

Anon. *STAB*, 1988, **7**, (1), 45 - 48 *(Portuguese)*.

Information is provided by Lancer Soldas Ltda. on their electrodes and techniques for building up the crushing surfaces of cane mill rollers by welding metal onto the groove surfaces.

Limestone thermostability and the kinetics of deterioration of quick and slaked lime

R. Rodríguez M. and E. R. León L. *ATAC*, 1988, **47**, (6), 2 - 8 *(Spanish)*.

Parameters of major importance in the calcination of limestone were studied with the aim of establishing conditions for production of lime of required quantity and quality for clarification and for prevention of its hydration during transport and storage.

Study of various parameters that affect the sucrose crystal habit

J. V. Hormaza M. and G. E. Lines C. *ATAC*, 1988, **47**, (6), 34 - 38 *(Spanish)*.

Samples of normal factory *B*-massecuite were heated at 70°C and the crystals separated by centrifuge followed by analysis of both sugar crystals and molasses, including determination of the oligosaccharide and polysaccharide contents. Laboratory crystallization was also carried out. Results showed that the oligosaccharide concentration and oligosaccharide:water ratio had a major effect on crystal deformation in normal factory boiling, while the oligosaccharide:water ratio alone affected the habit of crystals obtained under laboratory conditions.

Effect of alkaline treatment on the standard purity of final molasses. Use of a mathematical method for its determination

J. A. Urrutia and E. L. Ramos. *ATAC*, 1988, **47**, (6), 39 - 47 *(Spanish)*.

Treatment of syrup with NaOH or $Ca(OH)_2$ has been found to delay the deterioration of raw sugar in bulk storage; however, while it raises the pH and thus reduces inversion, it also increases molasses sugar content. Experiments are reported in which NaOH was added to give a Na^+ concentration of 0.9% and 1.35% and Ca hydroxide to give a Ca^{++} content of 1.35% and 1.9% and the effects determined of the Na and Ca salts of the reducing sugar alkaline degradation products on molasses sugar; the effects of the Cl^- anion were similarly determined by adding NaCl and $CaCl_2$. The results showed that NaOH and NaCl increased molasses sugar by 0.67 - 1.4% , thereby having the same effect as pH on inversion; Ca hydroxide and Ca chloride reduced molasses sugar by 0.6% (0.4% with the higher hydroxide concentration) but also increased viscosity. It is therefore recommended to find an intermediate mixing point at which either hydroxide will minimize molasses losses and changes.

Characterization of the production and application of enzymes in the Cuban sugar industry

I. Namer, J. R. Pérez, H. Dávila and E. Rivas. *ATAC*, 1988, **47**, (6), 48 - 51; 1989, **48**, (1), 44 - 48 *(Spanish)*.

The use of dextranase to remove dextran from juice and of alpha-amylase to eliminate starch is discussed and the economics of manufacture and application of the enzymes discussed to show that construction of a plant for the manufacture of these and other enzymes in Cuba would be preferable to their importation.

Characterization of the size of suspended particles in mixed juice at Pablo Noriega agro-industrial complex

C. Fabré R. and I. Yanes M. *ATAC*, 1989, **48**, (1), 50 - 56 *(Spanish)*.

The distribution of particle sizes in mixed juice was determined by screening to provide data for the design of a battery of hydrocyclones. In the range 100 - 250 μm, bagacillo constituted the major source of the particles, while very fine bagacillo, soil and grit made up the rest of the material. The overall size range was 36 - 250 μm.

Improving clarification waste treatment with or without chemicals

S. Morales M. *CubaAzúcar*, 1988, (Oct/Dec.), 3 - 6 *(Spanish)*.

The efficiency of clarifier mud filtration was determined with up to 30% water added and with or without 15 mg/litre anionic flocculant. The optimum amount of water for cake exhaustion and insolubles retention was 15%. Although flocculant application increased the filtration rate by 5 - 8% and reduced cake losses by 0.4%, these results were not sufficient to justify the cost at the concentration tested.

Study on the use of lime as alkalizing agent to retard deterioration

R. González Z. and E. L. Ramos S. *ATAC*, 1989, **48**, (2), 6 - 12 *(Spanish)*.

While syrup treatment with NaOH had been found to reduce free amino-acid formation and raise the pH and buffer capacity (with salts of organic acids formed by the action of the hydroxide on

reducing sugars stabilizing the pH) so as to prevent deterioration of stored raw sugar, treatment of 30°Bx water-diluted syrup with $Ca(OH)_2$ at 20% concentration and 40 - 50°C with continuous stirring caused much greater total organic acid formation than the NaOH treatment and thus gave much greater buffer capacity. It was found necessary to seal the system against air so as to minimize losses caused by increase in the CO_2 content.

Results of evaluation of crystallization of commercial and low-grade massecuites in pans

I. Yanes, J. Lodos, O. Gómez and J. Castañeda. *ATAC*, 1989, **48**, (2), 13 - 22 *(Spanish)*.

Results of preliminary tests in which vacuum pans were used as crystallizers for *A*-massecuite and *C*-massecuite are reported. In the case of *A*-massecuite, there was a 1% rise in sugar purity after spinning which took 14% less time, and a 5% drop in *A*-molasses purity by comparison with normal crystallization. Vacuum crystallization of low-grade massecuite caused a 4% fall in both massecuite and final molasses purity and a 20% reduction in residence time by comparison with conventional cooling. Working capacity for both massecuites rose substantially as a result of elimination of the mixing difficulties normally encountered, and operation of the pans as crystallizers posed no problems at a normal vacuum.

Methods of calculating evaporation efficiency in multiple-effect systems in the sugar industry

R. González Q. and M. Derivet Z. *Centro Azúc.*, 1989, **16**, (1), 18 - 36 *(Spanish)*.

Because of considerable scatter in calculated values of the heat transfer coefficient and evaporation ratio, these criteria are considered of little value as guides to evaporator performance. New criteria were proposed as alternatives: the specific evaporation ratio SER (= $W/A \times DT \times GJO$, where W = amount of water evaporated, A = area, DT = temperature difference and GJO = feed juice volume), specific evaporation capacity SEC (= $W/A \times DT \times Q$, where Q = heat flow) and juice processing capacity JPC (= $GJO/A \times DT \times Q$). Analysis of results showed that values of these were subject to much less scatter.

Study of filtered juice clarification by flotation at Argelia Libre agro-industrial complex

G. Mayo P., J. Gil O., A. Enrich, O. Pupo and J. C. Obregón P. *Centro Azúc.*, 1989, **16**, (1), 37 - 40 *(Spanish)*.

Flotation-clarification trials demonstrated a high degree of insolubles removal, a substantial rise in juice purity and a major reduction in colour. A number of recommendations are made.

Some acid-base characteristics of cane juices

W. Burgos G., E. González G., E. Valdés B., M. Villalonga G. and R. Alvarez B. *Centro Azúc.*, 1989, **16**, (1), 41 - 45 *(Spanish)*.

Extraneous matter was found to cause an increase in the acidity and buffer capacity of weigher, crusher and mixed juice samples. The buffer capacity of mixed juice was greater than that of crusher juice and there was a significant relationship between buffer capacity and acidity but not between buffer capacity and pH. Buffer capacity is a more important indicator of juice quality in regard to liming.

Effect of phosphoric acid on the quality of commercial sugar

M. A. Perera S., O. A. Dobarganes E., S. M. Betancourt M. and A. A. Márquez S. *Centro Azúc.*, 1989, **16**, (1), 46 - 49 *(Spanish)*.

Analysis of sugar for pH, reducing sugars, ash, insoluble matter, moisture and pol showed that addition of 25 - 100 ppm phosphoric acid in vacuum pans had no effect on quality but reduced massecuite viscosity, substantially decreased sugar colour and increased crystal yield.

Protective equipment at Umzimkulu sugar mill

Anon. *S. African Sugar J.*, 1990, **74**, 38.

A 200-mm Kelburn cyclone separator installed in the main steam line at Umzimkulu prevents water reaching the turbine and subjecting the blades and thrust bearing to extreme hydraulic shock; it also helps remove scale or swarf. With dry superheated steam, 99.75% separation of particles as small as 75 µm is achieved.

Cía. Açucareira Vale do Rosário

Anon. *STAB*, 1989, **7**, (3/5), 4 - 9 *(Portuguese)*.

This 15,000-t.c.d. plant first operated in 1966 in Morro Agudo, São Paulo, and details are provided of the company's directors, factory capacities, cane supply from growers of cane on 41,400 ha and the agricultural conditions (climate, varieties, etc.). In addition, information is provided on the factory in respect of reception and weighing of cane as well as its washing, preparation and milling, juice clarification for sugar and alcohol manufacture, settling, evaporation, boiling, fermentation, etc. Data from the 1988 season are tabulated; 2,234,905 tonnes of cane were crushed of which 724,153 were used to produce sugar and 1,510,752 to produce 1,039,300 hl of alcohol.

Phytopurification of cane wash water by aguapé

N. S. Rodrigues and M. M. Rodrigues. *STAB*, 1989, **7**, (3/5), 48 - 51 *(Portuguese)*.

A scheme is presented for the purification of wash water and reduction of its BOD by ponding and growing of the title aquatic plant (also Baronesa or *Eichhornia crassipes*). This must be harvested from the treated water and can

be used for cattle fodder while it can also feed fish such as carp or be composted. The system employs a series of tanks through which the water passes and it has been installed at Usina Central Leão in Alagoas. The treated water meets the standards set by the Secretary for the Environment and is the only one to provide an economic return while reducing pollution. The advantages and disadvantages of the system are listed.

Operation of two four-roller mills in Florida

J. F. Alvarez, A. Pacheco and H. J. Cardentey. *Sugar J.*, 1989, **52**, (7), 13 - 15.

The 7th mill of the 7-mill Fulton tandem at Atlantic Sugar Association was provided with a forced-feed roller to make it a 4-roller mill, and the same modification was applied to the 6th mill in the following season. Benefits of a 4-roller mill discussed included: positive feed with a consistent mill performance and uniform flotation, the possibility of increasing the maceration rate significantly without affecting mill performance, a 20% reduction in mill speed without affecting crushing capacity, a fall in the amount of bagacillo released with the juice, decrease in roller wear, greater extraction with lower bagasse moisture; there was no apparent increase in power consumption. Comparison of the various parameters in 1987/88 (after modification of the 7th mill) with those in 1988/89 (with both modified mills in operation) demonstrated the advantages of using two modified mills as against only one in terms of reduced bagasse losses and moisture content and increased pol extraction.

Evaluation of sugar-sharing scheme by cane quality and its application

C. N. Chiu and R. Y. Chen. *Taiwan Sugar*, 1989, **36**, (6), 9 - 10 *(Abstract only)*.

Comparison between cane trash contents in the entire loads of 20 cane box-cars and results obtained by core sampling at Hualien sugar factory in 1987/88 showed a very significant correlation between the two methods. In 1988/89, nine sugar factories adopted a sugar-sharing payment scheme based on cane quality as determined by the two methods, results of which were again compared for 29 loads. Although the findings confirmed the earlier results, a difference of 0.41% was found between the values for soil content; the difference rose to 0.80% where the cane was harvested manually. The ratios between the trash contents and between the soil contents in the upper, middle and lower layers of an entire truckload were, respectively, 100:110:113 and 100:136:219.

Comparison of cane trash contents between estimation from a core sampler and directly from a whole vehicular load

P. C. Yang, Y. R. Tseng, C. P. Huang and C. Y. Su. *Taiwan Sugar*, 1989, **36**, (6), 14 *(Abstract only)*.

Results for the 29 loads measured at the nine factories mentioned in the preceding abstract showed that the average cane trash content determined by core sampler was 8.79% compared with 8.80% for the entire truckload. However, where the cane was harvested manually and loaded mechanically, the average content as determined from the entire load was 11.19% as against 9.07% by core sampling, whereas the figures found from the entire load where the cane was manually cut and loaded, harvested green and harvested burnt were lower than the core sampling values by 0.08, 1.01 and 1.35 units, respectively. The average fibrous trash and dirt contents determined from the entire load were 7.64% and 1.16%, respectively, compared with corresponding core sampler values of 8.04% and 0.75%. The average dirt content found from the whole load for manually cut and mechanically loaded cane was 2.69% as against 0.80% by core sampler; the values for the entire load for manually harvested and loaded cane, cane harvested green and cane harvested burnt were 0.26, 0.04 and 0.15 units lower than the core sampler values.

Vacuum sulphitation system

L. G. Liu and F. J. Ho. *Taiwan Sugar*, 1989, **36**, (3), 16 *(Abstract only)*.

Double carbonatation followed by double sulphitation is the main process for white sugar manufacture in Taiwan. Conventional sulphitation is carried out under pressure; any leakage of SO_2 from the pipeline or tank may cause serious air pollution. In 1988/89, vacuum sulphitation was tested at Touliu sugar factory. A blower was installed at the sulphitation tank to create vacuum in the sulphur burner and gas washer. No SO_2 leakage occurred, and any residue in the flue gas was absorbed by a wet sieve plate scrubber. The body and vanes of the blower are of stainless steel to prevent corrosion and abrasion. In tests during the season, there was no atmospheric pollution by the gas.

Studies on vertical crystallizers

M. H. Tsai, H. N. Lai and R. Y. Chang. *Taiwan Sugar*, 1989, **36**, (3), 16 *(Abstract only)*.

In order to increase supersaturation in horizontal crystallizers, the temperature of the massecuite must be reduced in good time. There is often leakage of cooling water from the mixing coil into the massecuite, seriously affecting sugar recovery. By contrast, the cooling elements in vertical crystallizers are stationary and separate from the mixer so that they do not fracture so easily. The cooling surfaces are large and it is easy to reduce the massecuite temperature steadily and smoothly. Vertical crystallizers are also cheaper to build and occupy less floor space. Test data from Huwei sugar factory showed that a combination of a horizontal and a vertical crystallizer gave satisfactory results. Molasses purity drop was 3.05 units in the horizontal unit and 5.52 in the succeeding vertical crystallizer.

Beet sugar manufacture

Evaluation at Otmuchow sugar factory of a candle filter station manufactured by ZUP Nysa

I. Oglaza and S. Zarzycki. *Gaz. Cukr.*, 1990, **98**, 35 - 39 *(Polish)*.

Exploratory tests were conducted on a Polish-built prototype candle filter designed to handle thick juice and remelt liquor and to replace imported models. 2nd carbonatation mud was used as precoat. Every aspect of the filtration process was examined. The performance of the station proved to be generally unsatisfactory for a number of reasons, ranging from excessive effective volume of the filter relative to the amount of precoat, considerable juice turbidity when the feed pressure exceeded 0.1 MPa, poor cake removal from the elements, rapid blinding of the septa (with temperature change having greatest negative effect on flow through the elements) and unsuitability of acid regeneration of the cloth sleeves. A number of suggestions are made arising from the tests.

The effect of perlite on processing parameters of juices in various stages of purification

V. A. Loseva, N. V. Govorunov and I. S. Naumchenko. *Dokl. Voronezh. Tekhnol. Inst.*, 1989, 8 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (7), Abs. 7 R1558.

For maximum raw juice purification efficiency, a method was developed in which perlite filter aid was added to raw juice before conventional treatment so as to provide supplementary coagulation of non-sugars. The effective amount was 0.04 - 0.06% by weight, depending on the quality of the juice. Use of perlite lowered the lime salts content by 10 - 20% (by weight), the content of reducing matter by 25% and the colour of purified juices by 3 - 14% by comparison with the traditional system. Investigation of the effect of perlite on juice thermostability showed that it inhibited sucrose degradation.

Development of rational conditions for adding perlite to raw juice

V. A. Loseva, I. S. Naumchenko, Yu. S. Serbulov and N. V. Govorunov. *Dokl. Voronezh. Tekhnol. Inst.*, 1989, 17 pp.; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (7), Abs. 7 R1559.

When 0.04 - 0.06% perlite was added to raw juice (see preceding abstract), the purification efficiency of preliming was greater at lower temperatures (45 - 55°C) than at higher temperatures. Raw juice should be in contact with perlite for 1 - 2 minutes, under which conditions there is increased removal of non-sugars. The purification efficiency of preliming was 77% of the total purification efficiency as against 60% with conventional treatment.

Modelling the process of sugar crystallization by cooling

V. I. Tuzhilkin, M. V. Lysyuk, A. I. Sorokin and A. R. Sapronov. *Izv. Vuzov, Pishch. Tekh.*, 1990, (4), 66 - 68 *(Russian)*.

A mathematical model is presented of the massecuite cooling process which, unlike those based on a hypothetical molasses, allows for the influence of non-sugars composition. It is a dynamic model that assumes the presence of ideal mixing and displacement and the absence of local turbulence in the immediate vicinity of the sugar crystal, with growth rate conforming to the McCabe law whereby the excess sugar concentration has a positive value and temperature reduction in the massecuite occurs at a regular rate. A diagram is included of a structural scheme for calculation of the crystallization rate as well as curves illustrating the changes with time of temperature, cooling rate and mass growth rate for massecuites of different non-sugars composition.

Investigation of the effect of monoammonium phosphate on the sugar crystallization rate in massecuite cooling

I. P. Mel'nik and A. P. Kozyavkin. *Izv. Vuzov, Pishch. Tekh.*, 1990, (4), 90 *(Abstract only)*.

It was found that addition of monoammonium phosphate to low-grade massecuite increased the crystallization rate 1.4-fold, the cooling rate 1.1 - 1.25-fold and the crystallization efficiency by 1.2 - 1.5%. The greatest crystallization efficiency was achieved when 0.10 - 0.25% monoammonium phosphate was added (by weight of massecuite).

Calculation of the heat exchange surface area in sugar factory vacuum pans

V. V. Maiorov, V. M. Fursov, O. V. Fadeeva and I. V. Fadeev. *Izv. Vuzov, Pishch. Tekh.*, 1990, (4), 90 *(Abstract only)*.

A program, VATRA FOR, has been developed and tested for use in an Elektronik-100-25 computer to calculate pan heat exchange surface. The program enables optimum variants of the thermotechnical system in a sugar factory to be determined.

Effect of monoammonium phosphate on molasses quality factors

I. P. Mel'nik and A. P. Kozyavkin. *Izv. Vuzov, Pishch. Tekh.*, 1990, (4), 92 *(Abstract only)*.

It has been found that addition of monoammonium phosphate to low-grade massecuite reduces the molasses sugar content and lowers standard molasses purity by 1.3 - 3.3%. At temperatures above 50°C it causes a sharp fall in mother liquor viscosity.

Czechoslovakian filter fabrics

E. Havlová. *Listy Cukr.*, 1990, **106**, 74 - 76 *(Czech)*.

Two types of filter fabric are generally used in Czechoslovakian sugar factories, both of them mixtures of polyester and polyamide. However, the quality of 747-707, developed by Technolen as a replacement for Neotex (imported from

the UK) when filter-thickeners were first introduced, has fallen as a result of changes in its manufacturing process so that it is no longer suitable, chiefly because of its low chemical and mechanical durability. The main requirements of a desirable filter fabric are indicated and attempts to develop suitable material are discussed. A polyester cloth showed promise in factory experiments over a short period, with a permeability of 0.148 $m^3/m^2/sec$, and should further tests confirm the results it is recommended to start production on a sufficient scale (although there is a shortage of the fabric). Parafil polypropylene cloth gave very good results in factory experiments, with a permeability of 0.144 $m^3/m^2/sec$, and it has very good chemical resistance; it is felt that it should be tested on a wider scale, but the equipment for manufacture of the fabric would have to be imported.

Juice purification and the energy economy of sugar factories

M. Smetana. *Listy Cukr.*, 1990, **106**, 76 - 78 *(Czech)*.

Czechoslovakia is the fourth highest fuel- and energy-consuming country in the world. There is need to reduce energy consumption in the sugar industry, and the effect of heat losses in juice purification processes on the energy economy of a sugar factory is analysed. These losses are calculated at 3.5 - 5.4% nominal steam on beet. Convection losses from the surfaces of equipment should not exceed 0.4 - 0.6% in a simple scheme but will be higher with a complex system; considerable levels occur in settlers and rotary filters (1.3 - 1.5% and 1.1%, respectively) while 0.2 - 0.4% may be lost in filter-presses. Heat consumption in carbonatation includes that used to raise the temperature of the CO_2 (gas which has been cooled in the scrubbers to 30 - 40°C) to approximately that of the juice; the amount used increases with the lime consumption and in extreme cases may be 5.3% on beet. Water that is introduced with milk-of-lime and for filter cake sweetening-off increases the evaporation requirements and hence steam consumption. Mention is also made of the effect of thick juice purity on the amount of steam used in boiling and for melting; tabulated data show how an increase in purity from 89 to 93 is accompanied by a fall in steam consumption from 24% to 18.79% on beet.

The Polish waste water treatment plant at Hodonín sugar factory

V. Pohunek. *Listy Cukr.*, 1990, **106**, 82 - 88 *(Czech)*.

At the modernized and expanded Hodunín factory waste water is treated anaerobically and then with activated sludge (in two stages) in a plant supplied by the Polish organization Chemadex. The first of its kind in the Czechoslovakian sugar industry, the plant has been in operation for three years. Details are given of the scheme and of the water economy of the factory. Average reduction in BOD_5 in 1987/88 (including post-campaign processing of stored thick juice) was 98.6%, with the anaerobic stage accounting for 68.4%, while 98% reduction was achieved in the following campaign (without thick juice processing) with a maximum final BOD_5 level of 880 mg/litre and a maximum inorganic matter content of 245 mg/litre despite initial levels that far exceeded the design values.

Density measurement

V. Zemánek. *Listy Cukr.*, 1990, **106**, 89 - 90 *(Czech)*.

Three differential pressure systems used to measure Brix and milk-of-lime density are described with the aid of diagrams.

Carbonatation juice sampling for pH measurement and control in carbonatation vessels

V. Zemánek. *Listy Cukr.*, 1990, **106**, 90 - 91 *(Czech)*.

Because of incrustation in the sampling line from a carbonatation vessel, a new arrangement was developed involving a 3-way cock and a downward sloping polyethylene-lined tube which had the same diameter (1.5 or 2.0 in) throughout; the tube may be at an angle of 30° or 60° and at its upper end must be at a point that is 60 - 70% of the overall juice level in the vessel. Good results have been achieved, with no cleaning needed throughout a campaign.

Measuring liquid level in tanks using pressure and differential pressure sensors

V. Zemánek. *Listy Cukr.*, 1990, **106**, 91 - 95 *(Czech)*.

Various systems for level measurement in tanks based on the use of pressure and differential pressure sensors are described and guidance given on use and layout.

Sugar drying and cooling in a fluidized bed

L. Mörl, G. Lässig, V. González R. and N. Ley Chong. *Centro Azúcar*, 1988, **15**, (3), 3 - 11 *(Spanish)*.

A fluidized-bed dryer/cooler developed at Magdeburg Technical University in East Germany is described and its performance during two campaigns discussed in which the temperature of sugar was reduced from 50 - 70°C to 10°C and the moisture content from 0.5 - 2.0% to 0.025% at a throughput of 20 tonnes/hr and a power consumption of 3 - 5 kWh/tonne. While these results were identical to those obtained in a conventional drum dryer at the same throughput and power consumption, the fluidized-bed unit consumed only 20 - 30 kg of steam per tonne of sugar (compared with 50 - 70 kg/tonne in the drum unit) and had much lower volumetric capacity and surface area requirements.

Treatment of low-grade massecuite: the new Co.Pro.B. station

P. E. M. Cavicchioli and M. Maiani. *Ind. Sacc. Ital.*, 1990, **83**, 7 - 11 *(Italian)*.

Molasses of 50 purity is treated by the Quentin ion exchange process, diluted to 66°Bx, concentrated to 74°Bx in a

falling-film evaporator, boiled in a continuous crystallization tower to 94°Bx, cooled in a vertical crystallizer and spun to give a raw sugar that is suitable, after affination, for refining. Details are given of the scheme, quantities involved and automatic controls. The energy consumption is relatively low and the amount of waste product minimized.

Technological development in food industries

P. W. van der Poel. *Paper presented to Symp. Comm. Int. Alim. Agric.*, 1990, 18 pp.

The activities of Centrale Suiker Mij. (CSM) in Holland, including sugar manufacture, are outlined and the CSM share of the Dutch sugar industry is indicated. The processes used in sugar manufacture and recent technological developments are explained, with mention of laboratory automation and quality assurance.

Automated purity determination of sugar house products

G. Witte. *Zuckerind.*, 1990, **115**, 245 - 249 *(German)*.

The purity of run-offs and pan feed syrups is automatically determined on the factory floor at three plants of Südzucker AG. and in the laboratory at a fourth plant. All steps in the process, including sampling, feeding of the 500 cm^3 sample to a dilution weigher, 1:1 dilution of the sample (1:4 dilution of molasses) with water, mixing, refractometry and polarimetry are automatic in the three factories while the first two steps are manual in the laboratory version. Purity calculation from the Brix and pol relies on three factors which correct, respectively, for dilution, temperature (the measurements are conducted at a selected value, e.g. 65°C, which is relatively close to the process temperature) and non-sugars composition. The purity is printed-out. Mean accuracy is ± 0.2 units. The temperature and non-sugars correction factors require regular adjustment (as a rule, daily per product) by reference to laboratory values, and both the refractometer prism and polarimeter cell must be kept clean. Relatively large fluctuations in readings caused by high air or foam content in the sample can be smoothed by comparing the values with the mean results. Experience has shown that the automatic initial feed step in the factory systems is subject to frequent disturbance.

On the 1989 campaign and new technical developments

K. Buchholz and D. Schliephake. *Zuckerind.*, 1990, **115**, 329 - 344 *(German)*.

Extraction and pulp pressing: Tests at Warburg factory on a system for juice extraction by pressing instead of diffusion showed that, although only 98% raw juice was obtained (on beet), the sugar extraction level was at least 98.5% and pressed pulp dry solids was significantly higher at approx. 50%. The process comprised low-temperature preliming of cossettes with 0.4 - 0.5% CaO on beet to stabilize the cell wall pectin and fix the colloids, treatment at higher temperature and residence time to make the cell membrane permeable, first pressing to extract sugar and juice, mixing to extract residual sugar and a second pressing to obtain the rest of the sugar and pressed pulp. Batch purification of the juice by the standard process without preliming or carbonatation mud recycling (0.8% CaO being used in liming) gave filtration coefficients, settling rates, mud volumes and thin juice colour contents that were comparable to normal factory values and sometimes better. Problems to be solved include the adverse effect of increased lime salts on evaporation and crystallization and the question of pressed pulp drying. The process could reduce energy consumption and atmospheric pollution.

Studies on the use of pressing aids revealed a clear interaction between pectin in the beet cells, the protons in added acids and polyvalent cations such as Ca^{++}; optimum pectin stability occurred at pH 4.5. Both types of ion contributed to cross-linkage and acceleration of water extraction in pressing and displaced Na^+ and K^+ that adversely affect pressing. Optimum for pressing was a press water pH of 5.2 - 5.8 and addition of Ca^{++} at approx. 20 meq/kg beet in the form of Ca sulphate at 1.5 g/kg or sulphuric acid at 150 - 250 mg/litre.

For control of microbial activity, formalin was continuously added via a ring system and lances to the middle of a tower diffuser so that it was evenly distributed throughout the diffuser cross-section; a dose of about 0.01% on beet kept the degree of infection almost stationary over a longish period, while addition of 10 ppm formalin once or twice a day (preferably in the lower section) restricted the infection level to e.g. 200 - 300 mg/litre lactic acid.
Juice purification: Brieghel-Müller preliming is based on colloid (particularly pectin) precipitation by backflowing coagulate heavily charged with Ca^{++}. Experiments showed that the effects of the countercurrent alkalization were utilized only if the optimum flocculation point (at which a maximum amount of colloid is precipitated) was adjusted with the limed and flocculated juice and not with the milk-of-lime; hence, adding milk-of-lime to the last compartment at an end-point of pH 11.0 gave a turbid juice, whereas adding the lime to the last compartment and then withdrawing it for a short retention in a circulation pipe and then returning it to the compartment at the same end-point of pH 11.0 gave improved settling rate and mud volume and a transparent juice, as did direct addition of milk-of-lime to the last compartment but at a final pH of 11.6 corresponding to the optimum flocculation point in the penultimate compartment.

A modification of the Braunschweig carbonatation system used at Tulln factory to treat the juice from 12,000 tonnes of beet daily comprises vertical tanks for precarbonatation, intermediate liming in the upper section of one vessel and 1st main liming in the lower section, 2nd main liming in the

upper section of vessel 3, 1st carbonatation in vessel 4, 2nd carbonatation in tank 5 and an after-reaction vessel 6 from which underflow is returned to 2nd carbonatation, while 1st carbonatation mud is recycled to the lower section of vessel 3 for after-liming. Directional feed pipes and internal ring distributors below the floor of the vessel are provided for each carbonatation; tangential feed via two distributors in the precarbonatator gives good residence time distribution and mixing. Good mud filtrability was obtained with reduced thick mud recycling and low lime consumption of 1.3 - 1.4% CaO on beet, and no problems arose when the campaign was prolonged and poor beet was processed.

Environmental protection: Problems concerning ammonia emission were tackled. While generally only 55 - 70% glutamine in thin juice is degraded before evaporation, the aim was to achieve at least 85% degradation; a reaction vessel after 1st carbonatation allowed 85 - 90% conversion (mainly to pyrrolidone carboxylic acid but also to considerable quantities of glutamic acid) at 90°C, an alkalinity of 0.4 - 1.0% on juice and a residence time of 15 - 30 min. The attached ammonia could then be removed by stripping with steam or air followed by acid washing; disadvantages include juice coloration (because of the higher temperature, alkalinity and concentration) and disposal of the resultant concentrated ammonium sulphate. Biological treatment of effluent converts nitrogenous compounds to ammonium-N, most of which is liberated during the anaerobic stage although there is also an increase of 20 - 100 mg/litre in the amount in the waste water.

Waste gas from pulp drying can be washed with milk-of-lime. Tests with carbonatation mud as wash solution reduced the SO_2 content by about 85%, while an experimental washer using an acid phosphate solution and serving as 2nd stage after a unit using a milk-of-lime wash considerably reduced the odour.

Non-sugars effect on molasses formation: Plotting values of the difference between the sugar introduced in beet and the amount produced as crystal product as a function of beet alkali and NH_2-N contents showed that the (K + Na) content had a more dominant effect on sucrose solubility. Non-sugars in thick juice and molasses (NS) may be divided into alkali salts and residual non-sugars (RNS); if the RNS:NS ratio is high and hence the alkali salts content low, the effect on solubility is reduced or may even be negative and vice versa. However, while this division of the non-sugars is theoretically sound, considerable individual deviations can occur in calculations.

Continuous white sugar boiling: Operation of the 4-chambered evapocrystallization tower at Schladen showed no need for cleaning of chamber 1 throughout the campaign, chambers 2 and 3 needed only one cleaning while there was sufficient incrustation in chamber 4 to warrant two cleanings so that the initial apparent heat transfer coefficient could be restored. The low value of 250 W/m²/°C was attributable to a number of factors including air entering the heating steam. A cascade of 4 linked batch pans as a continuous system with stirrers above the calandria at Brühl gave satisfactory crystal formation, with an hourly massecuite throughput of 73 tonnes and an average crystal content of 55.7%; however, fine grain occurred in the last pan, which was used to tighten the massecuite, while the heat transfer coefficient was distinctly lower than that in a tower, indicating the need to operate at a greater level to allow the effect of the stirrers to complement normal massecuite circulation.

Continuous low-grade boiling: An evapo-crystallization tower was used at Rethen for low-grade boiling at an average throughput of 30 tonnes/hr (reaching 37 tonnes/hr on occasions); heat transfer coefficients were very good. Steam pressure was 0.56 - 0.60 bar in chambers 1 - 3 and 0.86 - 0.90 bar in chamber 4. Brix fluctuations in chambers 3 and 4 caused by fluctuations in atmospheric air pressure were eliminated once vapour pressure control was transferred from a differential pressure to an absolute pressure system.

Crystal footing operations: By adjusting the quantities of seed slurry and of crystal footing used for white sugar 1 (WS 1) and WS 2 pans, it was possible to use the same crystal footing plant to produce a fine WS 1 crystal of 0.48 mm as well as a coarse one of 0.8 mm while maintaining the size of WS 2 crystals at 0.66 - 0.70 mm.

Measuring techniques: For determination of mother liquor Brix in continuous boiling from which to determine the crystal content and supersaturation, three approaches were tested: (i) refractometry to measure the Brix, (2) measurement of the surface boiling temperature simultaneously with measurement or control of the pressure in the vapour space and Brix calculation from the BPE, and (3) measurement of conductivity as indirect measure of Brix. Preliminary results of tests in an evapo-crystallization tower showed that a K-Patents refractometer gave points falling along a rectilinear curve that was parallel with the 45° line on a graph of measured Brix values *vs.* analytical data; there was a small measuring error with crystal-free solution, and a larger error for massecuite with a jump in the baseline (possibly due to distortion caused by light reflection on the crystal surfaces). A QuaT measuring system based on the relationship between temperature and the natural frequency of the quartz oscillator also gave results falling along a straight line parallel with the 45° line, but with some scatter caused by movement of the massecuite around the measuring point and contact between the sensor, vapour bubbles and crystals. A Siemens Ardometer E pyrometer for surface temperature measurement also gave good parallelity with the 45° line, with a greater error in massecuite than in crystal-free solution; aspects requiring attention include the distance from the massecuite surface, adjustment of the emissivity in accordance with the surface being measured, and prevention of condensation at the sensor.

By-products

Vinasse: treatment by anaerobic biodigestion — current prospects

B. B. M. Rocha. *STAB*, 1988, **7**, (1), 49 - 50, 52, 54 *(Portuguese)*.

The UASB (up-flow anaerobic sludge blanket) system for vinasse treatment appears to be the most suitable method of vinasse treatment and a table is presented on projects for its adoption, including operational and ordered units and one being installed. The use of the gas produced as a fuel for vehicles is studied; this requires its compression for storage in a vehicle fuel tank and the costs of producing such a fuel are discussed.

Study of the kinetic behaviour of industrial alcohol fermentation conducted by the discontinuous process

J. N. de Vasconcelos and V. Vilela. *STAB*, 1988, **7**, (2), 40 - 42, 44, 46, 50 *(Portuguese)*.

An industrial alcohol fermentation of cane juice was studied from start to finish by sampling and analysis at hourly intervals, with measurements of the cellular content (dry weight), total reducing sugars, ethanol, volumetric percentage of fermentate, and densities of the fermentation medium and yeast-free wine.The kinetic behaviour of the process was characterized, showing that the profile of must feeding had a marked influence on the fermentative efficiency and the productivity of the process.

Gasification of bagasse; an alternative for the cane sugar industry

A. D. V. Cortez. *Brasil Açuc.*, 1988, **106**, (5/6), 15 - 19 *(Portuguese)*.

The potential for cogeneration of steam and electricity by the use of gas turbines fed with gasified bagasse is discussed and an example quoted of a distillery in São Paulo state which is acquiring a multi-stage turbogenerator and is expected to be able to produce surplus power of 3000 kWh for sale. (See also Larsen *et al.*: *I.S.J.*, 1990, **92**, 49 - 54, 62 - 66.)

Removal of organic contaminants by the system of hydroselection in the process of ethanol manufacture

M. Paterson, S. E. L. de Araújo, J. I. de Moraes and F. A. D. Melo. *Brasil Açuc.*, 1988, **106**, (5/6), 20 - 26 *(Portuguese)*.

The hydroselection method of purification, introduced into a distillery in Paraíba state, was evaluated by quantitative determination of organic contaminants in the alcohol mixtures produced at different stages of the manufacturing process. Relationships were established between the ethanol content of the aqueous mixtures and the impurities present. The analyses showed that the system was efficient in the separation of both light (esters and aldehydes) and heavy (propyl, butyl and iso-amyl alcohols) components of the impurities. The average product quality met the standard specifications set by the Sugar and Alcohol Institute.

Evaluation of the development of ethanol fermentation in different situations of the industrial process

M. Paterson, J. M. M. Borba, F. A. D. Melo and J. I. de Moraes. *Brasil Açuc.*, 1988, **106**, (5/6), 27 - 32 *(Portuguese)*.

Fermentation processes were compared during the 1987/88 season at a distillery in Paraíba with two kinds of yeast (*Saccharomyces cerevisiae* and *S. uvarum*). The yeast was recovered by the Melle-Boinot system in which the pH is reduced to 2.5 to disinfect the process and also recovered direct without any pH adjustment. Physico-chemical and microbiological analyses were made of the cane juice, wine, yeast cream and separated yeast. The results showed that the best fermentation yield and productivity were obtained using *S. uvarum* and recovering the yeast after reducing the pH.

Whole cane and cane burnt without topping: preliminary results obtained

F. A. D. Melo, J. M. M. Borba and M. Paterson. *Brasil Açuc.*, 1988, **106**, (5/6), 33 - 37 *(Portuguese)*.

A study was made on an industrial scale of the use of green and burnt cane, topped and untopped, for the manufacture of alcohol in an autonomous distillery. The results showed that, in terms of fermentable sugars per ha, untopped green and burnt cane provided similar yields and that the use of whole cane as raw material is justified because of the higher amount of biomass. In both green and burnt cane better results were obtained with untopped stalks.

Sugar cane and its crop residues as cattle fodder

J. Ugarte. *ACPA*, 1988, **7**, (1), 44 - 49 *(Spanish)*.

To be suitable as cattle fodder, cane needs supplementing with nitrogen, usually in the form of urea. Cane dried in the sun to replace half of the cereals in rations fed to dairy cattle together with fresh pasture or silage has increased milk yields. Since cane in Cuba is harvested in the rainy season, it is difficult to preserve and yet is unsuitable if fed fresh because of its low digestible energy content, while ensilage has shown little promise. Cane leaves constitute a low-cost feed of value in the dry season; it is possible to harvest up to 2.7 tonnes/ha dry matter in the form of leaves, which would feed 2.5 - 2.8 cows/ha, although it needs to be treated to increase its energy value, and it is generally used as a fibre supplement in high-energy rations. Digestibility can be increased by treatment with NaOH.

Evaluation of clarifier mud as source of phosphorus for sugar cane with the use of P-32

A. Cabrera, M. López, E. Angarica and I. Chávez. *Rev. INICA*, 1986, **3**, (2), 93 - 100 *(Spanish)*.

A greenhouse experiment was conducted with ^{32}P to evaluate plant uptake of

phosphorus from clarifier mud applied to pot-grown cane at the equivalent of 100 tonnes/ha after single superphosphate had been added to the soil at 100 kg/ha. Results showed that the mud restricted P uptake from the superphosphate but increased uptake of soil P in the absence of the superphosphate. The P_2O_5 content of the mud was found to be equivalent to 650 kg/ha.

Thoughts on the efficiency of mixing cane crop residues with NaOH and molasses

J. R. Espinosa R. and A. Urquiza U. *ATAC*, 1988, **47**, (6), 21 - 30 *(Spanish)*.

A plant is described that was used in tests on cane trash mixing with NaOH and molasses to provide a suitable cattle fodder. Once modifications had been made to overcome some teething problems, it was expected to be able to produce feed of stable quality at a trash throughput of 2.5 tonnes/hr.

Study of the effect of treatment to retard raw sugar deterioration on the fermentability of molasses

M. López and E. L. Ramos. *ATAC*, 1988, **47**, (6), 52 - 56 *(Spanish)*.

Experiments are reported which showed that, although syrup treatment with NaOH or $Ca(OH)_2$ to delay raw sugar deterioration in storage caused a 10 - 20% decrease in the reducing sugars content, it had no adverse effect on the fermentability of the molasses used as substrate for cultivation of *Saccharomyces cerevisiae*.

Determination of the tensile strength and Young's modulus of cane residues

J. Bestard H., P. Hurtado M. and J. E. Nieot S. *ATAC*, 1989, **48**, (1), 33 - 34 *(Spanish)*.

The tensile strength and Young's modulus of green and dried cane leaves were determined at up to 88.6% moisture content as a contribution to the knowledge needed for mechanical chopping of the material. Results showed that non-uniformity of moisture distribution and hence of the texture caused considerable variation in the measurements. There was very little longitudinal elasticity, while the green leaves had greater tensile strength at below 40% moisture than above it.

Techno-economic aspects of furfural production from bagasse. I

Anon. *Ind. Azuc.*, 1988, **94**, (1048), 4 - 5 *(Spanish)*.

A brief review is presented of furfural manufacture from bagasse, including outlines of batch and continuous processes, furfural applications, development of a furfural industry in Latin America and the Caribbean and techno-economic and marketing aspects of furfural in Mexico.

Glucose from sucrose. Preliminary study

E. Duarte, A. Fariñas and G. Lago. *CubaAzúcar*, 1988, (Oct./Dec.), 18 - 20 *(Spanish)*.

A brief review is presented of methods used to produce glucose from sucrose. A method based on the difference in solubilities between glucose and fructose in saturated solutions at 20°C in the presence of invert syrup provided a rapid means of crystallization without the need to use glycerol as solvent (which thereby avoided the adverse effect of heat used for its recovery on the fructose syrup). pH and the amount of seed added were found to be of major significance, and optimum values were 4.5 and 2%, respectively; at these values, a glucose yield of 44% was obtained from a refined sugar liquor. A syrup of 71 - 73°Bx containing 58 - 61% fructose was also obtained.

Use of unfiltered clarifier mud as animal fodder. I

R. Rodríguez E. and C. Esturo C. *Centro Azúc.*, 1989, **16**, (1), 3 - 8 *(Spanish)*.

The benefits of unfiltered clarifier mud containing 20% dry solids, 11% sugar and 0.5% fibre as cattle feed under drought conditions are discussed by comparison with filter cake containing 25% dry solids, 2% sugar and 6.3% fibre.

Definition of a preliminary expression of the reaction velocity during sulphate pulping of bagasse

I. Rodríguez R., I. Hernández L., E. Pérez R. and E. González S. *Centro Azúc.*, 1989, **16**, (1), 50 - 52 *(Spanish)*.

An investigation of delignification on a pilot plant scale at 160 - 170°C of sulphate pulp produced from bagasse revealed two distinct sections on the curve of reaction velocity *vs.* lignin content of the pulp. On an industrial scale, the reaction velocity could be suitably expressed as a function of the permanganate number.

Study of the best conditions for operation of a semi-chemical pulp plant using a polyoptimization method

L. Perurena C. and E. González S. *Centro Azúc.*, 1989, **16**, (1), 53 - 62 *(Spanish)*.

The validity of a multi-criterion method for optimization of a process for cardboard manufacture from bagasse pulp was demonstrated in a study in which the physical properties of the pulp and yield were used as parameters.

An aggregate global model of the bleaching section at Jatibonico white paper combine

I. Rodríguez R., R. Santos H., S. León and M. Estrada. *Centro Azúc.*, 1989, **16**, (1), 63 - 69 *(Spanish)*.

Mathematical models of the bleaching process were obtained that provided information on the effects of the more important variables on the properties of the bagasse pulp and plant performance for use in an overall model aimed at optimization.

Economic effect of some measures for energy conservation in a paper mill

G. Raumbaut and E. González S. *Centro Azúc.*, 1989, **16**, (1), 70 - 75 *(Spanish)*.

The economic benefits of: heat recovery from a Damují paper machine, replacement of the hydraulic system with drying presses, adjustment of the excess air coefficient in the steam boilers and using deaerated steam for bagasse heat treatment are discussed.

Bacteria contaminating the ethanol fermentation process and their sensitivity to penicillin and pentachlorophenol

M. A. T. Rodini. *STAB*, 1989, **8**, (2), 52 - 54 *(Portuguese)*.

A number of bacterial species were isolated from the different stages in the alcohol fermentation process and were tested for their reaction to penicillin (Pen) and pentachlorophenol (PCP). *Bacillus subtilis* and *B. megaterium* were resistant to up to 400 ppm Pen but were controlled by 60 ppm PCP. Another unidentified bacillus was resistant to Pen but was controlled by 40 ppm PCP, as were two *Lactobacillus* spp. *Acinetobacter calcoaceticus* was resistant to both Pen and PCP. *Micrococcus lylae* and a *Pediococcus* sp. were controlled by 400 ppm Pen and 60 ppm PCP while another species of *Micrococcus* was controlled by 300 ppm Pen and 40 ppm PCP. Two *Leuconostoc* spp. were controlled by 40 ppm PCP and one by 300 ppm Pen; the other required 400 ppm Pen.

Effect of the biocide Quimatec MA (non-chlorinated phenol) on the behaviour of Fleischmann, M-300-A (TA-79) and IZ-1904 yeasts

M. D. W. de Braunbeck, H. V. de Amorim and A. J. de Oliveira. *STAB*, 1989, **8**, (2), 55 - 58 *(Portuguese)*.

In Brazil most distilleries use the Melle-Boinot process in which the yeast is recycled after separation by centrifuge. The effects of the title biocide were examined in the laboratory on yeasts used for three cycles, measuring the cell numbers/ml, cell viability and reproduction, as well as fermentation yield and infection. Two strains of *Saccharomyces cerevisiae* and one of *S. uvarium* were examined and it was found that the biocide raised the fermentation yield with the former but did not affect the latter.

Considerations on new fermentation processes for the production of ethanol

L. A. R. Pinto. *STAB*, 1990, **8**, (3/4), 42 *(Portuguese)*.

Two basic requirements are stated for alcohol fermentation, viz. maximization of the time of retention and maintenance of the best environment possible. New techniques such as the use of immobilized cells meet the first of these and allow great efficiency, continuous operation and automation. The use of new organisms such as *Zymomonas mobilis* also shows promise; however, in addition to the fact that equipment such as suitable tanks, centrifuges, etc. are already in use for fermentation with *Saccharomyces* spp. employing the Melle-Boinot process, there is still scope for the latter's improvement, including continuous operation, while there are hazards in the adoption of the newer processes as well as the requirement for considerable investments.

Effect of beet pulp hydrolysis conditions on pectin yield and quality

V. V. Andreev, L. P. Parshakova and L. A. Demchnko. *Kachestvo Konservir. Produktsii i Metody ero Opredeleniya*, 1989, 77 - 81; through *Ref. Zhurn. AN SSSR (Khim.)*, 1990, (5), Abs. 5 R1497.

Investigations showed that the quality of beet pectin as gelling agent was considerably lower than that of apple or citrus pectin, from which it is concluded that it is inadvisable to use beet pulp for pectin production.

Ethanol production and flocculation at high temperatures by yeasts bred for fermentation of beet molasses

K. Moriya, H. Iefuji, H. Shimoi, S. I. Sato and M. Tadenuma. *J. Brewing Soc. Japan*, 1988, **83**, 834 - 837; through *Food Sci. Tech. Abs.*, **21**, Abs. 9 H 125.

The relationship between ethanol production and flocculation at high temperature was studied, using *Saccharomyces cerevisiae* bred for ethanol production from beet molasses. Dispersed yeast cells were more susceptible than flocculent cells to elevated temperatures (40° and 50°C). The flocculent strain M-9 produced 7.2% and 3.2% ethanol at 40° and 50°C, respectively. Flocculating capacity survived incubation at 70°C but was destroyed by chymotrypsin digestion.

Ways of utilizing waste from beet sugar manufacture in the Soviet economy

P. V. Poltorak, L. G. Belostotskii, V. A. Lagoda and L. I. Tanashchuk. *Izv. Vuzov, Pishch. Tekh.*, 1990, (4), 5 - 9 *(Russian)*.

A review is presented of the literature (with 62 references) on utilization of waste from beet sugar factories in the Soviet Union. The survey includes: soil separated from beet which contains a large quantity of valuable minerals and humic compounds and so is suitable for use in fertilizer manufacture; mud separated from flume-wash water which is also of benefit, possibly mixed with filter cake, for production of compost and fertilizers as well as for landfilling where little is grown; filter cake, which is of value as a fertilizer and soil ameliorant; overburnt lime and limestone residue suitable for use in road resurfacing and building work; boiler ash and clinker, also of value for road and building construction; waste water which, after suitable treatment, may be sprayed on the land; and CO_2 recovered from boiler flue gas for use in carbonatation.

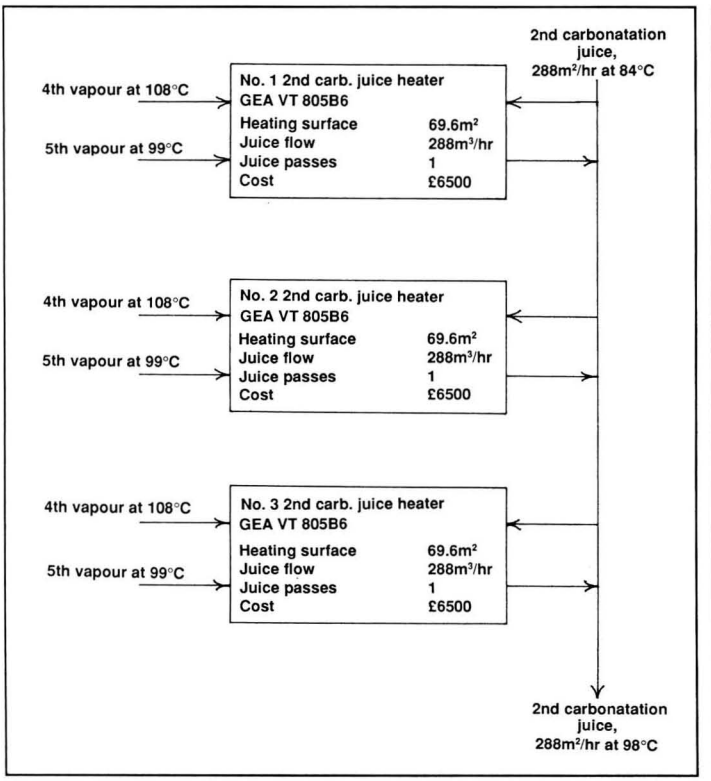

Figure 10. 2nd carbonatation juice heating

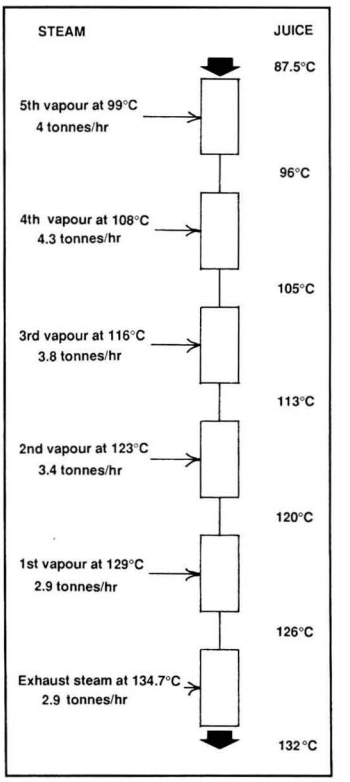

Figure 11. Thin juice heating

circulation juice heaters and only one of the two heaters was used throughout the campaign.

The raw juice heaters performed well except for a period when heater cleaning was not at its optimum owing to failure of the chemical cleaning pump. It should be noted how important this system of heater cleaning is; it is essential that the cleaning flow is above the normal juice flow rate and that the cleaning is performed in reverse to the normal juice flow.

The thin juice heaters performed well but the screen in the thin juice tank was not totally effective and small particles of sulphur/carbon still fouled the first heater in line. Another attempt at screening for the 1990/91 campaign will be required to overcome this and alleviate the repetitious cleaning.

Power generation plant

Prior to the 1989/90 campaign a new boiler and turboalternator were installed. This plant consisted of a 50 tonnes per hour coal-fired boiler generating steam at 72 bar and 510°C. The boiler was supplied by NEI Power Projects Ltd. and was manufactured by the Danish company, Aalborg. Fitted with an NEI International Combustion Ltd. chain gate stoker, the boiler is a radiant type hanging above the stoker from support steelwork. Steam passes from the boiler to a turbine manufactured by AEG of West Germany fitted with a 10 MW alternator supplied by Brush Ltd. of the UK.

Following the factory philosophy of central control, the boiler and generator controls were fitted with Turnbull Control Systems plant-mounted instrumentation and a Maxivis (VAX) overview computer was installed in the central control room, together with closed-circuit television equipment to allow viewing of the boiler house and power house from the central position. It had been intended that, once the boiler operators were fully trained in the operation of the new equipment, they would operate from the central control room with the ability to move freely from the control room to the power plant.

In practice this could not be achieved, owing to major problems with the boiler plant. These problems included failure of the stoker chain and

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Weak cation softening of thin juice

By T. H. Henscheid, L. Velasquez and D. Meacham
(The Amalgamated Sugar Company, Twin Falls, Idaho, U.S.A.)

For the past five years Amalgamated Sugar has been softening thin juice at their Twin Falls beet sugar factory. This past year another installation was commissioned at their Mini-Cassia facility. These softeners were not installed merely to produce soft thin juice even though there are some real advantages to be gained by doing so. The ultimate goal was to produce a soft molasses which could be processed in the company's "chromato-separator" for sugar recovery. This softening process has been a real success both from the thin juice and molasses standpoint. The first softener was placed in service several years before the separator was built so that the system was perfected and operating well when the separator came on line.

There are various methods available for softening thin juice. Some of the advantages and disadvantages of these systems are listed below:

(1) Conventional strong cation exchange
- (a) Low operating capacity
- (b) Excess regenerant is required
- (c) Large installation
- (d) Waste regenerant production

(2) The Gryllus process
- (a) No regenerant chemicals
- (b) No dilution
- (c) Low resin capacity
- (d) Molasses is not soft

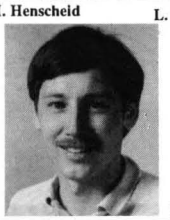
(3) The N.R.S. (New Recovery System)
- (a) Uses a strong cation exchanger in sodium form
- (b) Thin juice plus sodium hydroxide for regeneration
- (c) No dilution
- (d) Low resin capacity
- (e) Cooling to 40°C is required for regeneration

(4) The weak cation exchange system
- (a) High resin capacity
- (b) Small installation
- (c) Minimal dilution
- (d) Waste used as pressing aid
- (e) Excellent softening
- (f) Requires special operating conditions

A good summary appeared in 1988[1].

T. H. Henscheid

L. Velasquez



D. Meacham

The Amalgamated Sugar Company used the weak cation exchange system[2] which was developed in-house to soften thin juice. It was first installed in the Twin Falls factory for the 1984/85 beet campaign. Prior to this time a pilot unit was installed which processed about one-third of the juice flow. Installation was originally on an upflow basis using two cells. It was later changed to three cells and switched to downflow.

The softener uses a weak cation exchange resin in the hydrogen form. Because of this, special operating conditions have to be imposed on the system in order to prevent inversion of the sucrose. Flow rates through the resin bed are kept very high (40 - 100 bed volumes/hr) at temperatures slightly above 80°C. To maintain this high flow rate it is imperative that the juice be free of suspended solids. Double filtration of second carbonatation juice is practised at our plants and the filtered juice checked for suspended solids. In the six years of operation, plugging of the resin bed by suspended solids has never shut down the softener. Temperatures are also very critical to the operation because, below 80°C, bacterial infection became a real problem.

The system incorporates a three-cell design with two cells being exhausted on thin juice simultaneously. These are staggered with respect to exhaustion so that both do not require regeneration at the same time. The third cell is being regenerated or in standby (Figure 1).

The high resin capacity and the fast flow rates make it possible to process the entire factory stream (6200 short tons/day slice) with a very small installation in comparison to other processes using strong cation exchange resins.

When a new cell is placed on-line the processed juice leaves the cell at a low pH (Figure 2). This is due to the fact that not only calcium and magnesium are exchanged for hydrogen ions but also the sodium and potassium are picked up by the resin. As the cell continuous to exhaust, these sodium and potassium ions are displaced from the resin by calcium and magnesium. About 80% of the total resin capacity is occupied by divalent ions at the time the cell is removed from service. The remaining 20% is occupied by sodium, potassium and hydrogen ions.

This low pH juice must be neutralized as soon as possible after leaving the softener in order to reduce invert formation. This can be done by adding either MgO or soda ash. The amount of the invert formed across the softener is then very small. However, as lime salts increase and the system is cycled more often, the amount of invert would also increase. Invert is formed during the first 60 minutes of the cycle (Figure 3) when the pH is low. Toward the end of the cycle the pH approaches the pH of the feed and further neutralization is not needed and no invert is formed.

A characteristic of weak cation exchange resins is that in going from the hydrogen form to the monovalent metal cation form the resin swells significantly. If the flow rate is too high to allow this resin to expand, the beads are compressed together causing a high pressure drop across the resin bed. This swelling lasts for the first 30 - 60 minutes then starts to decrease again as

Paper presented to Sugar Industry Technologists, 1990.

1 Lancrenon & Hervé: *Sugar Tech. Rev.*, 1988, **14**, 207 - 274.

2 Schoenrock *et al.*: U.S. Patent 3,982,956 (1975).

the monovalent ions are displaced by divalent ions. Cell construction must be such that it allows the initial expansion.

Exhaustion cycle length varies with lime salts concentration. Minimum cycle lengths of four hours are necessary to turn around a cell properly and preserve the resin integrity. Cycle duration becomes very long as lime salts concentration decreases and may last 30 - 40 hours. Figure 4 shows the cycle length *versus* lime salts concentration for the Twin Falls softener during the 1989/90 campaign. This graph reflects the average of all three cells and over 594 cycles. With high lime salts concentrations the cycle length becomes so short that the softener cells cannot be turned around fast enough. Either some calcium must be allowed to leak through the softener or soda ash must be added to second carbonatation in order to reduce lime salts to a level at which the softener is able to process the juice.

When a cell first comes on line there is a very small amount of divalent ions in the processed juice. This is due to a small amount of divalent ions being left in the resin following regeneration. They may be either attached to the resin or present as residual calcium sulphate. Counter-current regeneration would eliminate this leakage. The quantity is so small, however, that it does not effect juice quality. Divalent ions are totally eliminated from the juice until the resin is nearly totally exhausted. When leakage starts to occur the cell is removed from service and the next cell placed on line (Figure 5).

During sweetening-on, the water in the cell is pushed forward and goes to the diffuser supply tank. During sweetening-off, the juice is pushed across the resin and returned to the softener supply. These cut-off points are determined by conductivity measurement with a timed back-up. As a result very little water is pushed forward to the evaporators.

Regeneration is carried out co-current to the juice flow. Sulphuric acid is the regenerant of choice so it can be recycled to the diffuser. Hydrochloric acid presents less of a problem but adds chlorides to the system which are detrimental to stainless steel and are more melassigenic than sulphates. Since the calcium sulphate formed during regeneration is only sparingly soluble, care must be taken to ensure that it

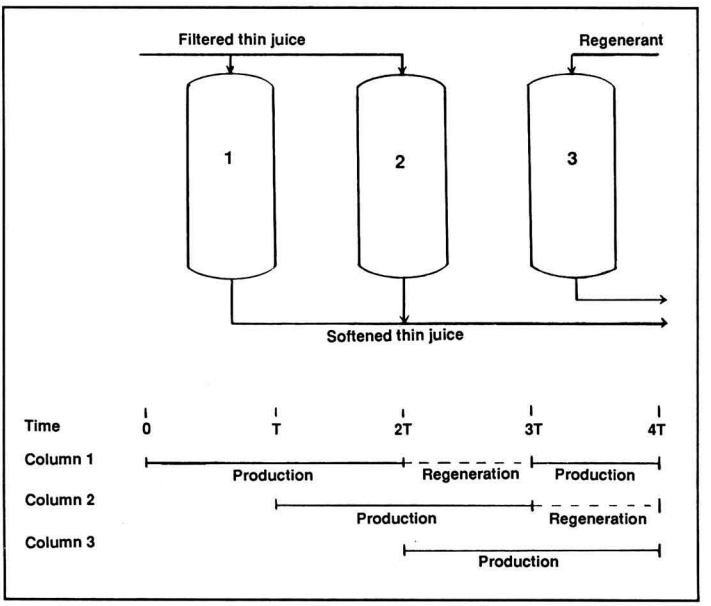


Fig. 1. Three-cell softener arrangement

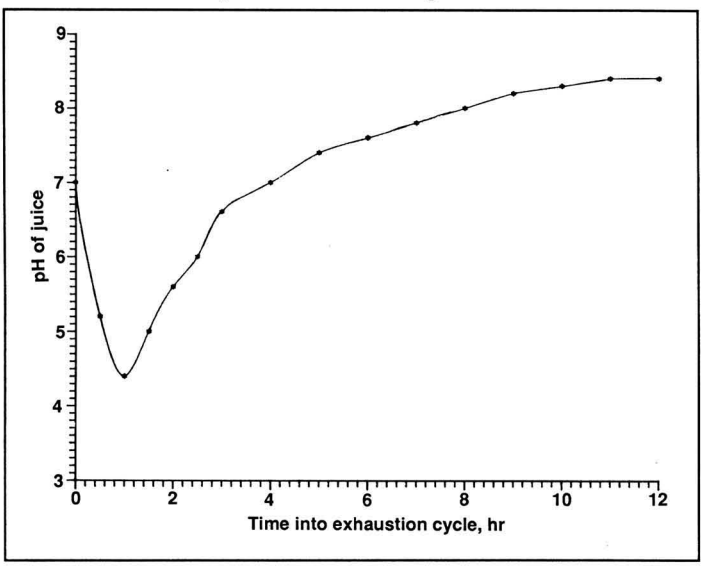


Fig. 2. Exhaustion pH profile

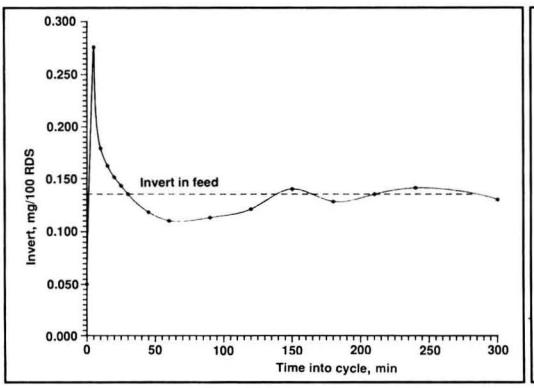


Fig. 3. Invert production across weak cation exchange softener

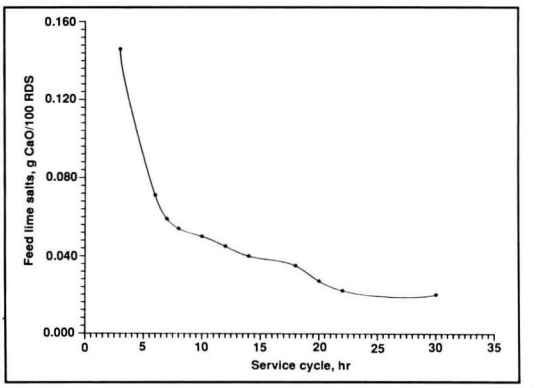


Fig. 4. Cycle length *versus* feed lime salts

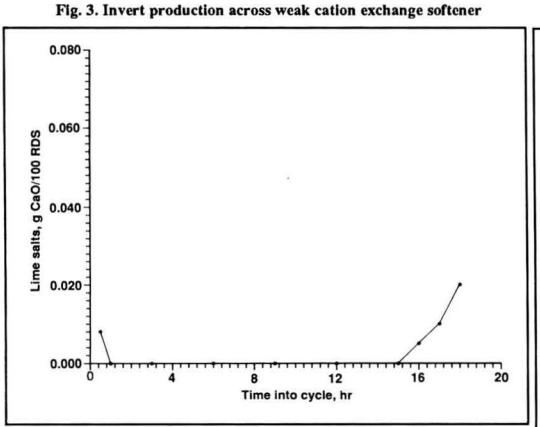


Fig 5. Softener exhaustion profile

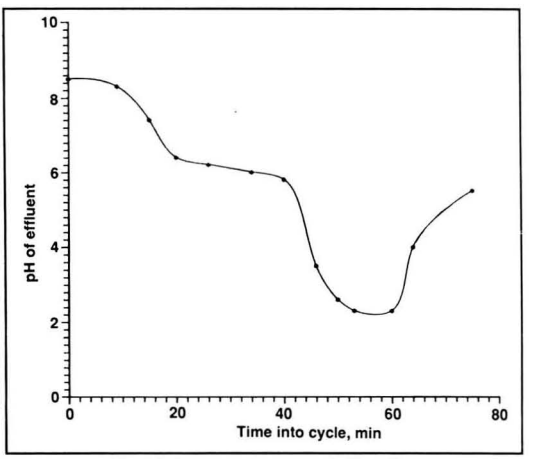


Fig. 6. Softener spent regenerant pH profile

remains in solution; to do this the acid concentration must be below 0.5%. The disadvantage here is that a large volume of spent regenerant is produced. It can all be returned to the process but must be metered into the diffuser supply at a rate which gives the desired quantity of pressing aid or pH to the diffuser supply water. Early in the regeneration cycle the effluent is primarily calcium sulphate. Toward the end of regeneration the pH drops and the acid concentration is the major constituent. A typical regeneration pH profile is shown in Figure 6.

The weak cation exchange system can be regenerated very efficiently with only 110% regenerant on capacity to give complete conversion to the hydrogen form (Figure 7). If run countercurrently the same regeneration could be achieved with 100% regenerant on capacity. In our process sulphuric acid is used to adjust the pH of the diffuser supply water. Any excess regenerant reduces this requirement and is therefore not wasted.

A typical regeneration profile is shown in Figure 8. Following regeneration a rinse step is very critical to ensure that any precipitated calcium sulphate is rinsed from the resin. This also keeps pipes and tanks free from scale. All the water is returned to the diffuser supply water so no waste streams are produced.

The system works very well and produces a thin juice with an average of less than 0.006 g CaO/100 RDS when the cells are exhausted to the point of leakage. If desired, this can be reduced to zero by switching cells at an earlier point.

The benefits gained by softening thin juice are substantial. Our factories have been able to slice more beets because of the clean evaporators. Energy usage per tonne of beets sliced has dropped significantly. Evaporator boil-outs have been eliminated and scaling of thick juice filters no longer occurs. Pan vapours have improved, increasing sugar

More and more CC-6 Centrifugals in Australia.

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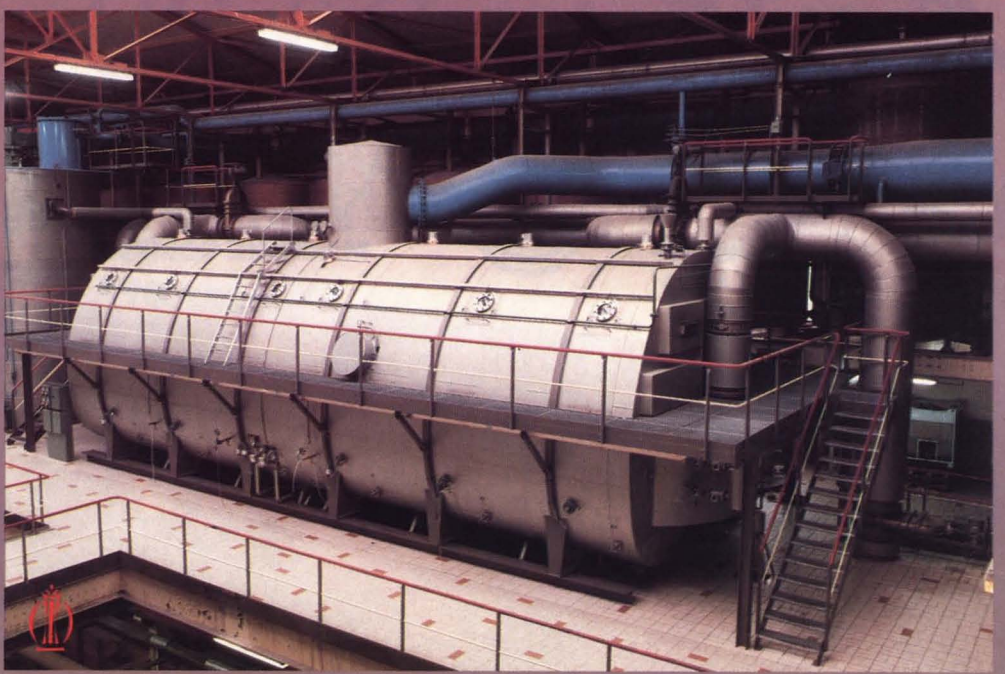
FS CRYSTALLISATION TECHNOLOGY



115 m^3 low raw pan at Südzucker A.G. Zeil. (Supplied through Wiedemann KG).

Installations of stirred and unstirred continuous pans with optimal Brix control using FS Duotrac radio frequency probes.

The prototype stirred pan at Zuckerfabrik + Raffinerie A.G. Aarberg has now been joined by a production unit for making 'B' and 'C' seed magma.

FS continues to demonstrate its leadership in sugar house technology.

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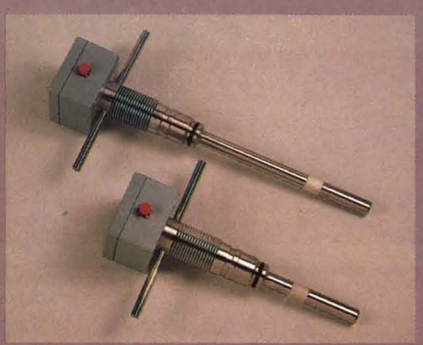
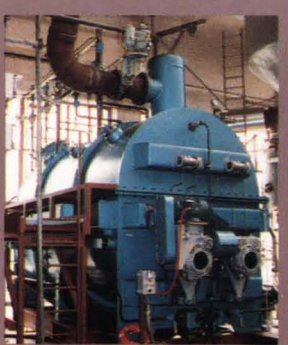


FS Duotrac Probes



Prototype

Production unit

Seed magma continuous pans - Aarberg. (Supplied through Wiedemann KG).

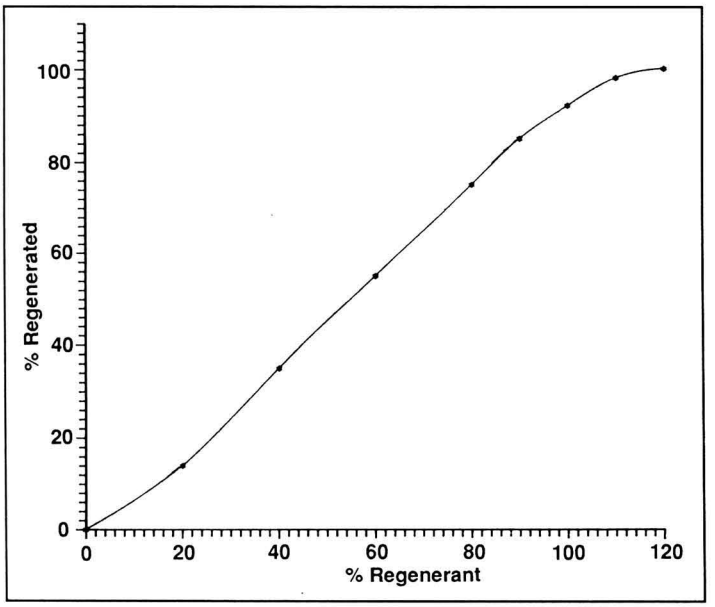


Fig. 7. Regeneration curve for softener

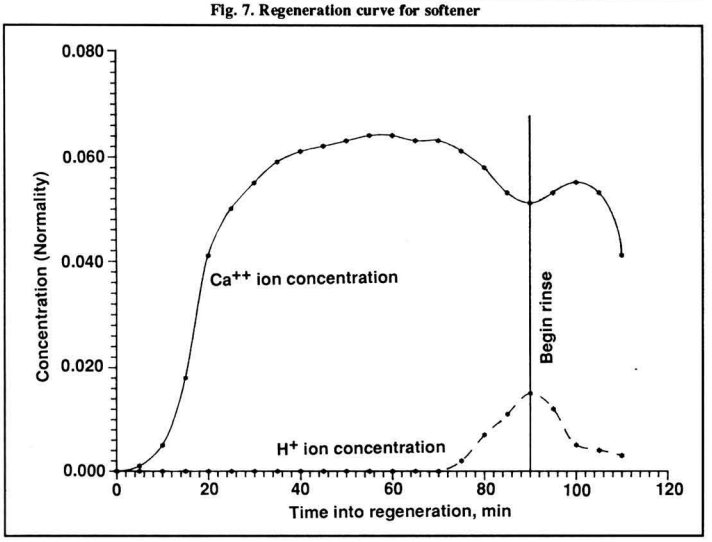


Fig. 8. Juice softener regeneration profile

end capacity and allowing the use of lower vapours. The resulting benefits to our process we feel would pay for the installation in about four years. The real economic benefit, however, is in producing a molasses that is of sufficient quality to process in the separator without any further softening.

With soft juice there can be some increased corrosion of pipes and evaporators. As a precaution the evaporator bodies were coated above the wetted surface. After five years of operation, the corrosion rates have not been excessive. If the evaporators are not coated, there is a slight increase in corrosion rate.

Total energy integration at Ipswich factory

continued from page 205

castings, heavy build-up of slag on the economizer and screen tubes, and the requirement to slice the slag from the side walls near the grate. Nevertheless, having all the information within the central control room allowed all production personnel to know the state of the power plant and the future integration of the boiler operator within the shift team will give a much more flexible operation and maximum utilization of labour.

Conclusion

(1) Thermal performance of the evaporator station was better than design.

(2) Thermal performance of the heaters was as design.

(3) Following the installation of a thick juice buffer system, the flow across the evaporators could be maintained, ensuring minimum colour formation and enhanced density control.

(4) The evaporator circulation pumps required mechanical seals to prevent loss of product.

(5) Despite the poor performance of the new boiler plant the central control system continued to work well and the factory performance is enhanced by the central control room concept.

(6) The final energy figure for the 1989/90 campaign was 593 GJ/100 tonnes of white sugar, compared with 786 GJ/100 tonnes in 1987/88 prior to the installation of the new equipment. The lowest weekly figure for the campaign was just over 500 GJ/100 tonnes and with the new power plant fully operational it should be possible to achieve even lower fuel usage figures.

Application of a NIR on-line automatic analyser system in a beet sugar factory

By Gianluigi Marchetti
(Consultant, Massa Finalese, Mo., Italy)

Introduction

Accurate analytical management of the intermediate products in the different production stages is a necessity for the optimization of sugar manufacture. This analytical management is carried out, in most cases, in the factory laboratory which is undoubtedly the focal point for gathering and distributing chemical and technological information. The laboratory, then, has the task of controlling production, technological processing, losses and other things.

Accordingly its function is very important and because of the increasing working capacities of the factory, it is becoming more and more difficult to keep under control the large quantity of material which moves about in the plant.

Control based on casual samples taken at intervals gives rather limited indications and is not suitable for immediately revealing the fast changes which are taking place in the process, because the time which elapses between taking the necessary representative samples and having the analytical data available is lengthy. The resulting values may no longer correspond to the real situation existing in the plant.

Whilst today sugar manufacture process is generally automated and characterized by the use of continuous processes, discontinuous methods continue to be used predominantly in the analytical techniques and instruments as previously. A manufacturing process plant functions to process sugar beet or sugar cane, or more generally, transform materials into products of the desired specification while meeting physical, economic, safety and environmental constraints. Information concerning inventories, sales, target, controls, and plant performance is constantly circulated and used to set and hold targets, regulate the plant, manage, maintain and improve the operation. Today many of these activities can and are being implemented by plant automation systems designed by control engineers to assist plant management operations and staff. Recently we have seen the introduction,

G. Marchetti

in sugar manufacture[1], of "Expert Systems" that will allow some degree of interaction with the manufacturing process.

(a) *Condition monitoring:* The Expert System checks the continuity of the process and indicates by an alarm when there is a conflict in the sensory inputs.

(b) *Process control:* The Expert Systems can utilize the present heuristic rules-of-thumb used by the plant operator to provide an automated control system. The Expert System also makes it easier to implement supervisory and alarm schemes which will assist in the smooth operation of the factory.

(c) *Help desk:* The Expert System, designed to train and advise operators, can reduce the number of mistakes made by inexperienced operators and assists experienced operators to achieve a higher standard and to reduce work load. The three functions are shown in Figure 1.

As we can see, to get maximum performance by the Expert System it is necessary to have all data in real time. This is simple for typical easy data acquisition sensory inputs such as temperature, pressure, conductivity, pH, Brix and colour, but some data inputs, however, are less readily available, e.g. pol, lime salts concentration, etc.

Full use of developments in processing technology and in automation is however possible only if determinations are made continuously and with short delay. This is possible only with analytical chains, separate from the laboratory, or with on-line analysers. Such consideration has inspired the development of continuous methods of measurement for determining Brix, pol and thence the purity ratio.

Near Infra-red Reflectance (NIR) techniques have been in use for some years in grain and food analysis[2,3]. Since Sverzut *et al.* first reported use of a near

1 Watson: *Proc. Australian Soc. Sugar Cane Tech.*, 1989, 258 - 262.

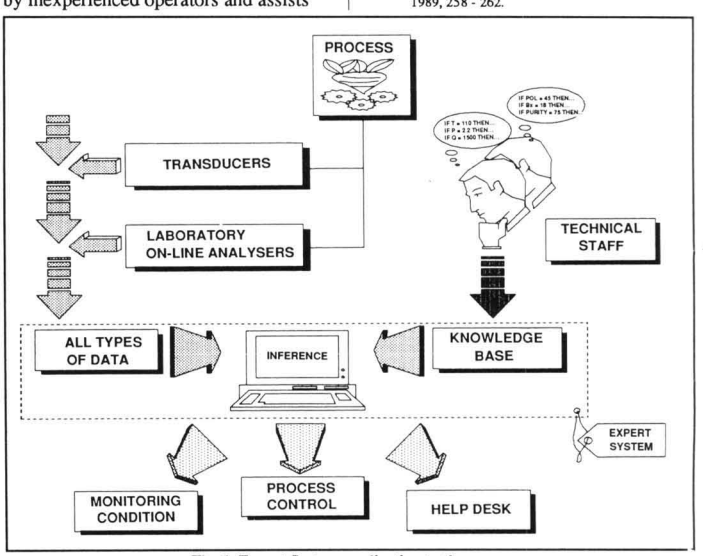


Fig. 1. Expert System application to the process

infra-red sugar meter[4], near infra-red spectroscopy has become of considerable use for sugar cane and sugar beet[5,6].

Many studies[7-19] on NIR for use in beet sugar factories, in sugar refineries and in cane sugar factories, have shown considerable promise. A current problem in the sugar industry, whether beet or cane, is the need to decrease usage of lead salts. Chou[8] and Marchetti[20] have found that the High Angular Resolution Polarimeter (HARP) is suitable for process control and offers time saving as it can work without the addition of lead acetate or any other clarifying agent and only requires sample dilution.

Clarke & Legendre[21] believe that the most probable answers to the lead salts problem are the application of NIR analysis and the development of polarimeters which can work without clarifying agents.

NIR on-line system

The NIR technique was first studied for the analysis of moisture in cereals in the 1960's[3]; the first commercial instrument (Dickey-John GAC) was sold in 1971. Since then developments have been remarkable and nowadays, thanks to the present powerful microprocessors, NIR instruments have a certain reliability and ease of use.

During recent years the sugar industry has also examined the possible application of this new analytical technique. In Italy the first tests were carried out by Vaccari *et al.*[7] with encouraging results. The systems using the NIR technique include spectrophotometers exploiting the principle governing the absorption and reflection of light in the near infra-red spectral region, 780-2500 nm (Figure 2). In this spectral region are found the absorptions of many chemical bonds (C-H, C=C, N-H, C=O, S-H, O-H, etc.) and it is consequently possible to analyse many substances. The sample to be analysed is irradiated by a beam of monochromatic light (Figure 2) obtained by the passage of polychromatic light through an appropriate interference filters specific for the functional group to be determined. Part of the

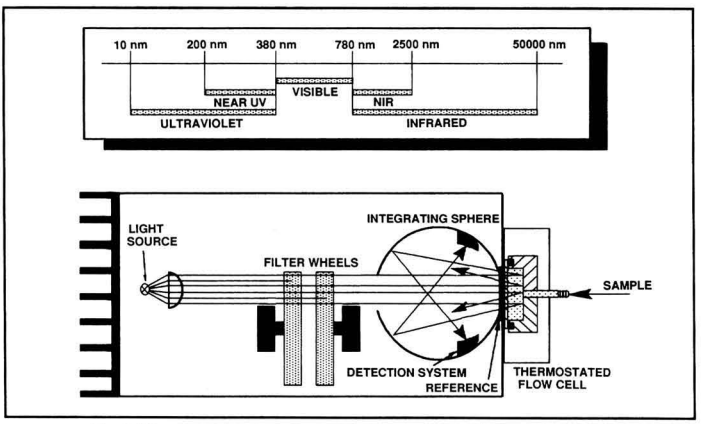


Fig. 2. Wavelength bands and the optical system of the "Inframatic 8620"

energy, proportional to the quantity of the functional group present, will be absorbed; the remaining part is reflected and gathered by an integrating sphere which transforms it into an electric signal through suitable lead sulphide detectors. The quantity of a given substance will be proportional to the quantity of absorbed light at a particular wavelength. The reflection of the standard is obtained through the reading of an internal reference for each filter.

The value is calculated for each filter of L, where

$$L = \log \left(\frac{\text{Reflection of the standard}}{\text{Reflection of the sample}} \right)$$

Each of these values is used in the following formula:

$$\% = C_{\Phi} + (C1 \times L1 + C2 \times L2 + \ldots \ldots + Cn \times Ln) \times \text{Slope}$$

where:

% = Concentration of the sample under examination

C_{Φ} = "Bias" factor, specific for each parameter under examination

C1 ... Cn = Constants of filters at specified wavelengths

L1 ... Ln = Values of log (Reflection) at different wavelengths

Slope = Slope calculated by the regression straight line.

NIR is then an indirect method of analysis, since it uses standard methods as reference (refractometric Brix, traditional polarimetry, Karl Fischer moisture, etc.). NIR is also an empirical technique; instrument readings are arbitrary and require calibration with a set of samples designed to "instruct" the instrument how to relate spectral data to concentrations of the required sample constituents. For perfect calibration of the instrument, samples must be analysed several times (at least three) with great

2 *Proc. NIR84 Int. Symposium on Near Infra-Red Reflectance Spectroscopy* (Royal Australian Chem. Inst., Cereal Chem. Divn., Melbourne), October 15 -16, 1984.
3 Osborne & Fearn: "Near infrared spectroscopy in food analysis" (Longman Scientific & Technical, Harlow, England), 1986.
4 *Amer. Soc. Agric. Eng. Meeting, Paper*, April 1986, (SWA 86-002).
5 Meyer *et al.: Proc. S. African Sugar Tech. Assoc.*, 1986, 205 - 211.
6 Mantovani: *Proc. 19th Session ICUMSA*, 1986, 213 - 231.
7 Vaccari *et al.: Paper presented to 34th Gen. Meeting Amer. Soc. Sugar Beet Tech.*, March 1987.
8 Chou: *Proc. 46th Meeting Sugar Ind. Tech.*, 1987, 1 - 26.
9 Burzawa & Melle: *Ind. Alim. Agric.*, 1988, **105**, 629 - 634.
10 Meyer & Wood: *Proc. S. African Sugar Tech. Assoc.*, 1988, 203 - 207.
11 Vaccari & Mantovani: *Paper presented to Sugar Proc. Res. Conf.*, 1988.
12 Stevens: *ibid.*
13 Vaccari *et al.: Paper presented to 25th Gen. Meeting Amer. Soc. Sugar Beet Tech.*, February 1989.
14 Berding *et al.: Proc. Australian Soc. Sugar Cane Tech.*, 1989, 8 - 15.
15 Baird & Beatts: *ibid.*, 237 - 245.
16 Ames *et al.: ibid.*, 246 - 252.
17 Burzawa *et al.: Ind. Alim. Agric.*, 1989, **106**, 587 - 591.
18 Marchetti: *Ind. Sacc. Ital.*, 1989, **82**, 221 - 234.
19 Meyer: *ISSCT Tech. Newsletter* (SASA Experiment Station, South Africa), 1989, (1).
20 *Zuckerindustrie*, in press.
21 *Proc. 48th Meeting Sugar Ind. Tech.*, 1989, 219 - 239.

accuracy. In this way, curves may be built up from a minimum of 30 samples.

During the 1988 and 1989 campaigns we have had the opportunity, at the COREBS sugar factory in Policoro, to use an Inframatic 8620 instrument put at our disposal by PerCon Italia S.r.l. of Grottaferrata (Roma). The Inframatic 8620 uses a spectral field from 1400 to 2400 nm. The instrument makes use of 20 interference filters and has an in-built computer which allows it a certain autonomy, with the possibility in the basic version of storing 64 parameters (calibration curves), extendable to more than 1000. For better convenience in data management the instrument was interfaced to an IBM PC.

During the 1988 campaign we intended to test the possible "on-line" application of the NIR analyser[18]. Two lines were brought into the laboratory from the factory; one consisting of raw juice and the other of thin juice. Samples were fed to the NIR instrument through two manual valves.

The first results were so encouraging that during the 1989 campaign the experimental set-up was transferred into the factory. NIR was applied for analysis of 14 samples; from the press water to the thick juice to storage. The scheme of application is reported in Figure 3.

Figure 4 shows the two pneumatic valve groups, line 1 and line 2, which collect alternately the samples transported by stainless steel pipes; only the last few metres of piping near the pneumatic valve groups are of copper.

Three filters, two located in the raw juices sample lines and one in the press water line, ensure that clean samples are sent to the NIR analyser.

To counter the high viscosity of some products, e.g. thick juice, the thermostatic temperature of the reading cell is increased to 40°C, so as to bring the viscosity sufficiently low to let the product circulate. A convenient pre-thermostatic circuit allows perfect control of the reading cell temperature. The supervision system and the NIR instrument are set up in an air-conditioned room at the beet house, near the

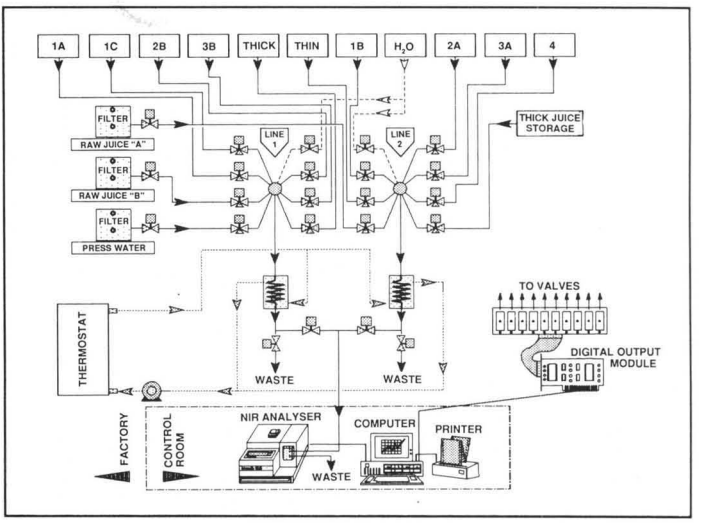


Fig. 3. NIR on-line automatic system at COREBS beet sugar factory, Policoro (Italy), 1989

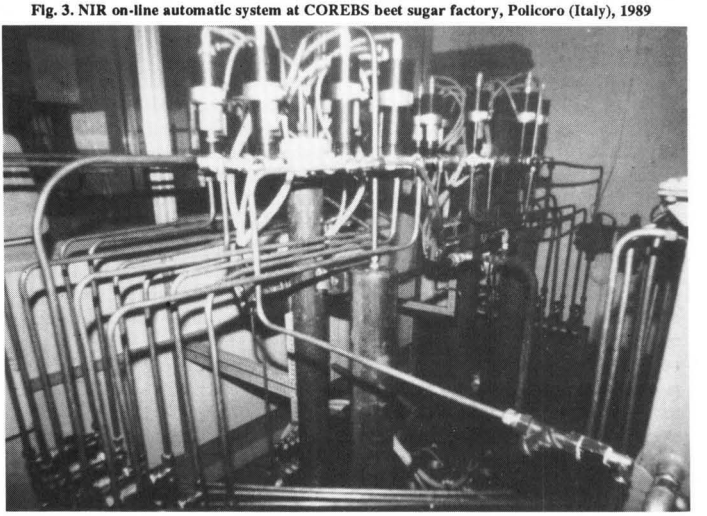


Fig. 4. Pneumatic valve groups, line 1 and line 2

valve groups.

The system of sampling and supervision is managed by computer. In Figure 5 may be seen the synoptic panel which constantly displays the status of all valves, the differential pressure in the filters and the correct operation of the thermostatic circuit. The control console also allows switching of all the valves from automatic to manual function. Finally, the computer controls, using a predetermined sequence generated by an especially compiled BASIC program written for this control, the opening and closing of the pneumatic valves. The printer prints out the analytical data.

In Figure 6 may be seen the NIR analyser and the connection pipes from

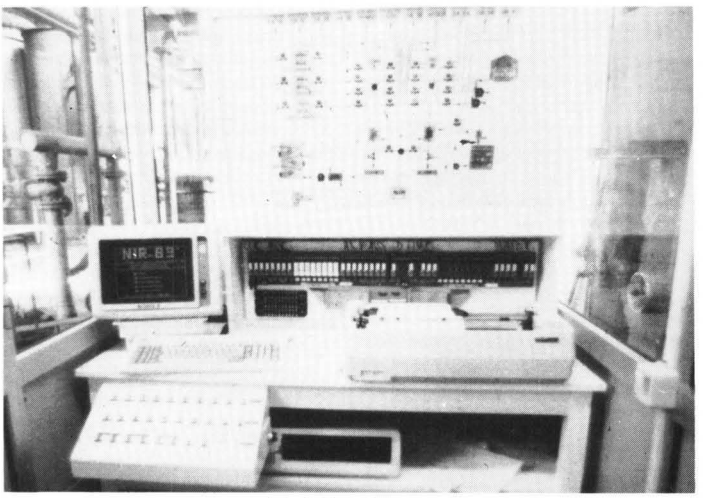


Fig. 5. Control room

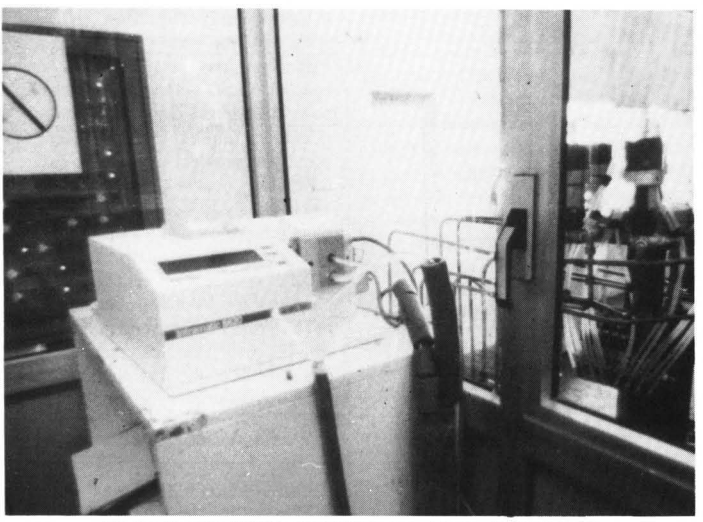


Fig. 6. Inframatic 8620 (PerCon) NIR analyser interfaced with IBM PC

the valve groups to the thermostated cell.

Results

It should be noted that the calibration curves and the sample controls were made during the last weeks of the sugar campaign. This was because the plant construction was started when the campaign was running and we were therefore obliged to set up the pipelines, the electrical plant and, finally the management system.

Some difficulties were found during the 1989 campaign in the filtration of raw juices and press water. The operative conditions, completely different from the previous experience[18], required the complete recalibration of the curves.

Once the systems is in position and the various tasks are well organized, the work of calibration or recalibrating curves is very simple and requires little effort. This easiness allows the systematic checking, several times a day, of the bias that needs small periodical adjustments.

Table I shows the first results. Calibration curves for the 1st, 2nd and 3rd intermediate juices were prepared for a better management of the NIR analyser.

Very interesting results were obtained concerning the determinations of calcium salts, as previously anticipated[18], and of colour. These determinations are made only in the thin juice and in the thick juice for the same reason as given above.

Thin juice calcium salts concentration could be used for deliming management as it provides the direct input data into the plant. The same determination in the evaporator bodies allows determination of whatever deposition occurs in the tubes. Such deposition of calcium salts in the evaporator bodies, as is well known, can allow excessive temperatures and so increases in juice colour and sucrose degradation.

The results obtained in 1989 were more than satisfactory, above all as far the control of the process samples is concerned. We are sure that, in the next campaign, it will be possible to improve some calibration curves, e.g. that of juice.

Conclusions

The use of on-line analysers will permit better analytical rhythm, elimination of error due to tiredness, etc., and better reliability of data. Hence, the analytical staff can be employed for non-routine analysis aimed at improved working and production.

We have seen that the technique can give many indications rapidly, in about 1 minute, and data results from only one sample reading. This allows several reading to be made from the

Table I. Statistical data of the samples analysed by the Inframatic 8620

Sample	*Parameter*		*Range*	*Standard deviation*	*Correlation coefficient*
Press water	Pol	%	0.3 - 2.4	0.146	0.980
Raw juice	Brix	%	10 - 15	0.134	0.996
	Pol	%	9 - 13	0.123	0.992
Thin juice	Brix	%	9 - 14	0.118	0.995
	Pol	%	8 - 13	0.143	0.990
	CaO % Brix	mg	250 - 550	22	0.994
1st Intermediate juice	Brix	%	13 - 40	0.145	0.992
	Pol	%	12 - 36	0.137	0.991
2nd Intermediate juice	Brix	%	38 - 66	0.135	0.997
	Pol	%	34 - 59	0.128	0.996
3rd Intermediate juice	Brix	%	64 - 73	0.223	0.990
	Pol	%	57 - 66	0.274	0.988
Thick juice to storage	Colour	UI	4000 - 6000	76	0.980
Evaporating unit:					
Three 1st bodies - Parallel feed Two 2nd bodies - Series feed			1st Intermediate juice		
Two 3rd bodies - Series feed			2nd Intermediate juice		
One 4th body One 5th body			3rd Intermediate juice		

same sample so giving averaged data that are more accurate and precise.

The determination of Brix and pol is a basis on which this technique is beginning to be applied as noted in ICUMSA[6].

Application of the instrument will not be limited to Brix and pol determination, but also in the determination of other substances so as to provide additional important and necessary information on colour, calcium salts, total nitrogen and so on.

If few of these data, outside of the Brix and pol, are essential they are nevertheless of great utility in process control, e.g. lime salts concentration for the deliming plant management.

Often traditional analytical data are obtained with an untimely rhythm, owing to time-consuming analytical methods or for other reasons; in some cases they may even not be measured. We believe that it is better to have analytical data, especially if they are near to the true value, than for the data to be non-existent.

Undoubtedly the NIR technique is and will be an interesting analytical technique which could give good results and so much instant information that industry, which although often bonded to old practices, will develop a greater interest in it.

A possible new application, which we hope to verify during the next sugar campaign, is the determination of pectin in the raw juice. To know the exact quantity of pectin in the raw juice means to know if diffusion is being well conducted.

Nowadays some companies use the NIR system for process control and analytical purposes[12,15-17]. The opportune correction of the calibration equation bias[16] can be made, every so often, by the laboratory.

Rightly, because of the empirical nature of this technique, some caution is needed in the use of NIR in the factory. However, with a suitable management, this technique can give rapid indication, both for management staff and at the process computer, of different parameters in the manufacturing process so to allow timely corrective action.

In the next campaign we will exchange the computer control system for the pneumatic valves by a PLC. In this way the computer will provide only a supervisory action in the management of the valves, it will receive a data load from the NIR analyser and will send all data to a few terminals located in the factory. A new management program will permit selection, for every single parameter, of the analytical rhythm (samples/hour). With the system already in position we will be able to start collection of data from the first days of the next campaign.

Acknowledgements

I would most sincerely like to thank PerCon Italia, the Management of I.S.I. at Finale Emilia and Ing. W. Bragalini, Aquakem, for their very kind cooperation. I would also like to thank the management of COREBS and Ing. Vito Di Noia in particular, for their encouragement and support to the project.

Summary

Formerly, it was often the practice to investigate by sampling and analysis in the laboratory. The results are inaccurate, however, because the time needed for analysis means that the value obtained is historical, and the current value is never determined. Continuous "on-line" monitoring, on the other hand, overcomes this problem and helps to ensure the uniform quality of the product. With an NIR analyser located in the process plant it is possible with a suitable computerized system, to analyse many samples with only a short delay. Not only Brix and pol may be determined but also many other useful indices. It then becomes possible to use the analytical staff for non-routine analysis aimed at improving working and production.

Aplicación de un sistema automático de análisis NIR (IRC, infrarrojo cercano) "en línea" en una fábrica de azúcar de remolacha

Antes, era una práctica corriente investigar a través del uso de muestreo y análisis en el laboratorio. Los resultados eran inexactos, sin embargo, debido al tiempo necesario para el análisis. Esto significa que el valor obtenido es histórico, y el valor real nunca es determinado. El análisis continuo "en

línea", por otro lado, resuelve este prob-lema y ayuda a asegurar la uniformidad en la calidad del producto. Con un analizador de NIR ubicado en la planta de procesamiento es posible, con un sistema computerizado apropiado, analizar muchas muestras con sólo una pequeña demora. Se puede determinar no sólo Brix y pol sino que también muchos otros índices útiles. De aquí nace la posibilidad de usar al personal analítico para el análisis no de rutina para mejorar el trabajo y la producción.

Application d'un système en ligne automatique NIR dans une sucrerie de betteraves

Dans le passé la qualité des produits fabriqués était souvent contrôlée en prélevant des échantillons qui étaient ensuite analysés au laboratoire. Ces résultats étaient cependant incorrects parce qu'il y avait un délai nécessité pour l'analyse. De ce fait les valeurs obtenues appartenaient à l'histoire et la valeur réelle ne fut jamais connue. En procédant à un échantillonage "on-line", ce problème est toutefois résolu et on peut ainsi s'assurer d'une qualité uniforme du produit. En installant un analyseur NIR dans l'usine même et à l'aide d'un système adéquat opérant avec ordinateur, il devient possible d'analyser beaucoup d'échantillons endéans un court délai. On peut non seulement déterminer le brix et la polarisation mais également un grand nombre d'autres paramètres utiles. Le staff analytique peut alors être utilisé à des analyses hors-routine destinées à améliorer le travail et la production.

Anwendung eines automatischen On-line-NIR-Analysersystems in einer Rübenzuckerfabrik

Früher war es oft üblich, Untersuchungen durch Probenahme und Analyse im Labor durchzuführen. Die Ergebnisse waren jedoch unsicher, weil die zur Analyse erforderliche Zeit zu einem Wert nur historischer Bedeutung führte, d.h. der aktuelle Wert wurde nimmer bestimmt. Dagegen wird dieses Problem mittels kontinuierlicher On-line-Überwachung gelöst, die auch eine einheitliche Produktqualität fördert. In Verbindung mit einem geeigneten Computersystem ermöglicht ein in der Verarbeitungsanlage errichteter NIR-Analyser manche Proben zu analysieren, mit nur kurzer Verzögerung. Man kann nicht nur den TS-Gehalt und den Zuckergehalt bestimmen sondern auch manche andere nützliche Indizen. Daraus kann der analytische Personal für Nichtroutine-Analysen eingesetzt werden, mit dem Ziel verbesserter Arbeit und Produktion.

Facts and figures

Cuba to build a sugar factory in Mexico[1]

Cuba is to build a sophisticated sugar factory in Mexico with a processing capacity of 4500 tcd according to the government news agency Notimex. The factory, to be located in the state of Quintana Roo on the Yucatan peninsula, will cost about $50 million and will be paid for by exports of tropical timber to Cuba. Cuban technologists were to arrive in Mexico to start work on the factory in August.

"About sugar – a user's guide"

This is the title of a brochure newly published by The Sugar Association Inc., the US office for publicity for the sugar industry. It was produced to respond to consumer inquiries about how and why sugar is used in food preparation and also explains sugar's role in food technology with accompanying expert-tested recipes that illustrate sugar's uses in home and commercially-prepared foods. A small section is devoted to nonfood uses of sugar, in pharmaceutucals, etc. Copies of the 32-page brochure may be obtained from The Sugar Association Inc., 1101 15th Street N.W., Suite 600, Washington, DC 20005, U.S.A.

Philippines sugar factory auctions

The Philippines government is planning to sell by auction in October 1990 a sugar company which was acquired by the Asset Privatisation Trust (APT) after the overthrow of the late President Marcos. This is the Calinog-Lambanao Sugar Mill Inc. which operated a 4000 t.c.d. factory on Panay island and is expected to fetch more than 1000 million pesos (£22 million). Another factory, Central Azucarera de Pilar, was auctioned in August and APT holds five other factories (AIDSISA in Negros Occidental, Carebi on Luzon, Central Santos-Lopez on Panay, Hilongos Development Corporation on Leyte, and Northern Cotabato Sugar Industries on Mindanao). APT, which was set up to sell off government-owned assets to the private sector, as well as those owned or controlled by Mr. Marcos, his wife and certain of their supporters, also holds shares in Bicolandia Sugar Development Corporation which operates a sugar factory on Luzon.

Mauritius sugar industry development loan

The African Development Bank is reported by the Press Trust of India to have provided a loan worth several million US dollars to Mauritius. Part of the loan, which will be released in stages between 1991 and 1993, will be used for the development of the island's sugar industry.

Hungary crop forecast reduction[2]

Drought has badly affected sugar beet production in Hungary this year and crop forecasts have been reduced from 40 tonnes/hectare to only 35 tonnes.

1 *Reuters News*, June 29, 1990.
2 *MTI (Hungary) news agency report*, August 8, 1990.

Alcohol imports by Brazil from the EEC[3]

The European Community has sold to Brazil 1,500,000 hectolitres of wine alcohol from surplus stocks and it is reported that sales could total 6,000,000 hl. Brazil has pledged not to re-export any alcohol it buys from the EEC nor to increase its sugar exports as a result of the alcohol imports, nor to export its own alcohol.

Pakistan beet sugar production, 1990

Sugar beets were grown only in the North West Frontier Province and occupied 10,450 hectares. The crop of 342,186 tonnes represented a yield of 32.74 tonnes per hectare and yielded 26,992 tonnes of white sugar (29,339 tonnes raw value), some 1.45% of the national total. With higher input and labour costs, growers complain that the $7^1/_2$% increase in the beet price is not sufficient to make it worthwhile growing beets. The result is a dwindling crop of very poor quality. To make matters worse, cloudy weather during March and April followed by abnormally hot weather in May and June resulted in an all-time low sugar content of only 7.88% against 9.36% in 1989.

Canada sugar imports, 1989[4]

	1989	1988
	tonnes, raw value	
Australia	505,000	450,280
Barbados	3,000	0
Belize	14,000	19,673
Cuba	169,000	103,873
EEC	6,367	9,118
Finland	0	543
Korea, South	2,501	1,165
Malawi	0	8,425
Mauritius	16,000	64,249
Swaziland	149,000	114,334
USA	94,244	159,120
Zimbabwe	15,000	20,018
Unknown	0	6,379
	977,553	957,177

West Indies sugar output fall[5]

It is clear that the downward trend in sugar production in the Caribbean in the Caricom sugar industry (apart from Belize) which started in the late 1970's is continuing. The total quantity in the five countries (Barbados, Guyana, Jamaica, St. Kitts and Trinidad) is estimated at 568,000 tons. Indications are that the Barbados production might be a thousand tons or so higher than the 65,000 tons expected but Barbados will be unable to meet fully its quotas in Europe and the United States. The sugar industry and the Barbados government are in negotiations for all sugar produced to be guaranteed a minimum price, as the industry claims that its costs exceed the price received when the preferential prices in the EEC and US are taken into account. Meanwhile more arable land is going out of cane production.

Zambia sugar exports[6]

In 1988 Zambia's sugar exports of 4904 tonnes, raw value, were less than imports of 7586 tonnes, a situation in considerable contrast to the previous two years when imports were not required and exports were more than 40,000 tonnes. A small recovery occurred in 1989 when no imports were needed but exports reached only 1911 tonnes.

Philippines sugar factory modernization

Binalbagan-Isabela Sugar Co. Inc. is to spend 269 million pesos (£6 million) to modernize its raw sugar factory at Binalbagan in Negros Occidental. The project, to be carried out during 1991, will involve rehabilitation of the mill equipment and up-grading the technology employed.

Association of Official Analytical Chemists

This association, better known by its acronym AOAC, held its 104th Annual Meeting in New Orleans, Louisiana, during September 10 -13, 1990 and included presentation of papers and posters on a wide range of topics. This year, however, it was preceded by a Workshop on analysis of sugar in foods and feeds, chaired by Dr. Margaret A. Clarke, which occupied the week-end of September 8 -9. This included presentations grouped as "Overview of techniques", "Sugars in molasses", "Sugars in chocolate and confectionery", "Sugars in bakery products, bread and cereals", "Environmental control", "Beverages" and "Fruit and fruit juice products".

Although primarily a North American organization, AOAC founded a Regional Section in 1989 to cover all of Europe and the Mediterranean countries. An informal link had been established in 1983 with meetings in Amsterdam, Reading, Antwerp, Florence and Paris during subsequent years. The formal section began its activities with a meeting in Almere, Holland with more than 70 persons present from 17 countries. Interested Europeans should get in touch with the Sectional Secretary-Treasurer, Ellen Jan De Vries, Dupar B.V., Postbus 2, 1380 AA Weesp, Holland, while others should write to the Association's US office at 2200 Wilson Boulevard, Suite 400-CY, Arlington, VA 22201-3301.

PERSONAL NOTES

We regret to report the death of **Dr. David Gross,** formerly of the Tate & Lyle Research Laboratories at Ravensbourne and later in Reading. He was 82 and had retired in 1974 after a career in which he had contributed greatly to the development of chromatographic and other techniques used in sugars analysis, research on raffinose and on the chemical changes occurring during processing. He was a leading member of the team which separated and identified kestose and he achieved the separation of amino- and other acids from sugars by the use of high voltage paper electrophoresis. From 1954 to 1966 he was the General Secreatary of ICUMSA as well as participating in its scientific work.

3 *Reuters News*, June 11, 1990.
4 *I.S.O. Stat. Bull.*, 1990, **49**, (7), 7.
5 *S. African Sugar J.*, 1990, **74**, 168.
6 F. O. Licht, *Int. Sugar Rpt.*, 1990, **122**, S.358.

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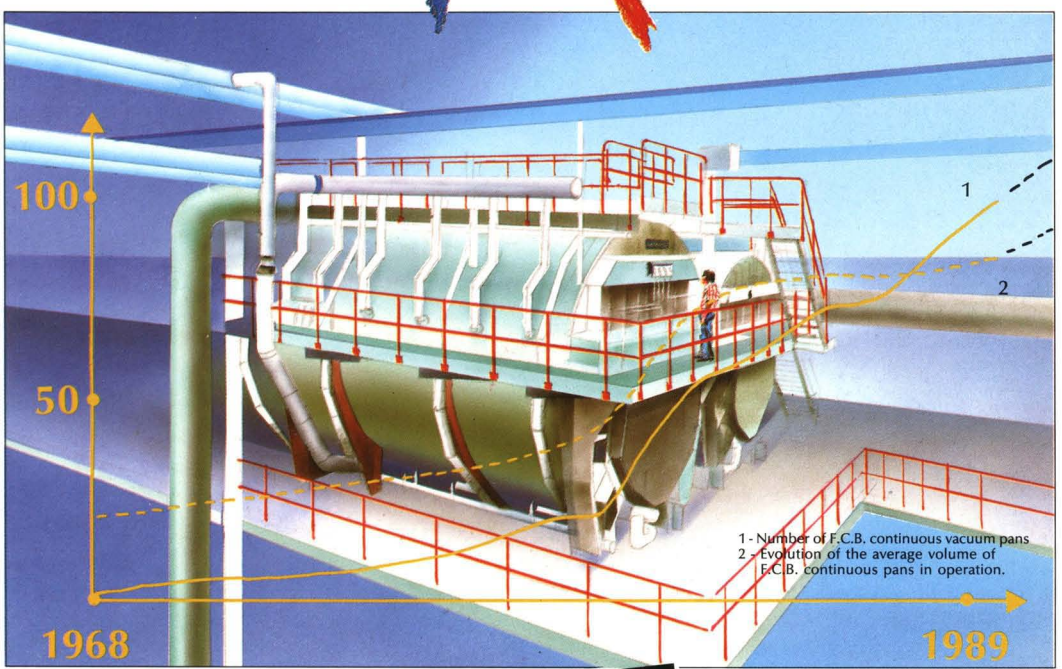

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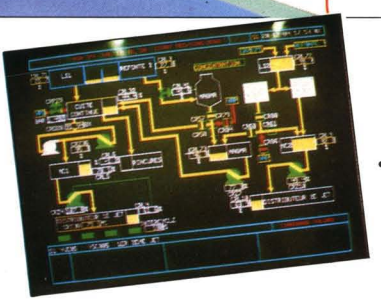

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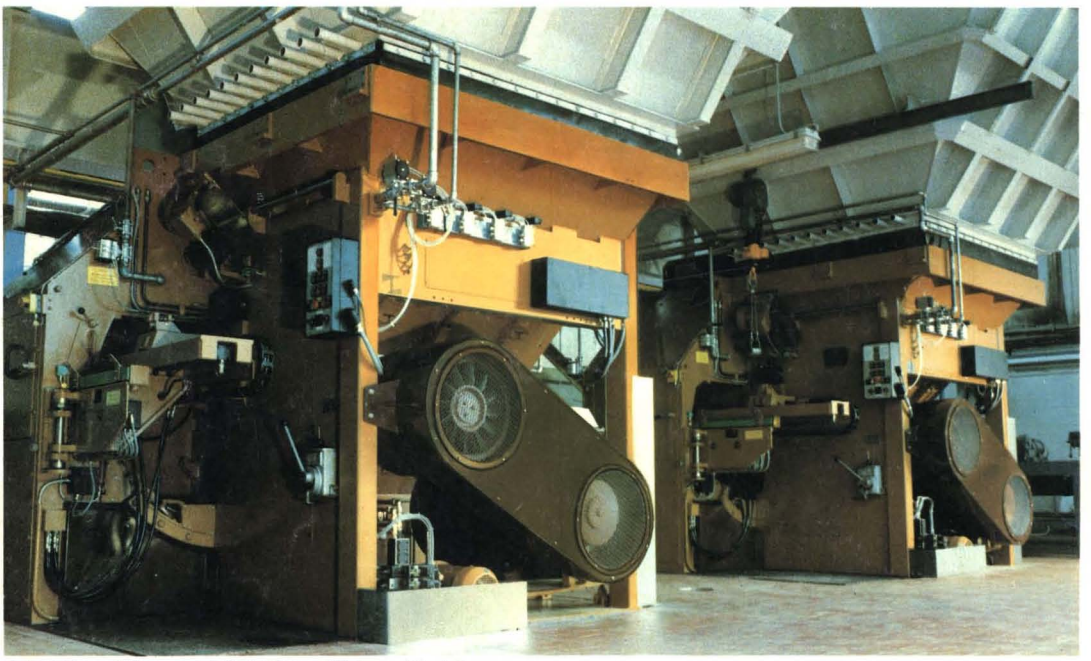

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